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A Structural Equation Model Examining the Effects of Gulf War Stress Exposure on Subsequent Mental and Physical Health Problems among Gulf War Veterans

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A Structural Equation Model Examining the Effects of Gulf War Stress Exposure on Subsequent Mental and Physical Health Problems among Gulf War Veterans.

A Dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy
at Virginia Commonwealth University

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LIST OF ABBREVRIATIONS

Acetylcholine	ACh
Acetylcholinesterase	AchE
Adjusted Goodness-of-Fit Index	AGFI
American Academy of Family Physicians	AAFP
American Medical Association	AMA
American Standard Code for Information Interchange	ASCII
Analysis of Moment Structures	AMOS
Anthrax Vaccine Adsorbed	AVA
Autonomic Nervous System	ANS
Beck Depression Inventory Scores	BDI
Biological and Toxin Weapons Convention	BTWC
Biological Weapons	BW
Botulinum Toxin	BT
British United Provident Association	BUPA
Cable News Network	CNN
Central Nervous System	CNS
Chemical Weapons	CW
Comprehensive Clinical Evaluation Program	CCEP
Deoxyribonucleic Acid	DNA

LIST OF ABBREVRIATIONS CONTINUED

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LIST OF ABBREVRIATIONS CONTINUED

ABSTRACT

A STRUCTURAL EQUATION MODEL EXAMINING THE EFFECTS OF GULF WAR STRESS EXPOSURE ON SUBSEQUENT MENTAL AND PHYSICAL HEALTH PROBLEMS AMONG GULF WAR VETERANS

By Frank J. Kenny

A Dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University

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The goal of this dissertation is to better understand the complex relationship between the stresses encountered by U.S. service personnel during the Gulf War and eventual physical and psychological health outcomes among its veterans. By developing and validating a stress model using structural equation modeling techniques, it is hoped that knowledge regarding wartime stress and its potential impact on the health of veterans will be gained. This knowledge can be used to guide future policy decisions on how to minimize the deleterious health consequences associated with deployment and combat, as well as furnishing a basis for future studies that examine the link between stress and health outcomes.

A structural equation model is developed to test a number of hypotheses concerning the relationship between stress and eventual psychological health and physical health outcomes among Gulf War veterans. A core model is first created to test whether or not physical health is a function of psychological health without stress in the equation. This model then expands to test whether or not physical health is a function of psychological health in light of differences in stressful exposures/experiences encountered by Gulf War veterans. The model finally further expands to test whether or not physical health is a function of psychological health and stressful wartime experiences/exposures adjusting for differences in veterans' age, gender, race, and marital status.

The models theoretical foundation centers on the "Stimulus-based Model of Stress," developed by Drs. Thomas Holmes and Richard Rahe in the late 1960's. Holmes and Rahe viewed stressful life events as additive in nature and that the more stress an individual experienced in a period of time, the more likely they were to suffer from a variety of physical and psychological illnesses. They developed a stress scale to measure the stressful life experience so as to predict heath outcomes. This study likewise quantified stressful wartime exposures/experiences by creating a stress scale that could measure the stress level of individual veterans. This stress scale was then used to create stress scores of veterans based upon their wartime experiences/exposures. These stress scores were then incorporated into the above structural equation model to determine the effect of wartime stress on veterans' physical and psychological health outcomes.

The dissertation has drawn upon prior research regarding stress and health outcomes in the creation of its stress model. Goodness-of-Fit tests were preformed to determine whether the pattern of variances and covariances in the data is consistent with the structural (path) model specified. The model was respecified to obtain a better fit by adding correlated error terms based upon the modification indices and theoretical considerations.

CHAPTER 1: INTRODUCTION

Introduction

Nearly 700,000 American military personnel were deployed to the Persian Gulf between August 1990 and April 1991 in support of Operations Desert Shield and Desert Storm (see Appendix I). These troops, together with those from a coalition of other nations (see Appendix II), were sent to enforce United Nations (U.N.) resolutions (see Appendix III) calling for an immediate withdrawal of the Iraqi army, which had just invaded Kuwait. The ensuing mobilization of men and equipment to the Persian Gulf was the largest mass military deployment since the Vietnam War (Leyden, 1997) and one that proceeded at a pace unprecedented in military history (Ursano, Norwood, 1996, Marshall, G.N., 1999). After months of negotiations failed to bring about a peaceful resolution to the conflict, in January 1991 United States (U.S.) and coalition forces launched a devastating air campaign against Iraqi military targets in Kuwait and southern Iraq in what would soon become known as the Gulf War (see Appendix IV for timeline). For five weeks the U.S. and its Coalition partners staged an unrelenting air bombardment over the Iraqi positions. This gave way to a quick and decisive ground assault that overwhelmed the overmatched Iraqi army, which in less than a week was routed. The war soon ended with Iraqi forces withdrawing from Kuwait and renouncing any claim they had to that nation.

Statement of the Problem

Upon their return home, approximately 80,000 of the nearly 700,000 American men and women who were stationed in southwest Asia during the Gulf War (some 11.4 % of all veterans who fought in that war) reported a variety of unexplained illnesses that they attributed to their participation in the war (Fulco, 2000). That number of ill veterans is staggering, especially in light of the fact that the war was hailed as an extraordinary successful military operation with very few battle-related casualties (see Appendix V). Veterans of the Gulf War nonetheless reported a wide array of health problems consisting of symptoms including persistent fatigue, cognitive difficulties, memory loss, diffuse muscle and joint pain, gastrointestinal symptoms, skin lesions, and respiratory problems (Spencer, 1998). Since no immediate explanation was presented for such health problems among the large number of veterans, the media soon labeled all unidentified illnesses associated with the Gulf War as "Gulf War Syndrome" (Sartin, 2000).

Department of Defense (DoD) and Veterans Administration (VA) officials, well aware of the health problems that some Vietnam era veterans had suffered upon their return home, immediately provided counseling services ranging from family therapy to treatment of post-traumatic stress disorder (PTSD) to any Gulf War veteran who requested those services. Officials also arranged for sick veterans to be given physical examinations and an array of medical tests to try to determine the nature of their illnesses. Despite these efforts, many men and women returning from the Gulf continued to suffer debilitating illnesses that often confounded medical experts (PACGWI, 1996).

Pressed by of veterans and their advocates, Congress and President Clinton in early 1993 authorized the Secretary of Veterans Affairs (VA) to coordinate research funded by the Executive Branch of the federal government into the health consequences of service in the Gulf War (FSRGWVI, 2001) (see Appendix VI, for Purpose of Research on Gulf War Veterans). The principal charge of this research was 1) to determine the nature and prevalence of symptoms, diseases, and other conditions among Gulf War veterans; 2) to identify the risk factors for those symptoms, diseases, and other conditions; and 3) to identify diagnostic tools, treatment methods, and possible prevention/intervention strategies (FSRGWVI, 2001). In response to this charge, the Veterans Administration and Department of Defense performed and contracted out research programs to study possible causes and treatments for the Gulf War veterans' health problems. Medical evaluation programs: the VA Gulf War Registry (see Appendix VIIA) and the Department of Defense's Comprehensive Clinical Evaluation Program (CCEP) (see Appendix VII B) were established to gather information on Gulf War veterans and their health problems.

Specific Aims of the Study

The primary goal of this epidemiological study is to examine the relationship between Gulf War Stress (GWS) and the mental and physical health outcomes of veterans of the Gulf War. Structural equation modeling techniques are used to test three models that describe that relationship. A core model (see Chapter 3 for model development) is first created based on theoretical considerations that describe the relationship between psychological and physical health among Gulf War veterans. This model centers on two latent (non-observable) variables, physical and psychological health, and includes 15 measures of health outcome data from the Comprehensive Clinical Evaluation Program survey (see Figure 1). A second model, based on the core model but taking into account the differences in stress that veterans had faced while serving in the Gulf War, is then created (see Figure 2). It incorporates data derived from a Gulf War Stress scale that is based upon survey data as well as on exposure data contained in the Comprehensive Clinical Evaluation Program survey. Finally, a third model, based upon the second model but taking into account differences in veterans' age, gender, race, and marital status is created (see Figure 3). This model is used to see whether those variables have any bearing upon physical and psychological health outcomes among Gulf War veterans.

For the three figures below, Psychological Health and Physical Health are both latent variables (non-observed) and thus are drawn as ellipses according to structural equation modeling guidelines. The terms e1-e15 represent the error terms for the 15 health outcome indicators. Since measurement errors are estimated and not measured directly, they are drawn as circles. The term f1 in all figures represents the error in the prediction of the endogenous latent variable Physical Health from the exogenous latent variable Psychological Health. As an error value, it is also drawn as a circle. The 15 health outcome indicators are derived from the Comprehensive Clinical Evaluation Program Survey. They are from observed (measured) variables and are therefore drawn

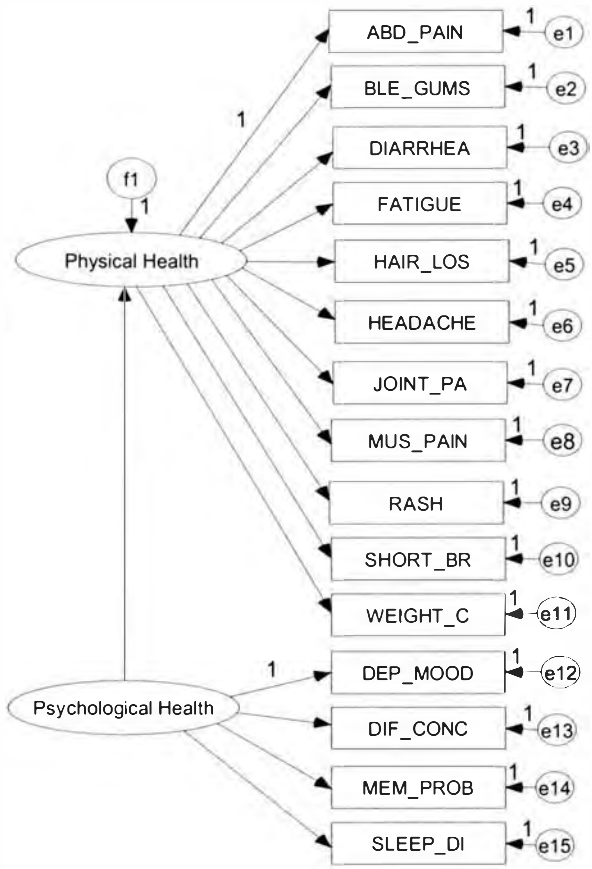

Figure 1: A proposed structural equation model showing how physical health outcomes are affected by psychological health outcomes in a cohort of Gulf War veterans.

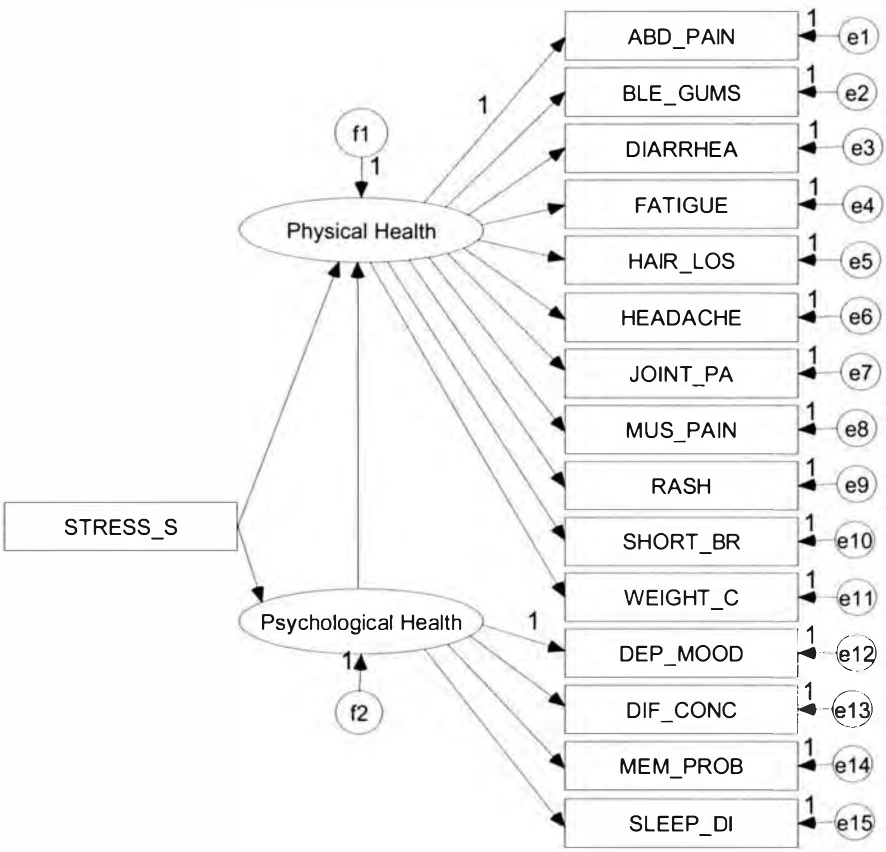

Figure 2: A proposed structural equation model based upon the core model in figure 1, showing how Gulf War Stress affects both physical and psychological health outcomes in a cohort of Gulf War veterans.

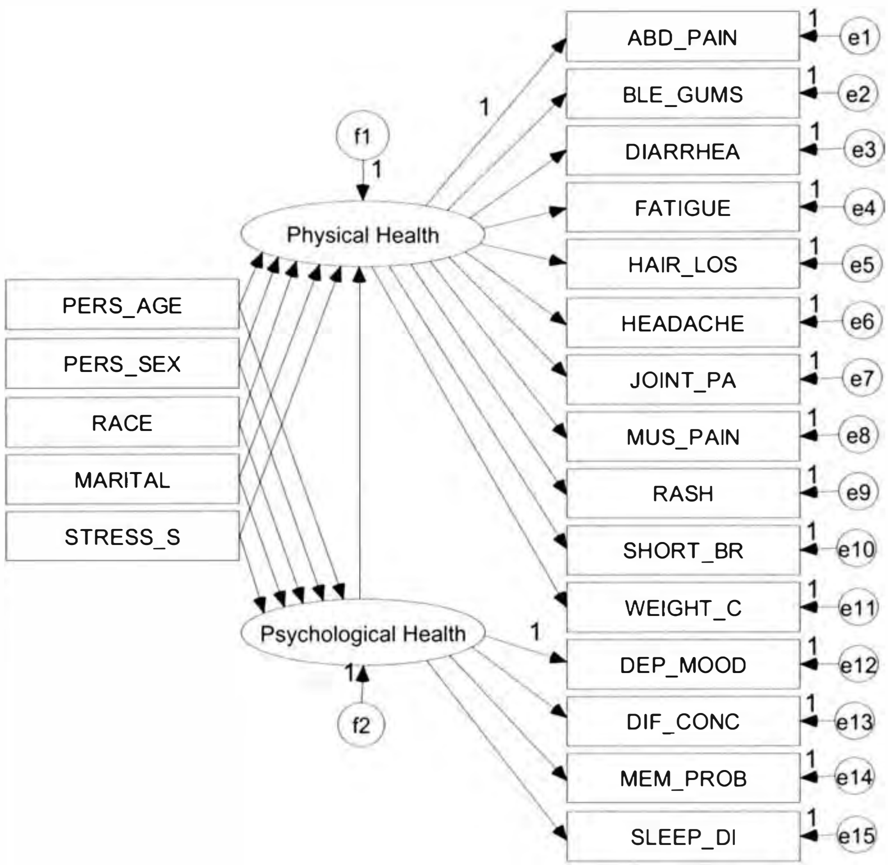

Figure 3: A proposed structural equation model based upon the model in figure 2, showing how the descriptive variables age, gender, race, and marital status affect physical and psychological health in a cohort of Gulf War veterans.

as rectangles. The coded health measures for the above three figures are translated in Table 1 below.

Table 1: Coded Health Measures

	Code	Text			Code	Text
1.	ABD_PAIN	Abdominal Pain		11.	WEIGHT_C	Weight Change
2.	BLE_GUMS	Bleeding Gums		12.	DEP_MOOD	Depressed Mood
3.	DIARRHEA	Diarrhea		13.	DIF_CONC	Difficulty Concentrating
4.	FATIGUE	Fatigue		14.	MEM_PROB	Memory Problems
5.	HAIR_LOS	Hair Loss		15.	SLEEP_DI	Sleep Disturbances
6.	HEADACHE	Headache		16.	PERS_AGE	Veteran Age
7.	JOINT_PA	Joint Pain		17.	PERS_SEX	Veteran Gender
8.	MUS_PAIN	Muscle Pain		18.	RACE	Veteran Race
9.	RASH	Rash		19.	MARITAL	Veteran Marital Status
10.	SHORT_BR	Shortness of Breath		20.	STRESS_S	Veteran Stress Score

The Gulf War Stress score is derived from a weighted stress scale developed through a survey of veterans and health professionals as well as through exposure data from Comprehensive Clinical Evaluation Program survey. Since a measured stress score is developed for each veteran, the variable is drawn as a rectangle. Data for the four additional descriptive variables (age, gender, race, and marital status) are taken from the Comprehensive Clinical Evaluation Survey. Since these variables are observed (measured) variables, they are drawn as rectangles. In figures 2 and 3, the latent variable Psychological Health is transformed from an exogenous (independent) variable to an endogenous (dependent) variable due to the influence of the descriptive indicators. As an endogenous variable, Psychological Health must now have an error term associated with it. The error term f2 is thus added to the model. As an error value, f2 like f1 is drawn as a circle.

The three hypotheses of this study, which are tested by structural equation modeling techniques using the primary data from the Gulf War veteran stress survey and the secondary data from the Comprehensive Clinical Evaluation Program survey are as follows:

Hypothesis 1: H_0 = physical health = f (psychological health).

H_A= physical health ≠ f (psychological health).

Hypothesis 2: H_0 = physical health = f (psychological health, Gulf War Stress).

H_A= physical health ≠ f (psychological health, Gulf War Stress).

Hypothesis 3: H_0 = physical health = f (psychological health, Gulf War Stress, age, gender, race, and marital status).

H_A= physical health ≠ f (psychological health, Gulf War Stress, age, gender, race, and marital status).

The hypothesized models are tested statistically in simultaneous analysis of the entire system of variables to determine the extent to which they are consistent with the data. If the goodness-of-fit tests are adequate, the model argues for the plausibility of the postulated relations among variables; if inadequate, the tenability of such relations should be rejected. Respecification of the model, based on theoretical lines, such as adding correlations among errors to improve model fit is performed if necessary.

Significance

This study has significance in that it uses both primary and secondary data in setting up structural equation models that analyze the impact of Gulf War service on those personnel who have reported unexplained health problems. The models tested examine the relationship that psychological health has on physical health among Gulf War veterans; the effect of wartime stress on that relationship; and how the variables age, gender, race, and marital status may affect that relationship. The importance of this study lies in the fact that it can clarify our understanding of how wartime stress affects the health outcomes of our veterans. This increased understanding of the role of wartime stress will hopefully lead to preventative measures that will reduce the number of veterans who come down with mysterious health problems after serving their country.

This study is also significant in that it employs structural equation modeling techniques in its analysis of the health outcomes of Gulf War veterans. Very few federally funded studies on Gulf War veterans' illnesses have used structural equation modeling techniques in their analysis and none of them have used the large Comprehensive Clinical Evaluation Program data (FSRGWVI, 2000). The use of structural equation modeling, a very powerful analytical tool that describes relationships between variables, allows the researcher to show causal relationships among both measurable and non-measurable variables. This capacity is important when looking at topics such as stress, psychological health, and physical health.

This research, by developing structural equation models that correlate varying levels of stress with subsequent health outcomes, will aid Veterans Administration and Department of Defense efforts to promote veterans' health by: 1) facilitating symptom recognition and diagnosis in areas of growing concern (physical and mental stress during war); 2) presenting an examination of the complex relationships that exist among health symptoms, hazardous environmental exposure, and war-zone stressor experiences; 3) comparing the prevalence of certain symptoms, medical conditions, and unexplained illnesses among differing groups of veterans of the Gulf War.

This study finally has significance in light of the current deployment of U.S. soldiers around the world who are waging the war on terrorism. The troops now fighting to protect our lives face similar circumstances to those encountered during the Gulf War, namely being in a highly stressful environment, far from home, and under the constant threat of attack. Since there is a strong possibility that many of these troops will return home with health problems similar to those faced by many of Gulf War veterans, it is important to apply any lessons learned from the Gulf War to help the troops in current military operations. The more knowledge that can be gained through continued research into the health problems of veterans of the Gulf War, the more likely it is that preventative action can be taken, and thus the less likely that similar problems will beset the veterans of current and future deployments.

Theoretical Framework

The theoretical framework for this study is the "Stimulus-based Model of Stress," which is based upon the work of the psychologists Thomas Holmes and Richard Rahe, who during the 1960s proposed it while studying the effects of life changes on an individual. Holmes and Rahe postulated that life changes act as stressors on individuals, and that too many life changes increase a person's vulnerability to illness (Rice, V.H., 2000). They developed tools such as the Social Readjustment Rating Scale (SRRS) (see Appendix VIII) and the Schedule of Recent Experiences (Holmes T.H.; Rahe, R;1967) to measure stress defined and operationalized as the adjustment required by selected major life changes or events. The Social Readjustment Rating Scale consists of 43 life events (e.g., marriage, loss of a loved one, pregnancy, vacation, divorce, retirement, and change in residence) that were assigned a priori weights derived from the mean ratings of the estimated amount of adjustment each life event would require (Holmes, T.H.; Rahe, R., 1967). In testing an individual using this scale, each of the 43 life events experienced within the last two years are be added up (using the a priori weights) to come up with a numerically assigned overall stress score value. Holmes and Rahe believed that the higher the stress score, the more likely that individual would become ill within the next year.

In their Stimulus-based Model of Stress, Holmes and Rahe viewed stress as an aggregate of the forces that together weigh upon a person. The greater these forces, the more likely a person will suffer from a variety of physical and/or psychological illnesses. Some stresses weigh heavily on a person, such as death in the family or the person's divorce. Other stresses such as a minor traffic violation or even going on vacation do not weigh as much, but still contribute to the overall stress an individual faces. In the Stimulus-based Model of Stress it is not only the number of stressful life events experienced in a year that predicts the health status of an individual, but rather the number of those stressful events in combination with the weight each event carries. This type of model has been very useful in understanding the effects of major events upon people involved in them. It is the intention of this study to apply the Stimulus-based

Model of Stress to those involved in the Gulf War and to attempt to understand how stressful events during the war may have affected their overall health.

Methodology

Source of Data

Data for this study come from the Department of Defense's Comprehensive Clinical Evaluation Program maintained by Electronic Data Systems (EDS), as well as a Gulf War Stress Survey sent out to Gulf War veterans and experts in the field of stress. The Comprehensive Clinical Evaluation Program is a voluntary program that has collected data on active duty Gulf War veterans since 1994, with oversight from the National Academy of Sciences and the Institute of Medicine. Data from the Comprehensive Clinical Evaluation Program include both exposure data and health outcome data. The Gulf War Stress Survey likewise is a voluntary survey sent out to Gulf War veterans and stress experts to gain their opinions on how stressful varying exposures were during the Gulf War. These data are compiled here to create a stress scale similar to the Holmes and Rahe Social Readjustment Rating Scale.
(Data collection, formatting, and cleansing as well as scale development are covered in greater detail in the Methodology section).

Structural Equation Modeling

This study employs Structural Equation Modeling (SEM) techniques to test how Gulf War stress exposure affected the mental and physical health of Gulf War veterans. Structural Equation Modeling techniques, which encompass path analysis, confirmatory factor analysis, multiple regression analysis, and causal modeling with latent variables, describe relationships between variables using a graphical modeling interface so as to allow a pictorial presentation of the complex path diagrams that are hypothesized (Kline R.B., 1998). Structural Equation Modeling techniques are usually viewed as confirmatory rather than exploratory procedures, meaning that the researchers' hypotheses are presented first and then evaluated during analysis. Goodness-of-Fit tests are used to determine whether the pattern of variances and covariances in the data is consistent with the structural (path) model specified. The main question to be answered in using this technique is whether or not the hypothesized models are supported by the data. If the data are consistent with the theoretical model, then the model is supported. If the data and the model are off by a small amount, an exploratory approach may be used to "tweak" the model for better fit. If, however, the data show that the theoretical model is implausible, it is recommended that the researcher abandon the model or modify the hypotheses upon which it is based (Kline, R.B., 1998).

When conducting Structural Equation Modeling analysis, it is important to follow a basic sequence of events, which are listed and briefly described below:

1. *Specify the model* – That is, put the researcher's hypothesis in graphical (or text if so desired) form, using the standard symbols (see Appendix IX) for creating a structural equation model. The defined variables are eventually linked to the data they represent, with the presumed relations between them being analyzed by the statistical software.

2. *Determine whether the model is identified* – A model is identified if it is theoretically possible for the computer to derive a unique estimate of every model parameter. The types of structural equation models must each meet certain requirements in order to be identified. If a model fails to meet the requirements for its identification, attempts to estimate it may not be successful (Kline, R.B., 1998).

3. *Select measures* – The variables represented in the model should have standardized numerical representation (e.g., Male = 1, Female = 0; age rounded off to the nearest year for all subjects, etc.).

4. *Analyze the model* – A model fitting program such as AMOS, EQS, or LISREL should be used to derive estimates of the model's parameters.

5. *Evaluate model fit* – Determine how adequately the hypothesized model accounts for the data, using goodness-of-fit measures.

6. *Respecify the model* – Revise of the model, guided by the theoretical underpinnings of the research and the results of the initial analysis if necessary.

The Amos Program

The statistical software used in this study to conduct the Structural Equation Modeling analysis is the AMOS (Analysis of Moment Structures) 4.0 program. This program, developed within the Microsoft Windows interface, allows the user to work within either a graphical interface or a more traditional programming interface. This study uses the AMOS graphical interface, for a pictorial presentation of the structural equation models being analyzed. AMOS 4.0 has the ability to handle large data sets such as the secondary data from the Comprehensive Clinical Evaluation Program being used in this study, and it can take data from a variety of sources, such as EXCEL or SPSS. It also allows the researcher to choose among a wide variety of analytic processes to test the models.

Statistical Analysis

Descriptive statistics are calculated for all variables in the study, using SPSS in order to provide simple quantitative descriptions of the data in a manageable form. The descriptive statistics include tests for mean, median, range, standard deviation, and frequency for all variables under consideration. They provide an overview of the sample population under consideration. If any flaws in the data may have occurred during the data collection and/or cleansing process, the descriptive statistics should point them out. This safeguard is useful when looking at large data sets like the Comprehensive Clinical Evaluation data, where there is a high likelihood of incorrect data being entered, due simply to the sheer volume.

The main focus of the statistical analysis, however, lies within the goodness-of-fit tests used in structural equation modeling. AMOS 4.0 is utilized to develop and test causal models of mental and physical health outcomes among Gulf War veterans. By specifying the particular types of analysis to be performed, AMOS 4.0 can take the data, plug them into the model under question, and perform desired statistical procedures. In Structural Equation Modeling, no single test determines whether or not a model fits the data; rather, multiple statistical procedures together provide information on how well the hypothesized model fits with the data. The goodness-of-fit tests performed in this study are the statistical procedures most commonly used in Structural Equation Modeling. They include tests for chi-square, chi-square/degrees of freedom, goodness-of-fit index, adjusted-goodness-of-fit index, root mean square error of approximation, and the test for Hoelter's critical N. Modification Indexes, which show areas of model misfit, are also used in this study, especially with regard to model respecification. (For more information on the goodness-of-fit tests and modification indexes, please see Appendix X.)

Organization of the Study

Chapter One provides a brief overview of the Gulf War, a description of the problems that some veterans are having because of their service in that war, and the theoretical framework of the study. It presents the study's specific aims, the hypotheses that are considered, and the models that are analyzed. It introduces background information on Structural Equation modeling and the AMOS program, the methodology employed, and the statistical procedures utilized.

Chapter Two reviews the relevant scientific literature on the stressful exposures and the subsequent mental and physical health problems associated with service in the Gulf War. It describes how the literature review was conducted, and presents areas of prior research on Gulf War illnesses, and the results thus far of that research. The chapter's focus is stress and how stressful exposures are associated with mental and physical health problems. It reviews the literature regarding the effects that wartime stress have on soldiers; in particular, it looks at how stressors during the Gulf War may have affected the troops who fought it. The findings of a number of studies on stress are listed in tables. Chapter Two, also reports what the scientific literature has to say about how age, gender, race, and social support may affect an individual's response to stressful experiences.

Chapter Three presents the methodology used in this dissertation. It details the development of the proposed structural equation models used to test the three hypotheses under consideration. Specifically, the derivation of outcome variables in the model is presented as well as how they and the remaining variables were developed, measured, and positioned. The chapter also shows how the data for this study were collected, cleaned, and made ready for analysis by the AMOS 4.0 program. It traces the development of the Gulf War Stress Survey that was sent out to veterans and other health experts and how the results of that survey were compiled to set up a Gulf War Stress Scale, similar to the Holmes and Rahe Social Readjustment Rating Scale. Finally, chapter three shows the process of respecification of the models, based on theoretical considerations, to obtain better fit with the data.

Chapter Four presents the results for all statistical analyses performed here: both the results of the Gulf War stress survey sent out to veterans and health professionals that were used to develop a stress scale, and the results of the factor and correlational analysis used to derive health outcome variables. This chapter also provides the descriptive statistics for all variables in the proposed structural equation model, and the results of the goodness-of-fit tests that are part of the statistical analysis described in the methodology chapter. Model respecification results for better fit are included, as well.

Chapter Five evaluates the findings from the results section and draws conclusions from the overall work. The chapter discusses in detail the meaning of the results and how they support or reject the proposed hypotheses. It will cover the theoretical, methodological, practical, and policy implications of the results; the limitations of the overall work; and offer suggestions for future study in this area.

Finally, the Appendices at the end of the dissertation provide background information and more in-depth coverage of certain topics discussed only briefly in the body of the text. Greater detail on many of the topics relevant to the dissertation is offered in the Appendices in order not to sidetrack the reader from the dissertation's main topics. Both the Gulf War stress survey sent out to veterans and health experts and the portions of the Comprehensive Clinical Evaluation Program survey used in this dissertation are included in the Appendices.

CHAPTER 2: LITERATURE REVIEW

Introduction

This chapter reviews the scientific literature pertinent to stressful exposures and the subsequent mental and physical health problems associated with service in the Gulf War. It begins by examining the major studies showing that Gulf War have higher rates of physical and mental health problems than do their military counterparts who did not serve in the Gulf. It then gives an overview of the major areas of research that have been conducted and are ongoing with regard to the health status of Gulf War veterans. The literature review next focuses on the overall link between stress and health outcomes found in the general scientific literature – specifically, how stress affects both psychological and physical health outcomes and why the relationship between psychological and physical health outcomes is a recursive (unidirectional flow), not a reciprocal one. The review then examines the effects of stress on health outcomes as shown in the military literature, including how stress relates to post-traumatic stress disorder (PTSD). The Gulf War literature is surveyed to see how the many stressful exposures that veterans encountered may have predisposed them to health problems upon their return home. Finally, the review delves into the existing literature on how stress affects differing groups of individuals such as older persons, females, minorities, and individuals who lack social support systems.

Conduct of the Literature Review

The literature reviewed for this dissertation came from a variety of sources, all of which are publicly available and unclassified. A variety of literature sources were used in order to avoid bias in the background information. Articles on Gulf War veteran's illnesses were found and researched through medical search engines such as medline, pubmed, and embase. The search terms used most often were Gulf War, stress, illness, and health outcomes. Articles were also found at the Veterans Administration internal library and through generic search engines such as www.yahoo.com and www.google.com. Other, published materials came from the Institute of Medicine, which is part of the National Academy of Sciences, and from the Rand Corporation, a nonprofit institution that helps improve policy and decision-making through research and analysis.

Specific study information came from the Research Working Group of the Gulf War Coordinating Board's Annual Report to Congress on Federally Sponsored Research on Gulf War Veterans illnesses (FSRGWVI, 2000) as well as from Rand reports. Information on stressful exposures that troops encountered came from a variety of online web pages: the Department of Veterans Affairs Gulf War web page at http://www.va.gov/gulfwar/, the Department of Defense page regarding Gulf War Illnesses at http://www.gulflink.osd.mil/, and the United Kingdom's Ministry of Defence Gulf Veterans' illness page at http://www.mod.uk/issues/gulfwar/index.html.

Health Problems in Gulf War Veterans

Although the majority of veterans of the Gulf War returned to an active and normal life after the war, many veterans found that they had unexplained mental and physical health problems that they attributed to the war. The Departments of Defense (DoD), Health and Human Services (HHS), and Veterans Affairs (VA) have sponsored numerous studies to investigate the health concerns of these veterans and the etiologic causes of their illnesses. The most compelling of these studies compare the health status of veterans who served in the Gulf War with those who did not. Table 2 reviews the major studies that directly compare the health status of Gulf War veterans and same era control groups who were not deployed. Those studies offer sufficient evidence that Gulf War veterans are indeed more likely to have mental and/or physical health problems than are those veterans who did not serve there.

Possible Causes of Health Problems among Gulf War Veterans

In 1995, the Presidential Advisory Committee on Gulf War Veterans' Illnesses, in consultation with the Department of Defense, Veterans Administration, and Veteran Services Organizations (VSOs) came up with a list of suspected risk factors for illnesses associated with the Gulf War. The Committee advised the President and Congress that federal funds should be provided for research in the following areas:

- Chemical warfare agents (See Appendix XI and Appendix XIX survey links 10, 11.)
- Biological warfare agents (See Appendix XII.)

Vaccines against chemical and biological weapons (See Appendix XIII and

Table 2: Major studies comparing the health status of Gulf War deployed vs. non-deployed veterans

Study:	Iowa Persian Gulf Study Group, 1997
Objectives:	Compared deployed and non-deployed veterans' self-report of symptoms and illness 5 yrs following the Gulf War.
Sample:	Stratified sample drawn from 4 study groups (Gulf War regular military, National Guard/Reserve, non-Gulf War regular military, and non-Gulf War National Guard/reserve). Sample stratified for age, race, sex, rank, and branch. N=3695, male=91%, White=91%, Age < 25=91%
Control:	Yes, N=1799.
Time of Assessment:	5 yrs post-Gulf War
Exposure Assessment:	Military Exposure Questionnaire; deployment as proxy
Methodology:	Between-group study comparing deployed versus non-deployed military personnel on post-Gulf War psychological symptoms. Not deployed to Gulf War as a control group. Stratified random sample with proportional allocations.
Relevant Findings:	Gulf War military personnel had significantly more PTSD, depression, chronic fatigue, cognitive dysfunction, bronchitis, asthma, fibromyalgia, alcohol abuse, sex discomfort than non-deployed Gulf War military personnel. National Guard/reserve reported more chronic fatigue and general health problems than regular military.

Study:	Iowa Persian Gulf Study Group, 1997
Objectives:	To compare prevalence of self-reported problems in deployed and non-deployed veterans
Sample:	Stratified random sample of 3695 active, reserve, and Guard troops: male=91%, white=91%, age <25=91%, response rate=76%, all from Iowa
Control:	Yes, N=1799, male=91%, female=9%.
Time of Assessment:	5 yrs post-Gulf War
Exposure Assessment:	Deployment; military exposure questionnaires
Methodology:	Epidemiologic study; self-reported
Relevant Findings:	Deployed had higher prevalence of selected mental and physical health symptoms and syndromes; reservists more chronic fatigue and alcohol abuse than regular military; most Gulf War exposures related to medical and psychiatric conditions.

Table 2 continued: Major studies comparing the health status of Gulf War deployed vs. non-deployed veterans

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Study: Sohler, 1992
Objectives: To assess the psychological sequelae of Gulf War service; examined gender, deployment, and pre-Gulf War exposure.
Sample: N=507; Reserve and Guard troops: female=21%, N=288 Gulf War deployed
N=199 not activated
Control: Yes
Time of Assessment: 7/91-9/91, 6 months post-Gulf War
Exposure Assessment: Deployed versus non-deployed; CES
Methodology: Between-group design comparing deployed and non-deployed veterans on health and self-reported psych./physical health symptoms.
Relevant Findings: Deployed reported higher IES than not deployed did.

Study: Stretch et al., 1996
Objectives: Examined the prevalence of PTSD symptoms in active and reserve deployed Gulf War veterans and active and reserve non-deployed Gulf War veterans following Gulf War
Sample: Active duty and reservists from Pennsylvania and Hawaii who were assigned to Army, Navy, Air Force & Marines. Subjects were either deployed (1524; active 715; reserve 766) or not deployed (2512; active 1576; reserve 948) to ODS. Gender not specified.
Control: Yes, N=2512.
Time of Assessment: Mail survey; 2 years post-Gulf War
Exposure *Assessment:* Deployed versus non-deployed; self-report of stressors.
Methodology: Between-group design examining prevalence rates of PTSD symptoms in active versus reservists, and deployed versus non-deployed to Gulf War.
Relevant Findings: Active duty=57 deployed subjects PTSD positive (8%) /21 of non-deployed PTSD positive (1.3%). Reservists=70 deployed PTSD positive (9.2%)/20 non-deployed PTSD positive (2.1%). Significant correlation between stressors and PTSD symptoms.

Table 2 continued: Major studies comparing the health status of Gulf War deployed vs. non-deployed veterans

Study:	Sutker et al., 1993
Objectives:	Examined the relationship between war stress and physical and psychological symptoms following Gulf War in activated deployed and non-deployed troops.
Sample:	Army National Guard and Army Reserve. Troops were distributed across air reserve, medical, and infantry support specialist, air ambulance, tactical fighters, maintenance, and quartermaster. N=215, male=82%, female=18%.
Control:	Yes, N=60.
Time of Assessment:	4-10 months post-ODS
Exposure Assessment:	ODS-SES (divided groups into high and low exposure).
Methodology:	Between-group design comparing deployed (high and low exposure) with non-deployed (no exposure) on variables of post-ODS psychological sequelae. Compared PTSD positive with PTSD negative on personal characteristics.
Relevant Findings:	High exposure group reported significantly higher MISS, PTSD Scale, BDI, anxiety and anger scores than did low and no exposure groups. High-exposed had group significantly more difficulties sleeping, concentrating, nervousness. Gender and race significant correlation with PTSD.

Study:	Stuart et al., 1998
Objectives:	To study assessed factors related to the long term psychological health of a sample of U.S. Army National Guard and Reserve Unit veterans who served during ODS.
Sample:	N=1,156 Army National Guard and 739 Army Reserve Subjects, male=90%, Average Age= 31 years.
Control:	Yes, N=279, No Deployment history.
Time of Assessment:	1 year post Gulf War
Exposure Assessment:	Hierarchical Regression used to conduct reported symptom levels of psychological distress
Methodology:	Interview assessing wartime stressors
Relevant Findings:	This subset of Gulf War reserve veterans had elevated levels of distress in comparison to the control group.

Table 2 continued: Major studies comparing the health status of Gulf War deployed vs. non-deployed veterans

Study:	Sutker et al., 1995
Objectives:	Examined and compared the prevalence of psychological symptoms among military participants in war-zone exposed and stateside duty. Examined gender and ethnicity between exposed and non-exposed.
Sample:	Gulf War war-zone exposed (n=653) and stateside duty troops (n=259). Included Army, Air Force, Marine, National Guard, and reserve units who underwent psychological debriefing post-Gulf War. N=912, female=13%, White=63%.
Control:	Yes, N=259, male=83%, female=17%.
Time of Assessment:	Within 12 months post-Gulf War
Exposure Assessment:	ODS-SES
Methodology:	Between-group study comparing war-zone exposed and stateside duty on psychological symptoms post-Gulf War. Examined gender and ethnicity.
Relevant Findings:	Significantly more depression, anxiety, and somatic complaints for deployed; Minority significantly more symptoms of depression; female significantly more somatic complaints. No main effect for gender and PTSD; interaction effect gender by ethnicity for PTSD. 10-12% deployed PTSD positive.

Study:	Unger et al., 1992, VA Report, Chap 8
Objectives:	Examined physical and psych. symptoms in deployed and non-deployed troops.
Sample:	N=85; Reserve and Guard veterans; no demographics provided.
Control:	Yes, N=51 of 85.
Time of Assessment:	Upon return to Rhode Island; time not specified
Exposure Assessment:	CES; deployment as proxy for stress exposure
Methodology:	Between-group design comparing deployed and non-deployed troops.
Relevant Findings:	Deployed troops had significantly higher physical and psychological symptoms except for depression (somatization not clear).

Appendix XIX survey links 15, 16.)

- Pyridostigmine bromide (See Appendix XIV and Appendix XIX survey link 13.)
- Various occupational exposures, such as petroleum products and paints (See Appendix XIX survey links 4, 5, 6, 7, 8.)
- Psychological and physical stress
- Insecticides and repellents (See Appendix XIX survey link14.)
- Depleted Uranium (See Appendix XIX survey link 9.)
- Smoke from Kuwait oil fires (See Appendix XIX survey link 2.)
- Endemic infectious diseases (See Appendix XIX survey link 17.)
(Source: PACGVI, 1995)

Since that time numerous studies of both large and small populations of veterans have been conducted that focused on these areas (see Appendix XV for a review of Federal research on Gulf War veterans Illnesses).

Although significant progress has been made in determining a cause and effect relationship between certain exposures and the subsequent development of health problems, no single exposure has yet been definitively linked to the many types of health problems experienced by veterans of the Gulf War upon their return home (IOM, 1999). Part of the problem in coming up with specific causes for to the wide variety of ill health effects is the lack of information available to researchers about troop exposures during and shortly after the Gulf War. The lack of credible exposure information has stymied investigators in their quest to answer fundamental health questions. One of the major lessons learned during the Gulf War with regard to preventing potential health problems in returning veterans is that more effort should be made to collect data before, during, and after future deployments. That lesson learned has been evident during the current U.S. deployments in Afghanistan and Iraq, where troops are much more closely monitored to try to prevent potential deployment-related health problems.

Despite the problems inherent in conducting Gulf War research, the Veterans Administration, the Department of Health and Human Services, and the Department of Defense remain steadfastly committed to improving the lot of ill veterans by continuing their research. As new information is discovered and new modeling techniques become available, new research will be funded. Solving the mysteries behind Gulf War illnesses remains a top priority, not only to help the veterans still suffering today, but also to safeguard future generations of veterans who may be asked in times of war to serve their country.

Focus on Stress

Although there are many potential areas to consider when looking at possible causes for the health problems veterans faced returning from the Gulf War, this dissertation focuses on the stress of deployment and the mental and physical health of returning veterans. Stress is considered here because there are data available to be mined on the subject (the Comprehensive Clinical Evaluation Program database) and also because there is an abundance of evidence from previous military conflicts that stress can adversely affect mental and physical health. Stress is likewise be considered because unlike other areas of Gulf War research, with the possible exception of exposure to oil well fires, no one risk factor has had as great an effect on as high a percentage of Gulf War veterans as has the stress of deployment and eventual combat.

Stress Definition

The literature provides several definitions of stress that are all fundamentally the same regardless of who is doing the defining. Webster's dictionary defines stress as "a physical, chemical or emotional factor that causes bodily or mental tension resulting from factors that tend to alter an existing equilibrium." (New Merriam-Webster Dictionary, 1989) The American Medical Association (AMA) defines stress as "any interference that disturbs a person's mental and physical well-being" (American Medical Association Family Medical Guide). In physics, stress is defined as the internal resistance, or counterforce, of a material to the distorting effects of an external force or load given by the equation Stress (σ) = F/A, where F = force and A = cross sectional area (Giancoli, 2000). Several psychologists define stress as "a real or perceived imbalance between environmental demands required for survival and an individual's capacity to adapt to these requirements" (Lazerus and Folkman, 1984; Chrousos and Gold, 1992; Lovallo, 1997; Pearlin, Lieberman, Menaghan and Mullen, 1981; Weiner, 1992). In all, stress is a term that covers a number of emotional and physical responses, ranging from anxiety, panic, unhappiness, fatigue, tension, and strain, to excitement, stimulation, and a feeling of challenge. It is a personal response to situations, so what may be stressful to one person may not be to another.

Stress and Its Relationship to Health

In the general scientific literature there is ample evidence of a connection between an individual experiencing stress and the development of subsequent health problems. Stress has been linked to the onset of diseases such as cardiovascular conditions (Benschop et al., 1998; Pashkow, 1999; Ornish, 1983), cancer (Cohen, 1998; Siegel, 1986) and colds (Cohen et al., 1998; Cohen 1991), as well as to the exacerbation of symptoms such as asthma (Wright, 1998), irritable bowel syndrome (Bennett, 1998; Dancey, 1998), ulcerative conditions (Whitehead, 1985), arthritis (Crofford, 1999), skin disorders (Lebowohl, 1998) and diabetes (Inui; 1998; Surwit, 1992). In addition, stress has been linked to symptomatic experiences such as headaches (Davis, 1998; Fanciullacci, 1998; Holm, 1997; Holroyd, 1991), musculoskeletal pain (Dyrehag et al., 1998; Stacy, 1992) gastrointestinal upset (Whitehead, 1995), hyperventilation (Ringsberg, 1999), insomnia (Vgontzas, 1998), and fatigue (Glaser, 1998).

Some of the characteristics that influence the stressfulness of an event include its intensity, chronicity, and complexity (Patterson, 1987), as well as its novelty, ambiguity, unpredictability, and uncontrollability (Averill, 1973; Mineka, 1975, Thompson, 1981). At the same time, whether or not individuals perceive a given set of circumstances as stressful depends upon their own life experiences as well as their personal, social, and biological resources and vulnerabilities (Marshall, 1999). Health care utilization research has repeatedly demonstrated that from 30% to 60% of all physician office visits are for illness experiences that are non-disease-based, with stress as the common contributor (Cummings, 1981; Sobel, 1995).

Stress Exposure and Psychological Health Outcomes

A large body of literature has examined the psychological morbidity associated with exposure to stressful life events. The aftermath of exposure to significant stressors ranges from moderate elevations of psychological complaints – including depression, anxiety, hostility, fatigue, appetite disturbance, headaches, back and neck aches, breathing difficulty, gastrointestinal complaints, and sleep problems – to severe forms of psychopathology meeting diagnostic criteria for psychiatric disorders (Adams, 1984; Gregg, 1995; Shore, 1989). Common psychiatric diagnoses reportedly stemming from war zone or other trauma exposure as well as other life events include PTSD, anxiety disorders, depression, and somatization (Bremmer, 1996; McFarlane, 1992; van der Kolk, 1996).

Most research suggests that psychiatric reactions to stressful life events (e.g., accidents and natural disasters) are short-lived, generally disappearing within 8-16 months (Fairly, 1986; Keane, 1990; Tranah, 1994). Numerous studies, however, attest that stress reactions can persist long after the stressful circumstances have subsided. Studies of persons exposed to traumatic life events, including combat veterans, prisoners of war, and holocaust survivors, indicate that symptoms of stress exposure can persist for decades (Beebe, 1975; Goldstein, 1987; Soloman, 1996).

A number of studies have examined the relationship between stress exposure during the Gulf War and subsequent psychological health problems. Table 3 is a summary of some of the major federally funded studies that examine the relationship between Gulf War stress and psychological health outcomes. For the most part these

Table 3: Major federally funded studies that examine the relationship between Gulf War stress and psychological health

Study:	Haley & Kurt, 1997
Objectives:	Examined the psychological and physical symptoms reported by veterans following the Gulf War.
Sample:	Members of the 24th Reserve Naval Mobile Construction Battalion. 58% retired from service; 42% still active. N=249.
Control:	No
Time of Assessment:	3 yrs/7 months post-Gulf War
Exposure Assessment:	Booklet measuring war-time exposure
Methodology:	Descriptive study examining the prevalence of health problems in Gulf War veterans. Factor analyzed reported symptoms.
Relevant Findings:	70% reported serious health problems attributed to war; six medical syndromes surfaced, explaining 70% of variance. Traumatic stress subscale was not elevated in any group of veterans with the reported medical syndromes.

Study:	Iowa Persian Gulf Study Group, 1997
Objectives:	To compare prevalence of self-reported problems in deployed and non-deployed veterans
Sample:	Stratified random sample of 3695 active, reserve, and Guard troops: male=91%, white=91%, age <25=91%, response rate=76%; all from Iowa.
Control:	Yes, N=1799, male=91%, female=9%.
Time of Assessment:	5 years, post-Gulf War
Exposure Assessment:	Deployment; Military Exposure Questionnaire
Methodology:	Epidemiologic study; self-reported
Relevant Findings:	Deployed had higher prevalence of selected mental and physical health symptoms and syndromes; Reservists had more chronic fatigue and alcohol abuse than did regular military; most Gulf War exposures related to medical and psychiatric conditions.

Table 3 continued: Major federally funded studies that examine the relationship between Gulf War stress and psychological health

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Study:	Perconte, 1993
Objectives:	To examine level of psychological distress among Gulf War veterans
Sample:	Convenience sample; N=581; Army, Navy, Marine Reservists: male=88%, white=91%, response rate=95%, 126 activated but not deployed; 26 deployed to Europe; 429 deployed to Gulf War
Control:	Yes
Time of Assessment:	11 months post-Gulf War
Exposure Assessment:	Military History Questionnaire units rank ordered by war-stress exposure
Methodology:	Comparison of deployed and non-deployed troops
Relevant Findings:	Distress higher among deployed. Among deployed, distress higher among females; No race effects; GSI and MISS; but not BDI, scores increased with war stress rank order (units with more combat stress).

Study:	Perconte et al., 1993
Objectives:	Examined war-related psychological distress among Gulf War veterans following Gulf War.
Sample:	Community sample of Army, Navy, and Marine Reservists. 126 activated but not deployed; 26 deployed to Europe; 439 deployed to Persian Gulf combat theater. N=581, male=88%, White=91%.
Control:	Yes, N=152.
Time of Assessment:	11 months post-Gulf War
Exposure Assessment:	Deployed versus not deployed
Methodology:	Between-group design comparing deployed Gulf War veterans with non-deployed Gulf War veterans on psychological symptoms following trauma exposure. Examined variables of gender, race, and prior combat exposure.
Relevant Findings:	Significant effect of deployment. Gender effect significant for MISS & BDI. Significant interaction effect for gender by deployment. Female significantly higher scores on MISS. No significant effect of prior combat.

Table 3 continued: Major federally funded studies that examine the relationship between Gulf War stress and psychological health

Study:	Sutker et al., 1993
Objectives:	Examined relationship between war stress and physical/psychological symptoms following Gulf War in activated deployed and non-deployed troops.
Sample:	Convenience sample; N=215; Army National Guard/reserve troops
Control:	Yes, N=60.
Time of Assessment:	4-10 months post-Gulf War
Exposure Assessment:	ODS-SES
Methodology:	Between-group design comparing deployed (high and low) with non-deployed on psych. and physical health measures
Relevant Findings:	Deployed with high exposure had higher depression, anxiety, and physical health complaints than did non-deployed. Deployed with low exposure reported symptom levels more comparable to those of non-deployed.

Study:	Sutker et al., 1995
Objectives:	Examined and compared the prevalence of psychological symptoms among military participants in war-zone exposed and stateside duty. Examined gender and ethnicity between exposed and non-exposed.
Sample:	Gulf war-zone exposed (n=653) and stateside duty troops (n=259). Included Army, Air Force, Marine, National Guard, and reserve units who underwent psychological debriefing post-Gulf War. N=912, female=13%, White=63%
Control:	Yes, N=259, male=83%, female=17%.
Time of Assessment:	Within 12 months post-Gulf War
Exposure Assessment:	ODS-SES
Methodology:	Between-group study comparing war-zone exposed and stateside duty on psychological symptoms post-Gulf War. Examined gender and ethnicity.
Relevant Findings:	Significantly more depression, anxiety, and somatic complaints for deployed; minority with significantly more symptoms of depression; females with significantly more somatic complaints. No main effect for gender and PTSD; interaction effect of gender by ethnicity for PTSD. 10-12% deployed PTSD positive.

Table 3 continued: Major federally funded studies that examine the relationship between Gulf War stress and psychological health

Study:	Sutker et al., 1994
Objectives:	Examined and compared psychological and physical symptoms post-Gulf War in Gulf War veterans who were deployed to graves registry with Gulf War veterans who remained stateside.
Sample:	Army Reservists assigned to 3 quartermaster companies that provided supplies and logistic support; 40 were deployed to graves registry. N=60, female=8%, Hispanic=98%.
Control:	Yes, N=20, male=95%.
Time of Assessment:	12 months post-Gulf War
Exposure Assessment:	Graves Registry Duty Scale; deployed versus non-deployed
Methodology:	Between-group design comparing Gulf War veterans deployed to graves registry with Gulf War veterans remaining stateside on post-Gulf War psychological sequelae.
Relevant Findings:	Exposure group reported more current and lifetime psychiatric disorders than non-exposure group did. Exposure group had more PTSD symptoms, higher BDI, STAS, STAI, & physical symptoms checklist scores. 53% of PTSD cases had concurrent psychological disorder.

Study:	Stuart et al., 1998
Objectives:	To study assessed factors related to the long-term psychological health of a sample of U.S. Army National Guard Reserve Unit veterans who served during ODS.
Sample:	N=1,156 Army National Guard and 739 Army Reserve subjects. male=90%, Ave. age = 31 years
Control:	Yes, N = 279, No deployment history
Time of Assessment:	1 year post-Gulf War
Exposure Assessment:	Hierarchical Regression used to conduct reported symptom levels of psychological distress.
Methodology:	Interview assessing wartime stressors
Relevant Findings:	This subset of Gulf War reserve veterans had elevated levels of distress in comparison to the control group.

Table 3 continued: Major federally funded studies that examine the relationship between Gulf War stress and psychological health

Study:	Unger et al., 1992
Objectives:	Examined and compared Gulf War veterans with National Guard veterans who remained in U.S., on post-Gulf War psychological symptoms.
Sample:	Gulf War veterans following return to Rhode Island from deployment to Persian Gulf and National Guard Servicemen (NGS) who remained in U.S., N=85.
Control:	Yes, N=51.
Time of Assessment:	Upon return to Rhode Island from Persian Gulf; time not specified
Exposure Assessment:	CES; deployment as proxy
Methodology:	Between-group design comparing deployed and non-deployed reserve personnel on post-Gulf War psychological sequelae
Relevant Findings:	Differences between NGS and Gulf War veterans on CES, MISS, SCL-90-R (7 of 9 scales). Of the Gulf War veterans, 50% under enemy fire saw someone killed; 75% felt in danger of being killed. Of Gulf War veterans, 50% had moderate-severe intrusive thoughts and avoidance and 35% had nightmares.

Study:	Unger et al., 1993
Objectives:	Examined physical and psychological symptoms in deployed and non-deployed troops.
Sample:	N=85; Reserve and Guard veterans; no demographics provided.
Control:	Yes, N=51.
Time of Assessment:	Upon return to Rhode Island; time not specified
Exposure Assessment:	CES; Deployment as proxy for stress exposure
Methodology:	Between-group design comparing deployed and non-deployed troops
Relevant Findings:	Deployed troops had significantly higher physical and psychological symptoms except for depression.

studies show a positive correlation between service in the Gulf and the onset of psychological disorders.

Stress Exposure and Physical Health Outcomes

There is an abundance of literature addressing the link between stress exposure and physical health outcomes. Stress has been shown to adversely affect the autonomic nervous system and neuroendocrine system, thereby causing problems with the immune, gastrointestinal, neuromuscular, and cardiovascular systems among others (de la Torre, 1994; McEwen, 1998). Stress has also been shown to activate short-term adaptive physiological changes as well as a whole range of somatic symptoms (e.g., rapid heart rate, increased perspiration, gastrointestinal motility) that may be experienced as symptomatic of ill health (Chrousos, 1992). Although there are short-term adaptive benefits to the body from these physiological responses, their chronic activation is believed to enhance vulnerability to cardiovascular, metabolic, immune-related, and other diseases (Chrousos, 1992; McEwen, 1998) as well as changes in the central nervous system and the structure of the brain itself (Sapolsky, 1996). Evidence in both animals and humans also suggests that exposure to stressful events may increase the permeability of the blood brain barrier, thus rendering the central nervous system susceptible to drugs that typically act only on peripheral mechanisms (Friedman, 1996). Table 4 summarizes some of the major federally funded studies that examine the relationship between stress in the Gulf and physical health outcomes. There appears to be sufficient evidence from these studies of is a positive correlation between Gulf War stress and some of the physical health problems experienced by returning veterans.

Table 4: Major federally funded studies that examine the relationship between Gulf War stress and physical health.

Study:	Haley & Kurt, 1997
Objectives:	Examined the psychological and physical symptoms reported by veterans following the Gulf War.
Sample:	Members of the 24th Reserve Naval Mobile Construction Battalion. 58% retired from service; 42% still active. N=249.
Control:	No
Time of Assessment:	3 yrs/7 months post-Gulf War
Exposure Assessment:	Booklet measuring war-time exposure
Methodology:	Descriptive study examining the prevalence of health problems in Gulf War veterans. Factor analyzed reported symptoms.
Relevant Findings:	70% reported serious health problems attributed to war; six medical syndromes surfaced, explaining 70% of variance. Traumatic stress subscale was not elevated in any group of veterans with the reported medical syndromes.

Study:	Iowa Persian Gulf Study Group, 1997
Objectives:	Compared deployed and non-deployed veterans' self-report of symptoms and illness 5 yrs following Gulf War.
Sample:	Stratified sample drawn from 4 study groups (Gulf War regular military, National Guard/Reserve, non-Gulf War regular military, and non-Gulf War National Guard/reserve). Sample stratified for age, race, sex, rank, and branch. N=3695, male=91%, White=91%, Age < 25=91%.
Control:	Yes, N=1799.
Time of Assessment:	5 yrs post-Gulf War
Exposure Assessment:	Military Exposure Questionnaire; deployment as proxy
Methodology:	Between-group study comparing deployed versus non-deployed military personnel on post-Gulf War psychological symptoms. Not deployed to Gulf War as a control group. Stratified random sample with proportional allocations.
Relevant Findings:	Gulf War military personnel had significantly more PTSD, depression, chronic fatigue, cognitive dysfunction, bronchitis, asthma, fibromyalgia, alcohol abuse, sex discomfort than did non-deployed Gulf War military personnel. National Guard/reserve reported more chronic fatigue and general health problems than regular military did.

Table 4 continued: Major federally funded studies that examine the relationship between Gulf War stress and physical health

Study:	Iowa Persian Gulf Study Group, 1997
Objectives:	To compare prevalence of self-reported problems in deployed and non-deployed veterans.
Sample:	Stratified random sample of 3695 active, reserve, and Guard troops: male=91%, white=91%, age <25=91%, response rate=76%, all from Iowa
Control:	Yes, N=1799, male=91%, female=9%.
Time of Assessment:	5 years post-Gulf War
Exposure Assessment:	Deployment; Military Exposure Questionnaire.
Methodology:	Epidemiologic study; self-reported.
Relevant Findings:	Deployed had higher prevalence of selected mental and physical health symptoms and syndromes; Reservists had more chronic fatigue and alcohol abuse than did regular military; most Gulf War exposures related to medical and psychiatric conditions.

Study:	Stretch et al., 1995
Objectives:	Examined self-assessed physical health of Gulf War veterans.
Sample:	Active duty and reservists from Pennsylvania and Hawaii; included all services: deployed=1524, non-deployed=2512.
Control:	Yes
Time of Assessment:	2/93-8/93
Exposure Assessment:	Deployment; self-report of stressors
Methodology:	Cross-sectional survey; self-report
Relevant Findings:	Deployed troops reported more physical health complaints even after adjustment for demographics.

Table 4 continued: Major federally funded studies that examine the relationship between Gulf War stress and physical health

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Study:	Sutker et al., 1993
Objectives:	Examined relationship between war stress and physical/psychological symptoms following Gulf War in activated deployed and non-deployed troops.
Sample:	Convenience sample; N=215; Army National Guard/reserve troops
Control:	Yes, N=60 of 215.
Time of Assessment:	4-10 months post-Gulf War
Exposure Assessment:	ODS-SES
Methodology:	Between-group design comparing deployed (high and low) w/non-deployed on psych. and physical health measures.
Relevant Findings:	Deployed with high exposure had higher depression, anxiety, and physical health complaints than did non-deployed; deployed with low exposure reported symptom levels more comparable to non-deployed.

Study:	Sutker et al., 1994
Objectives:	Examined psychological, physical, and psychiatric disorders in Army Reservists who served grave registry duty in Gulf War.
Sample:	N=24; Army Reservists assigned to Quartermaster unit: male=21, female=3.
Control:	No
Time of Assessment:	8 months post-Gulf War
Exposure Assessment:	ODS-SES
Methodology:	Descriptive study examining prevalence of self-reported health problems and diagnosed psychiatric disorders.
Relevant Findings:	Body handlers had elevated physical and psychological symptoms relative to civilian norms; 55% diagnosed w/current Axis I disorder.

Table 4 continued: Major federally funded studies that examine the relationship between Gulf War stress and physical health

Study:	Sutker et al., 1994
Objectives:	Examined and compared psychological and physical symptoms post-Gulf War in Gulf War veterans who were deployed to graves registry with Gulf War veterans who remained stateside.
Sample:	Army Reservists assigned to 3 quartermaster company that provided supplies and logistic support; 40 were deployed to graves registry. N=60, female=8%, Hispanic=98%.
Control:	Yes, N=20, male=95%.
Time of Assessment:	12 months post-ODS
Exposure Assessment:	Graves Registry Duty Scale; deployed versus non-deployed.
Methodology:	Between-group design comparing Gulf War veterans deployed to graves registry with Gulf War veterans remaining stateside on post-Gulf War psychological sequelae.
Relevant Findings:	Exposure group reported more current and lifetime psychiatric disorders than non-exposure group did. Exposure group had more PTSD symptoms, higher BDI, STAS, STAI, and physical symptoms checklist scores. 53% of PTSD cases had concurrent psychological disorders.

The Relationship between Psychological Health and Physical Health

Considerable evidence in the scientific literature suggests that an individual's physical health is partly dependent upon their psychological well-being. Numerous studies have shown that when an individual develops a psychological disorder, he or she they often develops physical health problems as a result of that disorder. Studies on common psychological disorders such as depression, for example, show that suffering individuals often develop muscle pains, digestive problems, and respiratory ailments as a result of their depression (Spilane, 2002). Other studies indicate that individuals who have had long-term depression are more likely to develop heart disease (Linden, 2003, Carney, 2001), cancer (Spiegel, 2003), osteoporosis (Vrkljan, 2003) and immune system problems (Scanlan, 2001), in comparison to persons who do not suffer from long-term depression. Anxiety, which is another common psychological disorder, has been known to cause dizziness, chest pain, abdominal discomfort, frequent urination, and shortness of breath (BUPA, 2003). Similarly eating and sleeping disorders, which often have a psychological basis, have been implicated in physical health problems. Anorexia and bulimia, for example, can lead to malnutrition, dehydration, electrolyte imbalances, edema, muscle atrophy, acid reflux, kidney failure, osteoporosis, dental problems, liver failure, infertility, stomach ulcers, and even death if not treated (Zerbe, 1996). Sleep disorders such as insomnia, obstructive sleep apnea, and parasomnias (disruptive sleep disorders, which include sleep walking, sleep eating, and sleep terror), have also been shown to cause physical health problems such as drowsiness, irritability, and hypertension (Schubert, 2002).

Although there is evidence in the scientific literature suggesting that physical health problems cause psychological health problems, the evidence for this relationship is not as convincing as that for the reverse relationship. Evidence from the scientific literature shows that most psychological disorders are a causal effect arising not from physical health problems, but rather from something else. Psychological conditions such as social phobia (Ramsay, 2001), schizophrenia (Maguire, 2002), panic attacks (Inada, 2003), depression (Wong, 2001), and attention deficit disorder (Doyle, 2002), for example, all have genetic components that play a large role. These conditions may have physical components as well; however, the scientific literature suggests that these are minor and are overshadowed by the genetic components. Many other common psychological health problems such as post-traumatic stress disorder, conduct disorder, and oppositional defiant disorder are thought to have been initiated by an upsetting external life experience, not a physical health problem (Quyen, 2001). Still other psychological disorders such as delusional disorder (Mullen, 2003) and obsessive-compulsive disorder (AAFP, 2002) have unknown etiologies. These disorders may have physical components, but as of yet the scientific community has not agreed upon their causes.

For the purposes of this dissertation, a recursive model postulates that psychological health problems cause physical health problems. This step is founded strictly upon theoretical grounds supported by the findings from the literature search. Although there is some evidence that a reciprocal relationship exists between psychological health and physical health, there is not enough to warrant a causal effect from physical health problems to psychological health problems.

War Zone Stress

The war zone is replete with hardships and dangers, including many that are only secondarily related to combat itself (Grinker, 1945; Hobfoll, 1991). Classic discussions of war-related stress have long recognized that exposure to combat can lead to mental and physical health problems (Carroll, 1985; Foy, 1987). In general, the literature describes a dose response relationship between combat exposure and increased risk of subsequent mental and physical health problems (Fairbank, 1990; O'Toole, 1996). Recent research on war zone stress has studied the possibility that war zone deployment may be associated with a wide range of potential stressors, some of high magnitude and others of low magnitude (King, 1995). High magnitude war zone stressors such as direct combat exposure and the witnessing of wartime atrocities have long been documented as potentially causing health problems (Litz, 1997). It is only recently, however that the same has potential been found for low magnitude stressors such as harsh living conditions, lack of privacy, long work hours, and difficult climatic conditions (Litz, King 1995). These low magnitude stressors often foster a sense of disheartenment, discomfort, or demoralization that, like high magnitude stressors, can lead to long-term adverse health effects (Litz, King 1997).

Stress in Past Military Conflicts

The association between war zone stress and subsequent health problems among soldiers is not a new phenomenon. War-related illnesses similar to those encountered by veterans of the Gulf War have been reported as far back as the Civil War, when records of such occurrences were first kept. During the Civil War, many soldiers on both sides complained of fatigue, shortness of breath, headaches, sleep disorders, memory problems, and difficulty in concentrating, which they blamed on the stress of battle (Hyams, 1996). Likewise, during World War I many soldiers were diagnosed with shell shock or trench neurosis, an acute illness attributed to combat stress. These soldiers became dazed or detached, exhibited an exaggerated or startled response to stimuli, and often had severe anxiety problems that caused them to break down in battle (Hyams, 1996). During World War II and the Korean War, also many soldiers reported health problems with concentration, sleeplessness, anxiety and physical and emotional exhaustion. Many described the onset of their symptoms as occurring even before they actually saw combat (Bramsen, 1999, Elder, 1995). As in other wars, some veterans of the Vietnam War experienced symptoms that included sleep problems, difficulty concentrating, and general anxiety. Many of these veterans attributed their health problems to the overall stress of deployment, preparation for combat, and actual combat (Kulka, 1990). In all, the stress of combat and the stress involved in preparing for combat have played a significant role throughout our military history in terms of the health outcomes of our veterans. Although the symptoms of these health problems are well documented, the causes and means of prevention are still not well understood.

Post-Traumatic Stress Disorder (PTSD)

Post Traumatic Stress Disorder (PTSD) is a stress disorder that deserves special attention due to the severity of its symptoms and the lasting effects it has. Although only recently (1980) added as a new diagnostic category to DSM (Diagnostic and Statistical Manual) by the American Psychiatric Association, PTSD is not a new disorder. There are written accounts of similar symptoms that go back to ancient times, describing soldiers having severe stress symptoms after experiencing traumatic battlefield events (Horowitz, 1999). Soldiers in many wars have often complained of health problems, lasting many years, that were the result of life-threatening experiences and witnessing and engaging in terrifying, gruesome acts of violence on the battlefield (Horowitz, 1999). The diagnosis of PTSD describes the adverse health responses that some experience after exposure to such life threatening or horrific events (APA, 1980). Some of the more prevalent symptoms associated with PTSD include 1) reexperiencing the event in varying sensory forms (flashbacks), 2) avoiding reminders associated with this trauma, and 3) chronic hyperarousal in the Autonomic Nervous System (ANS) (APA, 1994.). These symptoms are often accompanied by loss of function in jobs or social relationships. The effects of PTSD may last a lifetime if untreated. Even with treatment, trauma memories usually do not go away entirely. They become more manageable, however, as new therapies are given and coping skills are learned (Davidson, 1993).

Stress Exposures during the Gulf War

There is an abundance of literature citing potential sources of stress that U.S. troops may have encountered while serving in the Gulf. Much of it focuses on high magnitude stressors such as direct combat exposure, the witnessing of horrific carnage on the battlefield, or the fear of being wounded or killed. Such intense types of stress have often been associated in the literature with the symptoms of PTSD as defined by the

DSM manual of the American Psychological Association (event flashbacks, hyper arousal, etc.). Table 5 gives examples of how high magnitude stressors affected exposed troops. In most cases, troops exposed to traumatic stressful events were much more prone to psychological and physical health problems than were the troops spared such exposure.

To a lesser degree the literature on Gulf War stress examines low magnitude or day-to-day stressors that troops encountered while deployed. This literature looks at the relationship between such stress exposure and other mental and physical health problems not associated with the experience of a traumatic or life-threatening event. The research on low magnitude stress focuses on the factors of deployment that alter an individual's equilibrium, such as separation from loved ones (Litz, Orsillo et al., 1997), exposure to harsh living conditions (King et al, 1995), lack of privacy, long work hours, and limited opportunity for recreation. Other factors examined are mandatory vaccinations (Hotopf, 2000), the threat of biological or chemical attack (Fiedler, 2000), exposures to smoke from oil well fires (Smith, 2002), as well as many other low impact stressors that upset the balance of daily life. Like the troops exposed to traumatic events, the troops exposed to such low magnitude stressors were adversely affected in comparison to the troops who were not deployed to the Gulf.

The Stimulus-Based Model of Stress

The Stimulus-based Model of Stress views stressful life events such as loss of a job, marital difficulties, or the death of a close family member as additive phenomena that can be used to predict the health of an individual. The model's central proposition is

Table 5: High magnitude stressors

Study:	Baker et al., 1997
Objectives:	Examined relationship between combat exposure and subsequent symptoms of PTSD.
Sample:	N=188; 50% were help-seeking, and 50% were non-treatment-seeking veterans on active duty.
Control:	Yes, PTSD group (N=24.)
Time of Assessment:	Unspecified, but perhaps up to 3 years following Gulf War
Exposure Assessment:	Combat Exposure Scale; self-report
Methodology:	Correlational study and between-group comparison of veterans with and without PTSD
Relevant Findings:	Degree of combat exposure was positively associated with PTSD symptom severity scores.

Study:	Iowa Persian Gulf Study Group, 1997
Objectives:	Compared deployed and non-deployed veterans' self-reports of symptoms and illness 5 years following Gulf War
Sample:	Stratified sample drawn form 4 study groups (Gulf War regular military, National Guard/reserve, non-Gulf War regular military, and non-Gulf War National Guard/reserve). male=91%, White=91%, Age < 25=91%.
Control:	Yes; N=1799.
Time of Assessment:	5 years post-Gulf War
Exposure Assessment:	Military Exposure Questionnaire; deployments as proxy
Methodology:	Between-group study comparing deployed versus non-deployed military personnel on post-Gulf War psychological symptoms. Not deployed to Gulf War as a control group. Stratified random sample with proportional allocations.
Relevant Findings:	Gulf War military personnel had significantly more PTSD, depression, chronic fatigue, cognitive dysfunction, bronchitis, asthma, fibromyalgia, alcohol abuse, sex discomfort, than non-deployed Gulf War military personnel did.

Table 5 continued: High magnitude stressors

Study:	Sutker et al., 1993
Objectives:	Examined the relationship between war stress and physical and psychological symptoms following Gulf War, in activated deployed and non-deployed troops
Sample:	Army National Guard and Army Reserve. Troops were distributed across air reserve, medical, and infantry support specialist, air ambulance, tactical fighters, maintenance, and quartermaster. N=215, male=82%, female=18%.
Control:	Yes; N=60.
Time of Assessment:	ODS-SES (divided groups in high and low exposure)
Exposure Assessment:	4-10 months post-Gulf War
Methodology:	Between-group design comparing deployed with non-deployed on variables of post-ODS psychological sequelae.
Relevant Findings:	High exposure group reported significantly higher MISS, PTSD Scale, BDI, anxiety and anger scores, than did low and no exposure groups. High exposure group had significantly more difficulties sleeping, concentrating, nervousness. Gender and race significant correlations with PTSD.

Study:	Stretch et al., 1996
Objectives:	Examined the prevalence of PTSD symptoms in active and reserve deployed Gulf War veterans and active and reserve non-deployed Gulf War veterans following the Gulf War
Sample:	Active duty and reservists from Pennsylvania and Hawaii who were assigned to Army, Navy, Air Force, and Marines. Subjects were either deployed (1524) or not deployed (2512) to Gulf War.
Control:	Yes, 2512
Time of Assessment:	Mail Survey, 2 years post-Gulf War.
Exposure Assessment:	Deployed versus non-deployed. Self-report of stressors
Methodology:	Between-group design examining prevalence rates of PTSD symptoms in active versus reservists, and deployed versus non-deployed to Gulf War
Relevant Findings:	Significant correlation between stressors and PTSD symptoms

that too many stressful life events in a short time increase the probability that an individual will have disease or negative health consequences. The model is useful as a predictor of health for individuals who have numerous stressful life events. A researcher can pre-assign normative weights to stressful life events, using prior research, and then measure the likelihood of an individual suffering ill health by examining the individual's scores on researcher-selected tests. At each of predetermined score levels, a researcher can estimate the likelihood of a serious illness for that individual in the next few years.

The most noted advocates of the Stimulus-based Model of Stress are the psychologists Thomas Holmes and Richard Rahe, who in 1967 published the now famous Social Readjustment Rating Scale (SRRS) in the Journal of Psychosomatic Research. The scale used stress related life events to study and predict illness. Holmes and Rahe created the SRRS scale to attempt to quantify the impact of major life stressors on the health of individuals. They took 43 life events and scaled them from 1 (least stressful) to 100 (most stressful) in order to determine how much a person would need to adjust his or her established lifestyle to adapt to a particular situation. The life event of marriage was taken as the standard stimulus and given the value 50, and with other life events were assigned a proportion of that standard. Holmes and Rahe rated life events of a loss, such as the death of a spouse, divorce, and/or a serious personal injury or illness very high in terms of the effort it would take to adapt to such situations. Further down the scale are events such as change in financial state, vacation, and/or a minor traffic violation, which although disruptive are proportionally less stressful. Individuals were asked in a survey to check off which events they had experienced in the preceding 24 months. Holmes and

Rahe found that people who had accumulated stress scores of 300 points or higher had significantly higher rates of illness than did those who had scored lower (Holmes, Rahe, 1967).

The Stimulus-based Model of Stress has become the dominant paradigm of stress research from the early 1970s to the present (Rice, 2000). It has become important to many disciplines, including psychology, sociology, nursing, medicine, psychiatry, occupational therapy, and physiology. A large body of evidence has emerged since the initial Holmes and Rahe studies to support the additive nature of stressful life events and the onset of health problems. Multiple stressful events have been shown to influence the risk for a wide range of physical and emotional disorders, from colds and infections (Cohen, Tyrell, & Smith, 1991) to major health crises such as myocardial infarction, sudden cardiac death (Rahe & Lind, 1971), and PTSD (American Psychiatric Association, 1994).

Vulnerable Populations among Gulf War Veterans

The military personnel who were deployed to the Gulf to take on the Iraqi army during Operations Desert Shield/Storm were by far the most diverse group of individuals assembled as a fighting force in U.S., if not world, history (PACGWVI, 1996). The force was composed of men and women of different ages, ethnic makeup, religious affiliations, social networks, and income levels. Some were married, some were single; some were full-time military, and others were reserves that served only when called upon. When looking at stress and how it affected the health of troops returning from the Gulf, it is important to look not only at the overall health outcomes of veterans who served, but also those of the subpopulations of veterans. Some of the above subpopulations may or may not have been at increased risk of developing health problems stemming from stress. Among those who may have been more susceptible were older veterans, female veterans, minority veterans, and veterans who lacked social support networks.

An individual is considered at risk, or vulnerable, for a particular disorder if the likelihood that he or she will meet diagnostic criteria for that disorder is greater than for the population at large (Ruskin, 1996). Studies designed to test this vulnerability tend to involve attempts to identify characteristics of specific "at risk" individuals and differentiate them from those who are not "at risk." The following four sections in this review will look at the literature on the potential risk factors of age, gender, race, and social networks to see what role they may have played in an individual's vulnerability to stress-related health problems. The literature reviewed will look at both why these subpopulations may be considered vulnerable and the results of studies that have tested this potential vulnerability.

Age, Stress, and Health Problems

As one ages the overall decline in the structure and function of the body that can has widespread health implications. Some of the normal physical changes that occur during the aging process are decline in the senses (touch, taste, vision, olfactory function, and hearing), loss of muscle mass, drop in bone density, and slowing of the brain and central nervous system. These changes occur slowly, over time beginning for most adults during the mid-twenties and continuing unabated throughout life. Other physiological changes in individuals as they age include, but are not limited to, changes in the skin, musculoskeletal function, cardiovascular system, respiratory system, neurologic function, the immune system, renal function, and the genitourinary system. With increasing age, many organ systems lose some of the reserve capacity for regulating homeostatic capabilities. Thus older adults are more vulnerable to illness, trauma, and environmental changes such as stress (Porth, 1994).

Of particular concern with regard to stress are changes in the skin, cardiovascular, and immune systems. As one ages, one's skin changes. Studies have shown that the number of active sweat glands and the amount of sweat produced per gland decreases with age (Juniper; 1967, MacKinnon; 1954, Silver, 1964). This can impinge on many of the primary functions of the skin: protection from the environment, temperature regulation, maintenance of electrolyte fluid balance, and excretion of metabolic waste (Porth, C.M., 1994). Thus an older individual is more likely than a younger person to have problems in a challenging environment. As one ages, the aorta and arteries tend to become stiffer and less distensible. Numerous epidemiological studies have shown that in industrialized nations, resting systolic and diastolic blood pressure increases substantially with age (Epstein; 1967, Wheaton; 1985). In studies using pharmacological challenges as well a variety of behavioral and cognitive challenges, it has been observed that older individuals show greater stress-induced blood pressure reactivity as compared to younger individuals (Barnes, 1982; Gintner, 1986; Matthews, 1988; Wagner, 1981). In short, older individuals may have elevated responses to stressful life situations, in comparison to younger persons. Older persons also tend to have weaker immune systems than younger persons and tend to be more susceptible to illness and/or health problems.

Although the number of T cells remains unchanged with advancing age, there are changes in the functioning of helper T cells that alter cellular immune response in older adults are (Porth, 1994). This makes older adults more susceptible to urinary tract infections, respiratory tract infections, wound infections, and nosocomial infections than younger persons (Porth, 1994).

The literature is limited with regard to how age is related to the stresses of deployment and combat. One of the few major studies in this area was a cross-sectional survey of four Air Force units (n=1002) who served in the Gulf. The authors concluded that older age was significantly associated with a higher likelihood of being ill (Nisenbaum et al., 2000). Another study used structured interviews, with the Medical Outcomes Short form 36, of both Gulf War and non-Gulf War veterans (n=3723). In this study, the odds ratio of becoming ill over the age of 30 was much greater than for becoming ill under the age of 30 (Fukuda et al., 1998). Much of the other information available in this area focuses specifically on PTSD and natural disasters, not combat or preparation for combat. A major PTSD study done in the early sixties concluded from a literature review on casualties from World War II and natural disasters that the elderly are a "special risk" group for both physical and psychological consequences (Freidson, 1961). Another study, which examined the post-traumatic stress reaction of victims of the Mount St. Helen's eruption, found that individuals in the 35-44-year old age range were much more likely to suffer symptoms of PTSD than were individuals 18-34 years old (Shore et al., 1989).

Gender, Stress, and Health Problems

Throughout the history of combat, military service has been a male-dominated. Men would go off to fight battles while women would stay at home to care of family and practical affairs. This slowly but surely began to change during the late nineteenth and early twentieth century. Women first became active in wars as nurses caring for the sick and injured, and later took on administrative and other non-combat-related roles. As modern warfare has evolved to become much more technological and less individual combat, the role of women in military service has changed even further. By the time of Operations Desert Shield and Desert Storm, women were involved in almost every aspect of military service. Of the approximately 697,000 U.S. military personnel who served in the Gulf, 49,950 were female, accounting for 7% of the entire fighting force (Military Medicine, 1997) – by far the highest proportion that had served on any military mission in the history of the United States.

The women who served in the Gulf did so side-by-side with their male counterparts in multiple tasks related to the war effort. They integrated into almost every military unit and performed various war-related tasks: driving trucks, establishing communications systems, digging bunkers, refueling bombers and fighters, launching Patriot missiles, and guarding prisoners of war (POWs). Although theoretically they were not allowed to engage in ground combat, many of the women saw action during the war and faced many of the same life-threatening risks that the male soldiers did. Like the male soldiers in the Gulf, female soldiers were in range of Iraqi missiles that might contain biological or chemical warheads. They therefore underwent the same preparations for chemical and biological weapons attacks that their male counterparts did, which included familiarization with the use of protective suits and masks as well as how to respond to chemical and missile alarms. In some instances women were given prophylactics such as Pyridostigmine Bromide (PB) or other vaccines intended to combat the effects of a chemical or biological weapons attack. Like the men, many women gave their lives in the fight to free Kuwait from the Iraqi invaders. Of the 148 U.S. battle deaths that occurred during the Gulf War, 15 were women.

Female troops had many of the same deployment-and combat-related stressors that the male troops faced during the Gulf War; however, their reactions to those stressors may have been noticeably different that their male counterparts' reactions, because of physiological differences between the sexes. Differences in hormones, particularly the reproductive hormones, may significantly affect how men and women respond to stress (Heitkemper et al., 1996). During the luteal phase of the menstrual cycle, for example, female heart rate and systolic blood pressure rise significantly as compared to other phases. These fluctuations, unique to women, may affect on their reactions to stressful situations (Manhem, 1994). The average woman's heart is 25 percent smaller than the average man's and women have, on average, a heart rate 5 to 8 beats per minute faster than that for a man, since heart size is inversely related to heart rate (Stein, 1997). Many studies have shown that these faster, resting female heart rates show greater stress-induced increases than those for males do (Bell et al., 1968; Collins, 1978; McAdoo et al., 1990). Thus the effects of changes in heart rate caused by stressors may be felt much more in females than in males, because the resting heart rate already is higher. Finally, a woman's response to heat stress differs somewhat from a man's. Women sweat less, lose less heat through evaporation, and reach higher body temperatures before sweating starts, as compared to men. This difference may also affect how women respond to stressful situations, which could help to predict physical and mental health outcomes. Table 6 lists the major studies that have considered gender differences in health outcomes among Gulf War veterans.

Race, Stress, and Health Problems

Americans live in a multicultural society that draws strength and vitality from the diversity of its people. Persons from every corner of the earth have come to the United States with the dream of better lives for themselves and their families, bringing with them global ideas and perspectives that have helped to shape and enrich the nation. Diversity of the U.S. population has brought prosperity, energy, and optimism to the nation. The array of cultures, races, and ethnicities that make up the United States has helped it to become one of the most successful and affluent countries on the face of the earth.

While diversity has helped this the United States achieve unprecedented wealth and prosperity, its multicultural society does have certain problems that may have adverse effects on health. Language barriers, for example, which exist in many immigrant communities, tend to prevent persons who need medical help from seeking treatment (Timmons, C.L., 2002). Poverty, which is far more prevalent in minority communities than in non-minority, has long been shown to have adverse effects on health (Gallo, 2003; Everson, 2002). In some communities, cultural differences, such as the distrust of modern medical techniques or the stigma associated with having a medical

Table 6: Gender differences in Gulf War literature

Study:	Perconte et al., 1993a
Objectives:	Examined stress level in survivors of a missile attack before and after treatment intervention. Compared stress levels with a group of survivors who did not receive treatment intervention.
Sample:	Quartermaster unit hit by missile. N=25, Reserve troops; male=84%.
Control:	Yes, N=8.
Time of Assessment:	During Gulf War (2 months post-missile attack 4/91)
Exposure Assessment:	Missile attack (on site; guard duty; non-deployed)
Methodology:	Pretest and posttest between –group design comparing Gulf War veterans receiving debriefing with Gulf War veterans not receiving debriefing in a unit-based program.
Relevant Findings:	On-site group had significantly higher MISS and SCL-90-R scores; females had significantly higher BDI, MISS, and SCL-90-R at pre-treatment than males. Significant reduction in symptoms post-treatment. No change in symptoms for non-deployed, post-treatment.
Study:	Sohler et al., 1992
Objectives:	Interim report of ongoing study examining the psychological sequelae on Gulf War veterans following the Gulf War.
Sample:	National Guard/Reserve units in North Central Florida. Branch not specified. M=397, F=110.
Control:	Yes
Time of Assessment:	6 months post-Gulf War
Exposure Assessment:	Deployed versus non-deployed; CES
Methodology:	Between-group design comparing Gulf War veterans deployed on psychological sequelae post-Gulf War. Gender, unit, and combat exposure were also assessed.
Relevant Findings:	Deployed had higher IES scores than non-deployed; females had higher IES scores; Significant interaction effect for gender by deployment (i.e. higher IES scores for deployed females than males); experienced veterans reported significantly fewer intrusive thoughts.

Table 6 continued: Gender differences in Gulf War literature

Study:	Sutker et al., 1993
Objectives:	Examined the relationship between war stress and physical and psychological symptoms following Gulf War in activated deployed and non-deployed troops.
Sample:	Army National Guard and Army Reserve. Troops were distributed across air reserve, medical, and infantry support specialist, air ambulance, tactical fighters, maintenance, and quartermaster. N=215, male=82%, female=18%.
Control:	Yes, N=60.
Time of Assessment:	4-10 months post-ODS
Exposure Assessment:	ODS-SES (divided groups into high and low exposure)
Methodology:	Between-group design comparing deployed (high and low exposure) with non-deployed (no exposure) on variables of post-ODS psychological sequelae
Relevant Findings:	High exposure group reported significantly higher MISS, PTSD Scale, BDI, anxiety and anger scores than did low and no exposure groups. High-exposed group had significantly more difficulties sleeping, concentrating, nervousness. Gender and race are significantly correlated with PTSD.

Study:	Wagner et al., 2000
Objectives:	Investigated the impact of PTSD on physical health of veterans 18-24 months after returning from the Gulf; gender differences observed.
Sample:	N=2301; Gulf War veterans
Control:	No
Time of Assessment:	Immediately after returning home from the Gulf and a follow-up 18-24 months later.
Exposure Assessment:	Self-report of health problems.
Methodology:	Time scale differential in self-report data.
Relevant Findings:	Overall, female veterans reported significantly more health problems than their male counterparts did; not much difference in terms of time differential.

Table 6 continued: Gender differences in Gulf War literature

Study:	Sutker et al., 1995a
Objectives:	Examined and compared the prevalence of psychological symptoms among military participants in war zone exposed and stateside duty. Examined gender and ethnicity between exposed and non-exposed.
Sample:	War-zone exposed (n=653) and stateside duty troops (n=259). Included Army, Air Force, Marine, National Guard, and reserve units who underwent psychological debriefing post-Gulf War. N=912, female=13%, White=63%.
Control:	Yes; N=259, male=83%, female=17%.
Time of Assessment:	within 12 months post-Gulf War
Exposure Assessment:	ODS-SES
Methodology:	Between-group study comparing war-zone exposed and stateside duty on psychological symptoms post-Gulf War. Examined gender and ethnicity.
Relevant Findings:	Significantly more amount of depression, anxiety, and somatic complaints for deployed; minority had significantly more symptoms of depression. Females had significantly more somatic complaints. No main effect for gender and PTSD. Interaction effect gender by ethnicity for PTSD. 10-12% deployed PTSD positive.
Study:	Wolfe et al., 2002
Objectives:	Examined the prevalence of symptoms and identified risk factors for reported symptoms among a group of Army Gulf War veterans. Study objectives: to look at multi-symptom illnesses and gender differences.
Sample:	Mail survey to 2949 U.S. Army soldiers deployed to the Gulf; total of 1290 subjects responded to the mail survey; aggressive follow-up methods were employed.
Control:	No
Time of Assessment:	5 days after return from Gulf War.
Exposure Assessment:	Self-report
Methodology:	Correlational design examining relationship between exposure demographics and symptoms.
Relevant Findings:	Female gender, lower levels of education, ingestion of anti-nerve gas pills, anthrax vaccination, and exposure to oil smoke were significantly related to multi-symptom illness in logistic regression analysis.

problem are critical deterrents to use of health care utilization (Kelleher, 1996). Finally, there is racism, which pits one group of individuals against another. The distrust, fear, and often outright anger directed at a person of another racial group simply because of the person's race does also adversely affect the overall health of our society (Boulware, 2003).

Epidemiological studies have shown that for a variety of reasons there are racial and ethnic differences in the causes, expression, and prevalence of various diseases (Burchard, 2003). Some of these differences, e.g., those mentioned above, are the result of environment. Others are based on genetics. An example of an environmental factor that affects health is dietary intake, which often reflects cultural eating habits. Eastern diets, which generally have high salt content, predispose people to stomach and pancreatic cancer. Western diets, which contain less salt but more fat, are associated with lower rates stomach and pancreatic cancer but higher rates of colo-rectal and hormone-related cancers (WCRF, 1997). Genetic factors also play a role in whether or not an individual is susceptible to a particular type of illness. Hemophilia, sickle cell anemia, and cystic fibrosis all have genetic components that make individuals of certain races or ethnic groups vulnerable to acquiring them. Regardless of whether or not an individual is predisposed to a certain health problem by environmental or by genetic factors, apparent differences in vulnerabilities among ethnic or racial groups can be seen.

A review of the literature suggests that as with other ailments, responses to stress during wartime may vary with ethnicity or race. Studies from the Vietnam era show that during a military conflict, members of ethnic or racial minorities are more likely to have stress-related health problems attributed to that conflict (Loo, 1994). According to the National Vietnam Veterans Readjustment Study, both Hispanic and African-American male veterans of the Vietnam theater had higher rates of PTSD than did Whites. (Kulka, 1990). One reason for this discrepancy may have been that during the Vietnam War minorities were more exposed to war zone stresses (e.g., atrocities, violence, and combat) than their non-minority counterparts were (Loo, 1994). Another reason may have been the added stress of being a minority far away from cultural support systems. Whatever the reason, the literature on previous conflicts shows a higher rate of stress-related problems among minorities as compared to non-minorities. It is thus important when looking at data from the Gulf War to take ethnicity/race into account so as to identify discrepancies and understand the variations among racial and ethnic groups. By identifying discrepancies and understanding why they exist, progress can be made in the developing of strategies to improve health outcomes for everyone.

Social Support Networks, Stress, and Health Problems

Numerous studies have demonstrated that social support through connections or bonds to other people can improve the mental and physical outcomes of adults. Individuals who have solid social support systems have a lower risk for depression and psychological distress than do those without such social supports (George, 1989; Stansfeld et al., 1997). Persons who have strong social support networks are much less likely than those with few social ties to indulge in unhealthy behaviors such as cigarette smoking, abusing alcohol, use of illicit drugs, eating poorly, and exercising too infrequently. They therefore are not as likely to suffer the physical health problems stemming from such behaviors (Orley, 1998). Studies conducted across a variety of populations indicate that people who are more socially integrated live longer (House, 1998; Berkman, 1995), are more likely to survive a myocardial infarction (Berkman, 1995; Seeman, 1996), are less susceptible to upper respiratory infections and gastrointestinal problems (Cohen, 1985) and are less likely to suffer a recurrence of cancer (Helgeson, 1998) than are their less integrated counterparts. There have also been studies that have shown that social integration is associated with endocrine function (Seeman, 1994), cardiovascular function (Uchino, 1996), and the immune system's ability to fight off infections (Cohen, 1997).

Research has shown that individuals with strong social support networks are to some degree buffered from stressful life situations (Cohen, 1985). Family and friends can provide both emotional support and physical assistance to individuals undergoing stressful life events. They can remind us to exercise, help us to quit smoking, allow us to talk through our problems, and drive us to a doctor or other health care provider if needed. Social support networks provide activities, alternative viewpoints, and outlets for our emotional stress. They can provide a shoulder to lean on during rough times and help to moderate if not alleviate many of the life stressors. Studies have shown that young people reporting poor social connections – who have no one to talk to, no one to trust, no one to depend on, and no one who knows them well – are between two and three times more likely to experience depressive symptoms when compared to their peers (Glover, 1998). Thus strong social support networks can provide coping mechanisms that may help to lessen the impact of stress on both one's physical and one's emotional health.

One of the strongest and most meaningful of all social support networks is the bond of marriage, a partnership unlike any other social bond. Marriage joins two people to share life in both good times and bad, and in both sickness and health. It commits two persons to each other above all others so that they can live together and support one another. It provides an individual someone with whom to share intimate thoughts as well as leisure time. Marriage may also greater financial independence and a wider social network of family, friends, and neighbors. Studies have shown that married persons live longer and healthier lives than do those who have never married or are divorced (Lillard, 1995). Married people tend to eat and sleep more regularly, and live "a more "orderly lifestyle" than non-married persons (Panis, 1996). Research also has shown that being married ameliorates potentially stressful life events such as retirement (Wan, 1982). Such reductions in stress may help to explain why married persons are generally healthier and have longer life spans than non-married persons do.

Summary

Chapter Two has presented a review of the literature pertinent to examining the how the effects of stresses encountered during the Gulf War may have led to psychological and physical health problems among some Gulf War veterans. The chapter has covered in detail how the literature review was conducted, the major health problems that some Gulf War veterans have been facing, and what the scientific community believes are their possible causes. The chapter also has given an overview of stress and reviewed what the scientific literature says regarding how it can affect both one's psychological and physical one's well-being. It has gone into detail as to why the literature supports a recursive relationship whereby psychological health problems contribute to physical health problems and has shown why the reverse relationship is not supported. It has described the history of stress in military conflicts, and in particular has looked at how stressors during the Gulf War may have affected the troops. The chapter's conclusion provides an overview of what the scientific literature has to say about how stress affects potentially vulnerable populations such as the elderly, females, minorities, and those individuals who lack social support networks.

CHAPTER 3: METHODOLOGY

Introduction

The methodology chapter examines the proposed conceptual model that describes how stress during the Gulf War may have affected the mental and physical health of Gulf War veterans. It provides a detailed description of the Comprehensive Clinical Evaluation Program data source used in the proposed model, including a discussion on how that data was found and eventually acquired. It explains how the data from the Comprehensive Clinical Evaluation Program data was formatted into Access, cleaned of irrelevant material, and modified so that it would be usable for structural equation modeling. It then goes on to addresses important issues with regard to the data such as its reliability and validity.

This chapter next discusses the steps taken in creating of the Gulf War Stress survey sent out to veterans and health experts. It details the recruitment of survey participants as well as show how the results of the survey were recorded and analyzed. It explains how a Gulf War Stress Scale modeled after that of Holmes and Rahe was developed and how stress levels of individual Gulf War veterans were measured via that scale. Survey data reliability and validity are discussed, followed by a description of how the cleaned data from the Comprehensive Clinical Evaluation Program and the stress survey data were attached to the AMOS modeling software in preparation for analysis.

Finally, this chapter describes the development of the structural equation model used to study the health outcomes of Gulf War veterans. It details the creation of the core model and then shows how and why additional parts of the model were added to take account of stress in the Gulf War as well as differences in age, gender, race, and marital status. A discussion will take place concerning the reasoning behind the derivation of the health outcomes variables followed by a detailed description of important issues with regard to the model such as its identification, variable measurement, its analysis, and respecification.

The Comprehensive Clinical Evaluation Program Data Source Used in the Proposed Model

The secondary data source used in the proposed structural equation model examining the effects of Gulf War stress on subsequent mental and physical health problems among Gulf War Veterans came from the Comprehensive Clinical Evaluation Program. This voluntary program by the Department of Defense was created to provide a systematic and uniform medical evaluation of troops who served during the Persian Gulf War, to respond to the health concerns of veterans and the organizations representing them. It was set up, under oversight by the Institute of Medicine, to provide a two-phase clinical evaluation of Gulf War veterans. In phase I, all Comprehensive Clinical Evaluation Program participants were to be examined by a board-certified physician in either family practice or internal medicine (Roy, 1994). Participants were given a complete physical, which included a medical history, basic laboratory tests, and standardized provider-administered questionnaires (Joseph, 1997). For individuals who were healthy or who had problems that could be satisfactorily explained after the Phase I evaluation, no additional evaluation was conducted. Participants who felt they needed a more in-depth evaluation proceeded to Phase II at specialized Department of Defense regional medical centers, where additional tests were performed. Phase II tests included a structured clinical interview for DSM-III-R, a clinician administered PTSD scale test, a chest X-ray, and additional blood tests (Joseph, 1997).

The portion of the Comprehensive Clinical Evaluation data used in this dissertation came from the Phase I provider-administered questionnaire regarding wartime exposure/experience and health outcome information (see Appendix XXII). Demographic information (gender, race, age, marital status etc.) were obtained by connecting a relational database having this information to the Phase I provider-administered questionnaire. To preserve confidentiality, no specific personnel identifiers were given out with the data: no names, social security numbers, home addresses, or specific unit listings were given. Likewise, no information was given regarding lab work, medical histories, or physical examinations. Despite these limitations, the Phase I provider-administered questionnaire used in this study has been a valuable tool for analyzing the complex relationship between wartime exposures/experiences and veterans' health outcomes.

Acquisition of the Comprehensive Clinical Evaluation Program Data

Information about how to obtain a copy of the researcher-available data on the Comprehensive Clinical Evaluation Program data was found at: http://www.defenselink.mil/news/Sep1996/b090496_btprescc.html, which is part of the official web site for the Department of Defense. The website provides directions for contacting Electronic Data Systems, the contracting firm that maintains and archives the data. Although it is not required, Electronic Data Systems strongly encourages investigators who request a copy of the Comprehensive Clinical Evaluation Program data to submit an approved Institutional Review Board scientific protocol. That was done for this dissertation through the Virginia Commonwealth University Office of Research and Subject Protection. Since the research this dissertation posed no more than minimal risk to the subjects in the survey, an expedited review was requested and approved.

Formatting of the Comprehensive Clinical Evaluation Program Data

The Comprehensive Clinical Evaluation Program data used in this dissertation were acquired from Electronic Data Systems on August 12, 2002. They were provided as an Informix relational database (designed to handle large amounts of structured and unstructured data) with ASCII text delimited files (standard files that are recognized by most word processors or spreadsheet programs). The drawback in receiving ASCII files for the dissertation was that it treated each question asked to each participant in the database as an individual record. With some 60,000 participants in the Comprehensive Clinical Evaluation Program, responding to up to several hundred questions, the total number of records in the database easily exceeded the maximum capacity (65,000 records) of Microsoft Excel, an AMOS-compatible spreadsheet program. In order to process this amount of data, it was necessary to transfer the data into a form that could handle them, and then cut the size down so that it could fit into a format that could be understood by the Structural Equation Modeling software AMOS. The Comprehensive Clinical Evaluation Program data was thus transferred from its original Informix database into Microsoft Access 7.1, which could handle the large amount of data. That was done with the Access import procedure, which allowed the relational data to be viewed as tables. Once in Access, the data were sorted so as to identify non-study related data, which could then be eliminated.

Cleaning of the Comprehensive Clinical Evaluation Program Data

After importing the Informix database into Access, the next step in getting the data ready for analysis was to clean them of all items not related to the study. The original data supplied by Electronic Data Systems Corporation contained numerous Phase I and Phase II specialty tests that had nothing to do with the aims of this dissertation. To reduce the overwhelming amount of data in the Access program, all irrelevant study material was removed. In addition, within the questionnaire about wartime exposure/experience and health outcomes were survey answers from others than Gulf War veterans. Those data came primarily from family members and/or civilians who were in the Gulf during the war. To avoid introducing any data biases into the study, it was necessary to have those data records eliminated from the overall data set, as well.

Removal of unwanted data in the Access database was a multi-step process that required a sorting of the data to that unwanted records could be found and then deleted. Since the data given by out by Electronic Data Systems were in numerous large tables that contained several variables, the first step in the data cleansing process was to pull up the tables that contained the variables needed for this study. The two tables needed were the wartime exposure/experience and health outcomes response table and a personal information table, which were linked to each other by a common identifier variable.

Once the tables were found, the next step in data cleansing was to query the needed variables in the Access design view. Since all variables had numerical representation assigned to them, (see numbers on Appendix XXII data), data could be sorted in a way that permitted needed data to be separated from unneeded data. Thus data that were non-study-related could be deleted and kept out of the study.

Several data sorts were made to identify and delete unnecessary data. The initial sorting separated those persons who took the survey regarding wartime exposure/experience and health outcomes from those who did not. Only the results and personal identifier information of persons who had taken this survey were saved for an updated data set. The results of all other, unrelated surveys were deleted. After that, another sort separated the records of Gulf War veterans and any records of non-veterans who may have participated in the survey. Only records of military personnel who served in the Gulf War were kept for an updated data set. The results of all other, non-Gulf War veteran records were deleted. A third sort looking at the birth year of the survey respondents was then done as a data set quality control measure. Since the Gulf War was in 1991 and participants had to be at least eighteen years old to participate in the war, persons who stated that their year of birth was after 1973 were excluded from the sample. Included within this deleted group were a number of veterans who mistakenly filled in the test completion year as the year of birth. In all, the result of this data cleaning process was a ridding of extraneous and potentially biasing material within the Access database. This reduction of extraneous material helped to solve the problem of transferring the data into a spreadsheet program such as Microsoft Excel or SPSS that could be recognized by the AMOS.

Modification of the Comprehensive Clinical Evaluation Program Data

The next step in preparing the Comprehensive Clinical Evaluation Program data for structural equation modeling analysis was to have it modified to account for several problems inherent within the data: what to do with missing/incomplete data, how to handle duplicate data, how to transfer coded data into a recognizable form that could be utilized by the modeling software, and how to deal with do not know/do not recall responses to questions. Several data handling decisions were implemented to deal with these problems while at the same time upholding the integrity of the data set.

For missing/incomplete data, it was decided to eliminate any record that did not contain responses to all variables needed for analysis. That was done both because the data set was large enough to be statistically relevant without these records, and because it would eliminate the records of individuals who might not have completed the survey, through a lack of interest or understanding. Most of the incomplete wartime exposure/experiences and health outcome data came from the same respondents. Approximately 400 records were eliminated from the final data set because of incomplete/missing response data.

Duplicate data or multiple responses to the same question posed another problem. In order to have a single response to each item in the survey questionnaire, several decisions had to be made on what to do with duplicate or multiple survey responses. It was decided that if two answers that were similar were given to a single question, the least extreme response would be kept in the data set and the more extreme response eliminated. If, for example, a participant checked off that they experienced a health problem all of the time and also checked most of the time, the data handling decision would be to go with "most of the time." This was done to keep such duplicate records in the survey while at the same time making sure that if an error were to be made, it would be made on the side of caution. If two answers to the same question were far apart such as when a participant had checked off that he or she never has experienced a particular health problem and also had checked off that they experience a health problem most of the time, the record would be eliminated. Finally, if three or more answers to the same question were given, the record was likewise eliminated from the data set. In all, about 200 records were modified by data handling decisions about duplicate records, and another 100 records were eliminated.

Another decision that had to be made about to the data was how to transfer the coded Comprehensive Clinical Evaluation Program data into a form that could be recognized by the AMOS software. The data acquired from Electronic Data Systems contained a very complicated code that was meant to encompass the whole Comprehensive Clinical Evaluation Program. To analyze these data using the AMOS Structural Equation Modeling Software, it was necessary to simplify the code so that AMOS could make sense of them. Several data handling decisions thus had to be made in order for the data to be interpreted and then analyzed. One major initial decision was to code all "yes" answers as "1" and all no answers as "0." Another was to code all responses that required a degree answer on a numerical scale. This meant that for questions of onset, duration, frequency, and amount of impairment, a "1" represented the minimal choice, followed by "2", "3", "4" and "5," representing ever increasing degree choices. Converting the coded answers of the Comprehensive Clinical Evaluation Program into more simplified scaled responses enabled the AMOS structural equation modeling software to make sense of the data and analyze it.

Finally, there was the question of what to do with the "I don't know" responses to wartime exposure/experiences questions in the Comprehensive Clinical Evaluation Program data. Since this dissertation is looking to differentiate definite exposures/experiences from non-exposures/experiences in its creating of a Gulf War stress scale, a data handling decision was made to treat all "I don't know" answers as "no" answers. Thus if a veteran was not sure whether he or she had been exposed to a particular event, the study treats that response as a non-exposure. In terms of data coding, this means that all "yes" answers to particular exposure/experiences questions were coded as a "1" and that all "no" or "I don't know" answers were coded as "0."

Reliability of Comprehensive Clinical Evaluation Program Data

For the most part, data from the Comprehensive Clinical Evaluation Program may be considered a reliable reflection of the health status of veterans who served in the Gulf War. The demographic characteristics of those veterans who participated in the program are highly consistent with the actual characteristics of the veterans who participated in the war (see Table 7). Similarly, the total number of Comprehensive Clinical Evaluation Program participants, currently over 50,000, is roughly seven percent of the over 697,000

Table 7: A comparison of demographic characteristics of 20,000 Comprehensive Clinical Evaluation Program participants and those of all U.S. veterans of the Persian Gulf War.

	Percent with the Characteristic	
Characteristic	CCEP Participants[a] (*n*=20,000)	All Gulf War Veterans (*n*=697,000)
Gender		
Male	88 %	93 %
Female	12 %	7 %
Age in years[b]		
17-25	32 %	55 %
26-30	24 %	20 %
31-35	23 %	12 %
36-65	21 %	13 %
Race / ethnicity		
White	57 %	70 %
African-American	32 %	23 %
Hispanic	5 %	5 %
Other	6 %	2 %
Rank		
Enlisted	92 %	90 %
Officer	8 %	10 %
Military branch		
Army	82 %	50 %
Navy	4 %	23 %
Marines	4 %	15 %
Air Force	9 %	12 %
Military status		
Active duty	84 %	83 %
Reserves/National Guard	8 %	17 %
Civilians	8 %	- %

a. Among CCEP participants, valid data were not available for 3% of rank, 2% of age, and 1% of military branch entries.

b. Age was calculated as of August 1990. The mean age of CCEP participants was 28 years (median 30 years) compared to a mean age of 27 years (median 25 years) for all Gulf War veterans.

Source: Joseph, S.C. (1997), A Comprehensive Clinical Evaluation of 20,000 Persian Gulf War Veterans, *Military Medicine*, 162, 3:149.

U.S. participants in the war, which is a highly representative sample. Since the veterans who went through the Comprehensive Clinical Evaluation Program were the ones who had the most at stake in terms of the knowledge to be gained from it, they had an incentive to give time and thought to their answers to the survey questionnaires. This likelihood should indirectly increase the consistency of the data and thus their reliability, by limiting the number of frivolous answers (due to lack of interest). Finally, the protocol of the Comprehensive Clinical Evaluation Program was designed by the Institute of Medicine in conjunction with medical and public health experts to produce standardized questions. The standardized questions keep investigator bias to a minimum, which also helps to increase the reliability of the results.

Validity of Comprehensive Clinical Evaluation Program Data

An extensive quality-control process was instituted during the development of the Comprehensive Clinical Evaluation Program to ensure the validity of the database (IOM, 1996). Senior medical officials from all military services were consulted to guarantee the content validity (the degree to which content of a test or questionnaire covers the extent and depths of its subject). They along with representatives of the President's Advisory Committee on Gulf War Illnesses, the General Accounting Office, and the Office of Technology Assessment (IOM, 1997) made sure that the Program's accurately reflected the experiences and health concerns of Gulf War veterans. On top of this, a special outsourced committee of the Institute of Medicine independently reviewed and monitored the Comprehensive Clinical Evaluation Program process, including its design and implementation (IOM, 1996). That committee reported on how well the Comprehensive

Clinical Evaluation Program in met the health concerns of veterans. From its reports, the validity of the Comprehensive Clinical Evaluation Program data appears ensured.

Creation of the Gulf War Stress Survey

A primary source of data for this study was from a stress survey sent out to veterans of the Gulf War and to health professionals with expertise in the field of combat trauma and/or military stress. This survey was developed in order to quantify the potentially stressful exposures of Gulf War veterans so that a Gulf War stress scale could be created. The survey questionnaire asked veterans and health experts to rate, on a scale of 0 (least stressful) to 10 (most stressful), how stressful they thought 24 potentially harmful exposures that occurred during the Gulf War were to the veterans who experienced them. The 24 exposures veterans and health experts were asked to rate are listed in Table 8.

Table 8: Twenty-four potentially stressful exposures experienced by some veterans of the Gulf War.

1.	Passive cigarette smoke		13.	PB (pyridostigmine bromide pills)
2.	Oil fire smoke		14.	Insect repellents
3.	Tent heater smoke		15.	Botulism immunization
4.	CARC paint		16.	Anthrax immunization
5.	Other paints		17.	Malaria prevention
6.	Solvents		18.	Food contamination
7.	Diesel Fuel		19.	Water contamination
8.	Other petrochemicals		20.	Combat exposure
9.	Depleted uranium		21.	Wounded in action
10.	Nerve gas		22.	Witnessing of casualties
11.	Mustard gas		23.	Scud attacks
12.	Microwaves (strong radar)		24.	Chemical alarms

Each veteran and/or expert was instructed to give a single response for each of the 24 above listed exposures. Radio buttons were used on the emailed survey to ensure that only one response would be recorded. A detailed explanation of each exposure was included in the questionnaire, so that respondents could make informed ratings. The e-mailed version of the survey provided the explanations as a link that could be accessed by double clicking a listed exposure (see Appendix XXI for Survey Links). If a veteran had not been exposed to a certain event listed, the survey asked the veteran to rate the stress at the level he or she thought most appropriate. Thus, for example, if a veteran had not been subject to botulism immunization during the Gulf War, the survey asked the veteran to rate the stress at the level he or she thought such an exposure would have caused.

The 24 potential exposures that this survey asked about were the same as those in the Comprehensive Clinical Evaluation Program exposure/experience questionnaire (see Appendix XX). The difference between the two questionnaires is that this survey is looking at the stress level caused by each particular exposure, while the Comprehensive Clinical Evaluation Program questionnaire is looking for a yes/no answer about a particular exposure. The same 24 exposures were used in this study's survey so that a stress scale score for each individual veteran who participated in the Comprehensive Clinical Evaluation Program could be calculated. (That scale is discussed in detail later in this chapter.) Once individual veteran stress scores were calculated, the results were then fitted into a structural equation model to examine how Gulf War stress exposure affects mental and physical health.

Recruitment of Gulf War Stress Survey Participants

Veteran participants in the Gulf War Stress Survey were recruited from veteran locater web sites such as http://www.gulfweb.org/locator/locator_search.cfm and http://www.vetfriends.com/memberships.html, as well as through personal contacts. From the veteran locater websites, approximately 2400 veterans' e-mail addresses were obtained. Each of these veterans was sent a mass e-mail containing the Gulf War Veteran Stress Cover Letter (Appendix XIX) and a link to a Gulf War Veteran Stress Survey (Appendix XX). Another 50 Gulf War veterans were either mailed or personally given a Gulf War Stress Survey. Names and addresses of the veterans who were mailed the Gulf War Stress Survey were obtained through personal contacts. Most of the veterans who were personally given Gulf War Stress Surveys were given them during the 2003 Veterans Day gatherings in Washington D.C.

In addition to veterans, approximately 50 health experts in the field of stress were sent a Gulf War Stress Survey to fill out, for another perspective on how exposures during military service in the Gulf may have contributed to the overall veterans' stress. The health experts were given the same survey that the veterans were, but were told to base the ratings on their professional opinion rather than on personal experience. The names and contact information for health experts in the field of stress were obtained through several Veterans Administration regional medical centers and also through the National Center for Post Traumatic Stress Disorders (NCPTSD), as well as through personal contacts. In many instances the health professionals who responded recommended other colleagues who were familiar with combat stress and associated health outcomes. These individuals, too, were e-mailed a stress survey.

Handling of the Gulf War Stress Survey Results

The results (see Appendix XXII) of the e-mailed Gulf War stress survey were sent to a secure data site operated by Virginia Commonwealth University so as to keep the identity of all respondents confidential. Access to the site was password protected and limited to the study investigator and the systems administrator at Virginia Commonwealth University in charge of handling secure data. When a respondent hit the submit button after completing their questionnaire, responses would go to this secure site at Virginia Commonwealth University and assigned a number according to the time that they came in. That assigned number was the only way to identify which responses belonged to which respondent and the total number of responses to the emailed survey. Once all response data had been received, the data and all associated survey responses were pulled up by this assigned number into an Access database. From Access, the survey results were transferred into Excel and then on to SPSS where they were used for analysis.

The initial emailed survey was sent out to 1600 veterans on Tuesday, October 28, 2003 in the form of a group email. Responses came in at a high pace initially and then staggered in through the rest of the week. A second email was then sent out on Thursday November 6, 2003 thanking all veterans who responded for doing so and requesting that persons who had not already responded and wished to do so to please go ahead and respond. After the first and reminder email, 118 responses to the Gulf War Stress survey were recorded at the secure data site. In order to increase the number of responses to this survey, an additional 800 veterans were sent the same email containing the Gulf War Stress survey on Monday November 17, 2003. Again, there was an initial burst of responses followed by a slow but steady drop off. A second follow-up email was sent to this second group of veterans on Monday November 24, 2003 again thanking those veterans who had already responded and asking for additional responses. From this second mass email and follow up came an additional came another 60 responses bringing the total number of responses to the emailed survey up to 178. This was the total number of responses used in the email portion of the Gulf War Stress Survey.

The Gulf War Stress Survey results that were acquired either by mailing or by in person interview were added to the Access database that contained the emailed veteran responses. A total of 32 veterans responded to the Gulf War Stress survey in this way with 12 coming in by mail and another 20 via interview. Adding this total (32) to the total number of emailed respondents (178) gave a grand total of 210 veterans who responded to the Gulf War Stress Survey. Like the emailed survey, both mailed and interviewed respondents were assured that confidentiality concerns would be respected.

All health professionals who responded to the Gulf War Stress Survey were contacted via email during the fall of 2003. Unlike the mass mailings emailed to many veterans, emails sent out to health professionals were done mostly on an individual basis. Their email addresses were obtained through Veterans Administration regional medical centers, the National Center for Post Traumatic Stress Disorder, and through personal contacts. In many instances health professionals who responded to the Gulf War Survey recommended other colleagues who were familiar with combat stress and associated health outcomes. These individuals were likewise emailed a stress survey to take. As with the veterans, assurances were given to health professionals that personal identifiers would not be included in the study. Out of the 50 emails sent out to health professionals containing the Gulf War Stress survey, 28 persons submitted responses. These responses were then manually transferred to an Access database similar to the one set up for veteran respondents. The results of all

Development of a Gulf War Stress Scale

A Gulf War Stress Scale, similar to the Holmes and Rahe Social Readjustment Rating Scale, was created using the data obtained through the stress survey sent out to Gulf War veterans and health experts. Veterans and health experts had been asked to rate from 0 (least stressful) to 10 (most stressful) the amount of stress involved in 24 potentially stress inducing events. If they had not experienced an event that was being rated, they were asked to estimate how stressful that event would be, in light of the experiences they had had during the Gulf War. Of the 2450 Gulf War veterans who were asked to participate in this survey, 210 responded. The results of their ratings of the 24 potentially stress-inducing events were averaged to create a veteran stress scale, (see Vet Scale column in Table 9). A similar scale was created from the results of the Gulf War Stress Survey sent to health professionals who had expertise in the fields of stress, combat, and health outcomes. The only difference between the survey sent to health experts and that sent to veterans was that the health experts were asked for their professional opinions as to the ratings whereas the veterans were asked to base their ratings upon personal experience. Of the 50 stress surveys e-mailed to health experts, 22 were returned. The averages of their ratings are shown in the Expert Scale column in Table 9. A Gulf War Stress Scale was then developed by averaging the veteran scale results and health expert scale results for the 24 items in the survey (see the Gulf War stress scale column in Table 9).

Table 9: Development of a Gulf War Stress Scale

		Vet Scale	Expert Scale	Gulf War Stress Scale
Q1	Passive cigarette smoke	2.80	2.27	2.54
Q2	Oil fire smoke	6.20	5.95	6.08
Q3	Tent heater smoke	2.75	2.23	2.49
Q4	CARC paint	2.46	1.86	2.16
Q5	Other paints	2.38	3.09	2.74
Q6	Solvents	3.47	3.18	3.33
Q7	Diesel fuel	4.85	3.55	4.20
Q8	Other petrochemicals	4.20	3.95	4.08
Q9	Depleted uranium	3.77	6.14	4.96
Q10	Nerve gas	4.94	5.45	5.20
Q11	Mustard gas	4.08	5.23	4.66
Q12	Microwaves (strong radar)	3.80	2.86	3.33
Q13	PB (pyridostigmine bromide)	6.36	6.68	6.52
Q14	Insect repellents	4.31	3.18	3.75
Q15	Botulism immunization	5.04	4.32	4.68
Q16	Anthrax immunization	6.15	6.23	6.19
Q17	Malaria prevention	4.23	4.91	4.57
Q18	Food contamination	3.61	3.14	3.38
Q19	Water contamination	3.96	3.55	3.76
Q20	Combat exposure	6.52	6.95	6.74
Q21	Wounded in action	3.35	5.95	4.65
Q22	Witnessing of casualties	5.29	5.77	5.53
Q23	SCUD attacks	6.35	6.91	6.63
Q24	Chemical alarms	7.17	7.59	7.38

Procedure Used to Measure the Stress Score of Individual Veterans

Both the data from the Comprehensive Clinical Evaluation Program and that from the Gulf War Stress Survey were used to determine stress scores for individual veterans. Stress scores were calculated with of the following formula:

$$S_i = \Sigma\, Q_i\, W_i$$

where S_i = Stress Score, Q_i= Question number and W_i = Weight (Gulf War Stress Scale).

The above formula calculated stress scores for all veterans who had filled out the exposure portion of the Comprehensive Clinical Evaluation program questionnaire. The maximum possible stress score was 109.55, meaning that the veteran was exposed to all 24 listed items; the minimum score was 0, meaning that the veteran was not exposed to any of the 24 listed items. The average veteran stress score for from the 12,205 Comprehensive Clinical Evaluation Program participants was 47.19. An example of how an individual veteran's stress score was calculated can be seen in Table 10.

Gulf War Stress Survey Reliability

The reliability of data refers to whether or not a measurement can be repeated over and over with consistent results. In short, it is the degree to which an instrument measures the same way each time it is used under the same condition with the same subjects. Since the Gulf War Stress Survey was e-mailed to veterans on two separate occasions (October 28, 2003, November 6, 2003) the results of each of those separate surveys can be compared for consistency and thus reliability. Similarly, results of those surveys that were either mailed in or taken personally from veterans could be compared to survey results that were obtained via e-mail, to check for consistency. The results shown in Appendix XXIII show that the questionnaire responses to that were mailed to veterans were very similar to the responses that were e-mailed to veterans. Likewise the results of the Gulf War stress survey e-mailed to health experts were similar to both the mailed and e-mailed responses of veterans. The overall pattern of results thus appears to give evidence that the Gulf War Stress Survey sent out to veterans and to health experts is a reliable one.

Table 10: Example of the procedure used to measure the stress level of an individual veteran

	Veteran # 1	Yes(1)/No(0)	Gulf War Stress Scale	Sum
Q1	Passive cigarette smoke	0	2.54	0.00
Q2	Oil fire smoke	0	6.08	0.00
Q3	Tent heater smoke	1	2.49	2.49
Q4	CARC paint	0	2.16	0.00
Q5	Other paints	0	2.74	0.00
Q6	Solvents	1	3.33	3.33
Q7	Diesel fuel	1	4.20	4.20
Q8	Other petrochemicals	1	4.08	4.08
Q9	Depleted uranium	1	4.96	4.96
Q10	Nerve gas	1	5.20	5.20
Q11	Mustard gas	1	4.66	4.66
Q12	Microwaves (strong radar)	0	3.33	0.00
Q13	PB (pyridostigmine bromide)	1	6.52	6.52
Q14	Insect repellents	1	3.75	3.75
Q15	Botulism immunization	0	4.68	0.00
Q16	Anthrax immunization	0	6.19	0.00
Q17	Malaria prevention	0	4.57	0.00
Q18	Food contamination	0	3.38	0.00
Q19	Water contamination	0	3.76	0.00
Q20	Combat exposure	1	6.74	6.74
Q21	Wounded in action	0	4.65	0.00
Q22	Witnessing of casualties	1	5.53	5.53
Q23	SCUD attacks	1	6.63	6.63
Q24	Chemical alarms	1	7.38	7.38
			Score	65.44

Gulf War Stress Survey Validity

Validity is the degree to which the results of a study are likely to be true, believable and free of bias. It is a measure of the accuracy of a study's conclusions, inferences, and propositions, reflecting the strength of the research design. In considering validity in terms of the Gulf War Stress Survey, it is important to examine both survey design and how representative the respondents are of the population in question. If the survey is designed well and representative of the population under consideration, it is more likely to be a valid one.

The Gulf War Stress Survey was designed to elicit the perceptions of veterans and health experts about 24 potentially stressful wartime exposures. Their responses were used to develop the Gulf War Stress Scale, which assesses the amount of stress experienced by an individual veteran. In order for the scale to be valid, the stress survey had to be an accurate reflection of the major stressors encountered by Gulf War veterans. That was ensured by taking questions about stress exposure that had been developed by military and civilian health experts for the Comprehensive Clinical Evaluation Program survey and incorporating them into the Gulf War Stress Survey. Those questions dealt with the experiences that such experts thought to be most likely to cause stress in veterans. Using the same items in the survey supported the validity of the survey and thus of the stress scale.

The target audience of the survey is the component relevant to whether or not the survey results are a valid representation of the views of the overall population under study. For the Gulf War Stress Survey, two audiences were targeted: veterans and health experts. To ensure that only the responses of targeted individuals would be included in the results, a question at the beginning of the survey questionnaires asked, "Are you a Gulf War veteran?" for those sent to veterans, and "Do you consider yourself an authority in the field of military health and/or stress?" for those sent to health experts. If this question was answered "No" or left unanswered, the respondent's responses were not included in the final survey results. Ensuring that only targeted responses are included in the results supports the validity of the survey.

Attaching Data to the AMOS Software

The cleaned Comprehensive Clinical Evaluation Program data, which was in a Microsoft Access database, was transferred into Microsoft Excel using a Stat Transfer program. Once in Excel, a formula ($S_i = \Sigma\ Q_i\ W_i$) was used that combined the Comprehensive Clinical Evaluation Program individual veteran question exposure data (Q_i) with the Gulf War Stress Scale weights (W_i) from the results of the Gulf War Stress Survey, to create a stress score (S_i) for each of the 12,205 veterans under study. This new stress score data as well as the cleaned Comprehensive Clinical Evaluation Program data were then transferred from Excel to SPSS, again using a Stat Transfer program. Once in SPSS, the data could be uploaded into the AMOS software and attached to a structural equation model.

Creation of the Structural Equation Model Used in the Study

Figures 4-8 show the development of the proposed structural equation model used to examine the effects in Gulf War Stress exposure to subsequent mental and physical health problems among Gulf War veterans. The core of that structural equation model focuses on the two latent variables, psychological health and physical health, and their effects upon the 15 health outcome indicator variables. The 15 health outcome measures emerge from a factor analysis of medical complaints/symptoms listed in the Comprehensive Clinical Evaluation Program data. (The derivation of the 15 health outcome measures is discussed later in this chapter).

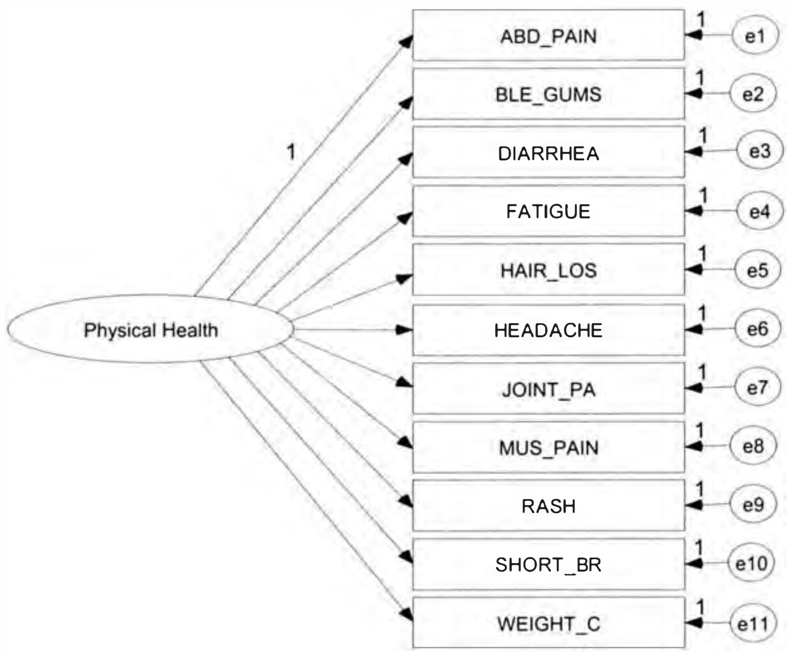

Figure 4: Eleven medical complaints/symptoms associated with physical health problems.

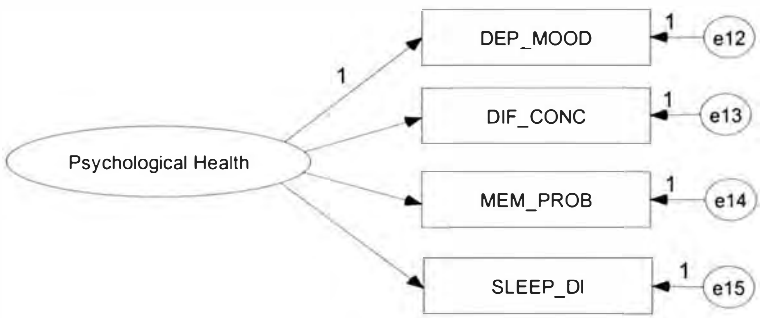

Figure 5: Four medical complaints/symptoms associated with psychological health problems.

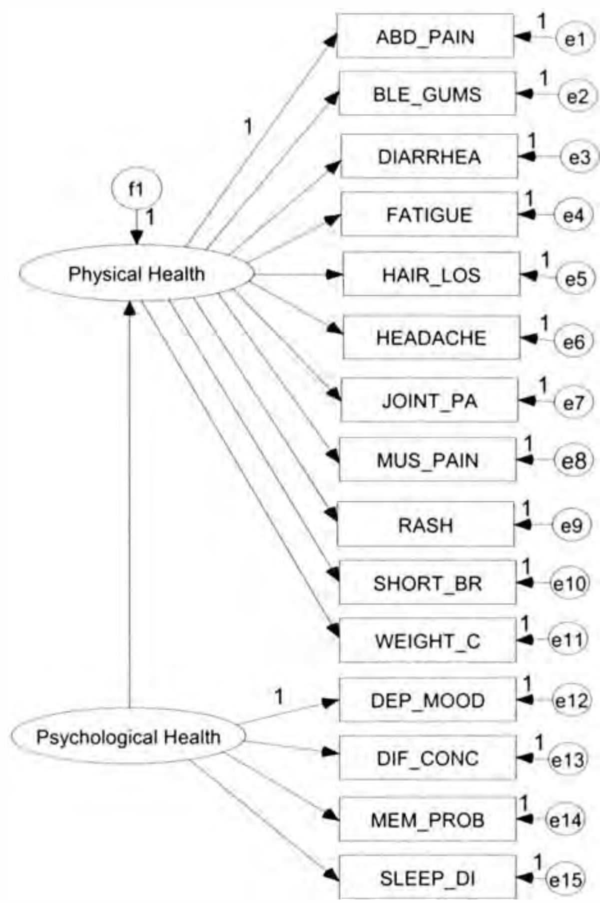

Figure 6: A proposed structural equation model showing the relationship between physical and psychological health.

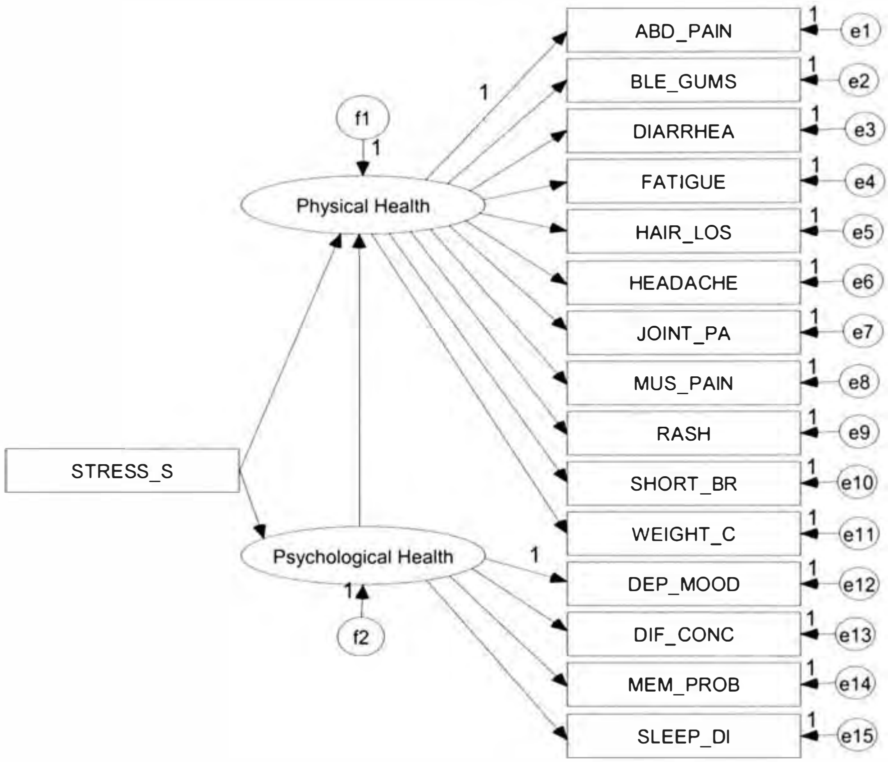

Figure 7: A proposed structural equation model showing the effects of Gulf War stress on two latent variables, physical health and psychological health.

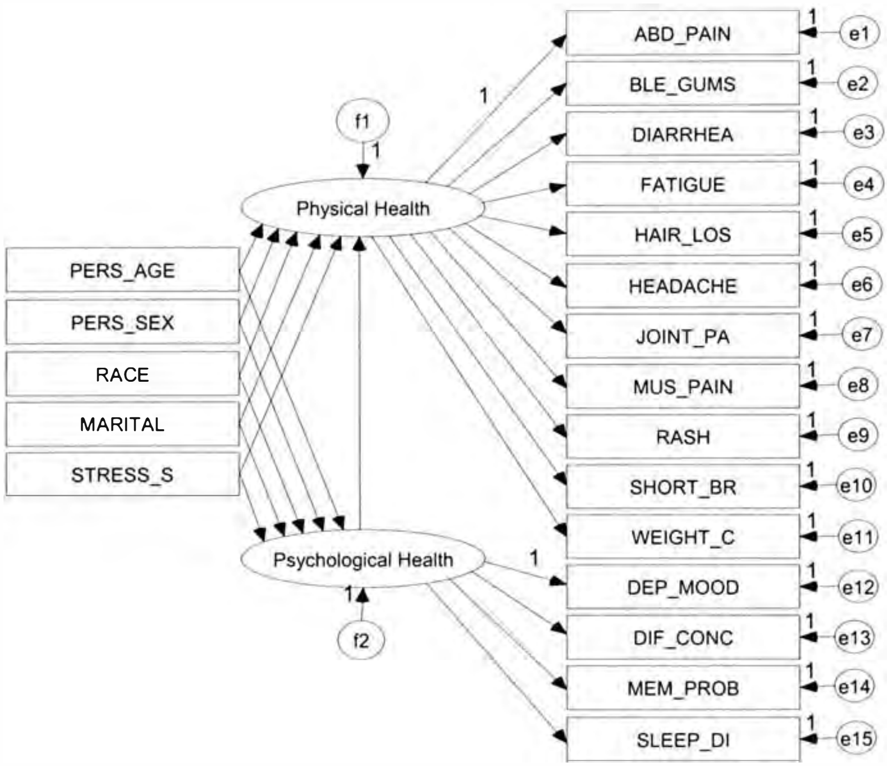

Figure 8: A proposed structural equation model showing the effects of age, gender, race, marital status, and Gulf War stress on two latent variables physical health and psychological health.

Since the medical complaints/symptoms are measured variables, they are shown in rectangles in accordance with the guidelines of structural equation model analysis. The error terms e1-e15 associated with these measured variables cannot themselves be measured, and thus are shown as circles. The regression weights between the 15 health outcome variables and e1-e15 are set to "1" for model identification purposes.

Of the 15 medical complaints/symptoms listed, eleven (abdominal pain, bleeding gums, diarrhea, fatigue, hair loss, headaches, joint pain, muscle pain, rash, shortness of breath, and weight change) are physical health problems, and thus arrows emanating from the latent variable physical health go to them (Figure 4). The remaining four complaints/symptoms (depressed mood, difficulty concentrating, memory problem, and sleep disturbances) are psychological difficulties, and thus arrows emanating from the latent variable psychological health go to them (Figure 5). Two regression weights labeled "1" are included in this model to scale the two factors, psychological and physical health, so that this model could achieve identification. (Model identification is discussed in detail later in this chapter).

The literature review establishes that psychological health has a causal effect on physical health. That relationship is reflected in the proposed model (Figure 6) by the arrow emanating from psychological health and directed toward physical health. Since in the core model, psychological health is an independent (exogenous) variable, there is no error term associated with it. Physical health, on the other hand, is influenced by psychological health and is thus considered a dependent (endogenous) variable, which must have an error term associated with it. The error term f1 is thus added to the model.

Since f1 is an estimated and not measured value, it is drawn in a circle.

The stress scores of Gulf War veterans (calculated by the Gulf War Stress Scale) are next added to the core model. Since a veteran's stress score is a measurable item, derived from the data on wartime exposure/experiences and the developed stress scale, it is represented by a rectangle in the proposed structural equation model. The literature review presents a significant amount of evidence that stress directly affects an individual's physical as well as psychological well-being. This conclusion is reflected in the proposed model by arrows emanating from the stress scores to the latent variables, physical health and psychological health (Figure 7). The addition of a stress score indicator to the model causes the latent variable, psychological health, to change from an independent (exogenous variable) to a dependent (endogenous) variable. Since exogenous variables require error terms, a new error term, f2 is attached to psychological health in the model. Like f1, which represents the error term for physical health, f2 is an estimated value and thus is drawn in a circle.

Four additional indicators (age, gender, race, and marital status) were next added to the model (Figure 8). From the literature review, it is apparent that each of these indicators has an effect upon both physical and psychological health. This effect is reflected in the structural equation model by arrows emanating from each indicator variable toward both physical health and psychological health.

Derivation of the Health Outcomes Variables

Many Gulf War veterans returned home with a wide range of health problems similar to the 15 (abdominal pain, bleeding gums, depressed mood, diarrhea, difficulty concentrating, fatigue, hair loss, headaches, joint pain, memory problem, muscle pain, rash, shortness of breath, sleep disturbance and weight change) listed in the medical complaints/symptoms portion of the Comprehensive Clinical Evaluation Program survey (see Appendix XXII). For some veterans, these problems were a chronic source of pain and suffering that disrupted their lives. For others they were minor nuisances that often just came and went. In order to derive health outcome variables that accurately reflected the health status of veterans who had fought in the Gulf War, it was necessary to incorporate not only yes/no data assessing the presence of health care problems in the veteran population, but also scaled data that could reflect the severity of those problems.

In the medical complaints/symptoms portion of the Comprehensive Clinical Evaluation Program survey, veterans were asked yes/no questions as to whether or not they had experienced or were experiencing any of the listed 15 health problems. If they answered yes to either question, they were directed to follow-up questions, which asked about the onset, duration, frequency, and level of impairment of that health problem. The follow-up questions had response choices scaled from lowest level impact on the veteran (1) up to the greatest level of impact (5). Veterans were asked to identify the impact levels of their health problems in terms of onset, duration, frequency, and impairment level. The results for that set of choices as well as the results of the yes/no experience questions were used together to come up with health outcome variables for the study.

Table 11, as an example, shows how presence and follow-up data were recorded for abdominal pain (one of the 15 listed health problems) for the first 20 of 12,205 Gulf War veterans who had responded to the medical complaints/symptoms portion of the

Table 11: Examples of how past and current experiences with abdominal pain were combined to create abdominal pain presence scores. (n=20.)

Veteran Number	Past Abd. Pain	Current Abd. Pain	Presence Abd. Pain	Abd. Pain Onset	Abd. Pain Duration	Abd. Pain Frequency	Abd. Pain Impairment
1	0	1	1	2	5	2	1
2	0	1	1	5	5	2	2
3	0	0	0				
4	1	0	1	5	3	1	2
5	0	1	1	3	5	2	2
6	1	0	1	5	1	1	1
7	1	0	1	5	3	3	1
8	0	0	1	4	1	2	2
9	0	0	0				
10	0	1	1	3	5	2	2
11	1	0	1	5	2	2	2
12	0	1	1	3	2	2	2
13	0	0	0				
14	0	0	0				
15	1	0	1	5	4	2	1
16	0	0	0				
17	0	0	0				
18	0	0	0				
19	0	0	0				
20	1	0	1	5	1	2	1

Veteran Number:	These are the first 20 out of 12,205 veteran responses in the medical complaints/symptoms portion of the Comprehensive Clinical Evaluation Program survey data.
Past Abd. Pain:	Yes/No response to the question about having experienced abdominal pain.
Current Abd. Pain:	Yes/No response to the question about currently experiencing abdominal pain.
Presence of Abd. Pain:	Combination of Yes/No responses for abdominal pain.
Abd. Pain Onset:	Scaled score responses (1-5) for abdominal pain onset (1, lowest impact, to 5, greatest impact).
Abd. Pain Duration:	Scaled score responses (1-5) for abdominal pain duration (1, lowest impact, to 5, greatest impact).
Abd. Pain Frequency:	Scaled score responses (1-4) for abdominal pain frequency (1, lowest impact, to 4, greatest impact).
Abd. Pain Impairment:	Scaled score responses (1-3) for abdominal pain impairment (1, lowest impact, to 3, greatest impact).

Comprehensive Clinical Evaluation program survey. In this example, the results of the column for past abdominal pain (a yes/no response) were combined with the results of the column for current abdominal pain (also a yes/no response) to generate the column denoting presence of abdominal pain for the 20 veterans sampled. If a yes response "1" was listed for either past abdominal pain or current abdominal pain, a "1" was recorded for that veteran under the heading presence of abdominal pain column, and that veteran was directed to the follow-up questions about abdominal pain. If a no response "0" was given for both past abdominal pain and current abdominal pain, a "0" was recorded for that veteran for presence of abdominal pain, and no follow-up questions were used. Table 11, which records 20 veterans' responses to a single health problem, is simply a small sample of how the medical complaints/symptoms portion of the Comprehensive Clinical Evaluation were recorded. The actual data used in the study consisted of the 12,205 veterans' responses to questions on 15 different health problems.

In deriving health outcome variables for this study, it was important to incorporate not only the information about the presence or absence of a particular health problem, but also information on the severity of the problem if it existed. Describing health problems in terms of both presence and severity yields a more accurate accounting of the veterans' health status. As Table 11 illustrates, for each of the 15 health problems examined in this study, "1" denoted the presence of a particular problem and "0" its absence. "0" listed for the presence of a health problem generated "0" listed in the health outcome variable, since the veteran had not experienced or was not experiencing that health problem. If "1"were listed, meaning the presence of a health problem, the results of the follow-up questions about the problems' onset, duration, frequency, and level of impairment were used to numerically establish the severity of that problem.

Factor and correlation analyses were performed in SPSS on the results of those follow-up questions for each of the 15 health problems listed in the study. The factor analysis procedure, which is a data reduction technique, was used to determine how many factors (common characteristics of the results of the questions) were needed to explain the underlying relationships among those questions. The results of the factor analysis (see Appendix XXIII) show that a single factor component for each of the 15 health problems is responsible for the majority of variance among the four follow-up questions: in each of the 15 health problems, over 75% of the variance among the questions could be explained by a single variable. In other words, the degree of uniformity among the four follow-up questions was very strong. A correlation analysis was also performed in order to generate a correlation matrix to describe how the results of individual follow-up questions linearly relate to one another. Correlation coefficients can range from -1.00 (perfect negative correlation) to +1.00 (perfect positive correlation), with a value of 0.00 representing a lack of correlation. The results of the correlation analysis in this study (see Appendix XXIII) show a high degree of correlation (.7 or greater) among the results of the four follow up questions in each of the 15 health problems. This high degree of correlation suggests that the follow-up questions were all very similar in terms of gauging the impact that a health problem had on the health status of a veteran.

Since the results of the factor and correlation analysis revealed that similarity, it was decided to have one follow-up question represent all four in terms of deriving a health outcome variable. For veterans who had experienced or were experiencing a particular health problem, one follow-up question out of the four (onset, duration, frequency, and level of impairment), was chosen to serve as a scaled response. The frequency with which a veteran experienced a health problem seemed to best represent the degree to which a health problem had affected the veteran, since in the correlation matrix (see results section) the results of the frequency question consistently correlate highest with all four questions.

Thus yes/no responses from the presence of a particular health problem column and the scaled responses from the frequency column were thus used to create a health outcome variable for each of the 15 listed health problems. Where there was a no "0" response in the presence column for a particular health problem, there would likewise be a no "0" in the health outcome variable column for that problem. Where there was a yes "1" response in the presence column, the corresponding scaled score from the frequency column would be transferred to the health outcome variable column. An example of how the health outcomes were derived can be seen in Table 12, which is an extension of Table 11. The health outcome variable to be used in the structural equation modeling analysis can be seen in bold. The procedure illustrated in Table 12 for deriving a scaled score for health outcomes was used for each of the 15 listed health problems, for 12,205 veterans.

Identification of the Model

Identification, a fundamental element in structural equation modeling, concerns the ability of a model to theoretically generate unique estimates for each of its parameters. The term "identified" describes a model that can generate unique parameter

Table 12: Examples of how Presence of Abdominal Pain and Frequency of abdominal pain were combined to create an Abdominal Pain Outcome Variable (n=20.)

Veteran Number	Past Abd. Pain	Current Abd. Pain	Presence Abd. Pain	Abd. Pain Onset	Abd. Pain Duration	Abd. Pain Frequency	Abd. Pain Impairment	Abd. Pain Variable
1	0	1	1	2	5	2	1	2
2	0	1	1	5	5	2	2	2
3	0	0	0					0
4	1	0	1	5	3	1	2	1
5	0	1	1	3	5	2	2	2
6	1	0	1	5	1	1	1	1
7	1	0	1	5	3	3	1	3
8	0	0	1	4	1	2	2	2
9	0	0	0					0
10	0	1	1	3	5	2	2	2
11	1	0	1	5	2	2	2	2
12	0	1	1	3	2	2	2	2
13	0	0	0					0
14	0	0	0					0
15	1	0	1	5	4	2	1	2
16	0	0	0					0
17	0	0	0					0
18	0	0	0					0
19	0	0	0					0
20	1	0	1	5	1	2	1	2

estimates, and "not identified" describes models that cannot do so (Kenny, 1987). Only "identified" models are of value in structural equation modeling. Those models that cannot produce unique estimates for its parameters do not provide much in terms of relevant information about the data in the model and are of little value to the researcher. Therefore, researchers who use structural equation modeling techniques in their data analysis make sure that their models are "identified" prior to analysis.

For a model to be "identified," it must meet two conditions: (1) the number of free parameters in the model must be less than or equal to the number of observations in the model, and (2) every factor must have a scale (Kline, R.B., 1998). The number of free parameters in a model consists of the total number of variances and covariances (i.e., unanalyzed associations) of the factors and measurement errors in the model, plus direct effects on the indicators from the factors (i.e. factor loadings) in the model (Kline R. B., 1998). The number of observations in a model is calculated using the formula: number of observations = v (v+1)/2, where v is the number of observed values in the model. In order for a model to be identified, the number of free parameters thus must be less than or equal to the number of observations in the model, and every factor must be scaled (weighted by designating one factor loading as 1.0).

The AMOS modeling software automatically determines whether or not a model is identified every time it is run with data. If a model is not identified, it will exhibit an error term stating so in the model output and setting the requirements for identification. If a model is identified, AMOS will state this in the model output and proceed with model analysis. The AMOS program confirmed that identification was achieved for all parts of this study's structural equation model.

Variable Measurement

The model in Figure 8 contains two latent variables physical and psychological health (shown at the center of the model), 15 health outcome variables (shown at the right side of the model) and five descriptive variables (shown at the left hand side of the model) along with associated error terms. Since the two latent variables and error terms by definition cannot be measured, they will be left out of this discussion. The derivation of the 15 outcome variables has already been discussed, which leaves this section to focus in on the measurement of the five descriptive variables in the model.

Four out of the five descriptive variables (age, race, gender, and social support systems) came directly from the personal identifier section of the Comprehensive Clinical Evaluation program data. The fifth descriptive variable (stress score) was derived though use of a stress survey results as well as exposure/experience information from the Comprehensive Clinical Evaluation Program data. Both age and stress score were normally distributed (see Results section) and thus treated as continuous data. The remaining three descriptive variables, gender, race, and social support systems were treated as discrete variables.

The variable age was measured by taking the date that the Comprehensive Clinical Evaluation Program exposure/experiences form was filled out and subtracting from it the birth year of the veteran. Since only birth years were given with the Comprehensive Clinical Evaluation Program data, the variable age was rounded down to the age in years that person was at the time they took the survey. The variable stress score was also rounded, but to the nearest hundredths position.

The discrete variables gender, race, and social support systems were each treated as binomial variables and measured as follows: gender was designated as "1" for males and "0" for females; race was divided into "1" for majority and "0" for minority; and social support systems was divided into "1" for married veteran and "0" for not married veteran. The latter two variables were designated as binomial values so that the AMOS program could understand them.

Model Analysis

Model analysis took place once all appropriate data was attached to the AMOS program, the model in question was connected to that data, and the settings on the analysis properties function were set to allow all the appropriate goodness-of-fit tests to run. The model analysis consisted of testing the three hypotheses set at the beginning of this dissertation, namely that: 1) physical health was a function of psychological health; 2) that relationship between physical health and psychological health would remain the same after taking into account the varying stress levels of Gulf War veterans; and 3) that the overall relationship would not change when the variables age, gender, race, and social support networks were introduced into the equation. The parts of the structural equation model which were used to test these hypotheses were figure 6 for hypothesis 1, figure 7 for hypothesis 2, and figure 8 for hypothesis 3. Model analysis results testing the three above hypotheses are found in the Results section.

Model Evaluation and Respecification

Once the model is run using the AMOS program, it can be evaluated to see how well it fits with the data using goodness-of-fit measures. The major goodness-of-fit measures used to determine model fit were the chi-square value, chi-square/degrees of freedom, goodness-of-fit index (GFI), adjusted- goodness-of-fit index (AGFI), root mean square error of approximation (RMSEA), Hoelter N, and the modification indices (see Appendix X). From these measures, a determination was made to respecify the model so that it would obtain a better fit with the data.

Model respecification involved reviewing the results of the modification indices to see where adjustments in the model might make a difference in overall fit and conceptually determining whether or not making these model adjustments would be theoretically meaningful. For the models tested, three modification indices were far and above higher than all others. Those were between error terms e1 (abdominal pain) and e3 (diarrhea), e7 (joint pain) and e8 (muscle pain), and e13 (difficulty concentrating) and e14 (memory problems). Since changes in these error terms conceptually made sense, they were added to the models to see if a better fit with the data could be obtained. The results of these model changes are detailed in Chapter Four.

Summary

Chapter Three describes the methods used in obtaining, formatting, and cleaning, the secondary data source (Comprehensive Clinical Evaluation Program data) used in this dissertation so that it could be made ready for structural equation modeling analysis by the AMOS modeling software. It also details the methods used in setting up, sending out, and recording the results of a stress survey so that primary data (stress scores of veterans) could be obtained. From both sources of data, structural equation models were developed to test the three hypotheses of this dissertation. The development of these models included discussions on model identification, variable measurement, the derivation of health outcome variables, and model respecification.

CHAPTER 4: RESULTS

Introduction

Chapter Four presents the empirical results of the analysis of that will be used to accept, reject, or modify the three hypotheses put forward regarding the relationship between physical health and psychological health in Gulf War veterans. It presents the structural equation models that graphically describe the three hypotheses regarding physical and psychological health and shows how well they fit with the data using numerous Goodness-of-Fit tests. From the results of these tests, decisions will be made as to whether a veterans psychological health has a causal effect upon their physical well being, whether or not the introduction of varying stress levels among veterans will change this relationship, and finally whether or not control variables such as a veterans age, gender, race, or marital status will further affect this relationship.

The Goodness-of-Fit tests that will be used to determine the course of action on the hypotheses are the following: the chi-square value, chi-square/degrees of freedom, goodness-of-fit index (GFI), adjusted-goodness-of-fit index (AGFI), root mean square error of approximation (RMSEA), Hoelter N (.05), and the modification indices (see Appendix X). Decisions on accepting, rejection, or modifying the hypotheses under consideration will depend upon the overall results of each of these tests. All three hypotheses will be considered separately when determining course of action, however all will be viewed together when interpreting results.

Model respecification will be examined in each of the structural equation models that graphically describe the three hypotheses under consideration. Respecification will be based upon theoretical considerations as well as the output from the modification indices. To statistically determine if respecification improves model fit, the Chi-Squares from the original and correlated models will then be tested for independence. If the respecified model shows independence from the original model and has a better fitting Chi-Square, then that model will be used to describe the data.

The structural equation model results will show how well the model in question fit with the data they supposedly describe. If, for example as shown in the model in Figure 9, psychological health has a causal effect on physical health, this relationship should be reflected in acceptable Goodness-of-Fit statistics. If a causal effect is not reflected by the data, the Goodness-of-Fit statistics will show an unacceptable model. A causal effect between psychological health and physical health should be interpreted as a positive association between the two variables. This means that veterans who experience psychological health problems are more likely to experience physical health problems. The reverse is also true; veterans who have fewer psychological health problems are less likely to develop physical health problems.

Results of Study Hypothesis 1

The first hypothesis under consideration for this dissertation is the following: H_0 = physical health = f (psychological health) versus H_A = physical health $\neq$ f (psychological health). The graphical representation of this hypothesis is shown in Figure 9. The arrow drawn from psychological health to physical health indicates a causal effect. The results of the model in Figure 9 are as follows: the Goodness-of-Fit

Index = 0.953; the Adjusted Goodness-of-Fit Index = 0.937; the RMSEA = 0.061; and the Hoelter N (.05) = 328. All of these figures suggest a reasonably fitting model. The Chi-Square = 4179.685 and the Chi-Square/df = 46.963 were rather higher in this model, but since the since Chi-Square is dependent upon the sample size, a large Chi-Square and Chi-Square/df were not unexpected for this model.

The three large modification indices shown: 812.80 for e13 (difficulty concentrating) and e14 (memory problems); 769.30 for e7 (joint pain) and e8 (muscle pain); and 610.19 for e1 (abdominal pain) and e3 (diarrhea) suggest that the model may be improved through respecification. Conceptually correlating the above error terms makes sense. Sufficient evidence exists in the literature to show that difficulty concentrating and having memory problems are related to one another; likewise joint pain and muscle pain often appear together; finally individuals who have abdominal pain often have accompanying diarrhea.

Figure 10 shows a respecification of the model in Figure 9 with correlations between the error terms e13 (difficulty concentrating) and e14 (memory problems); e7 (joint pain) and e8 (muscle pain); and e1 (abdominal pain) and e3 (diarrhea). The respecified Chi-Square value is compared to the original Chi-Square value in Table 13. Taking the differences in Chi-Square results between the original and revised models and then dividing by the difference in degrees of freedom gives a Chi-Square value that can be used to test the independence of the models. The resultant value 1013.996 is much greater than the acceptable value for dependence using

Results of Structural Equation Modeling Analysis

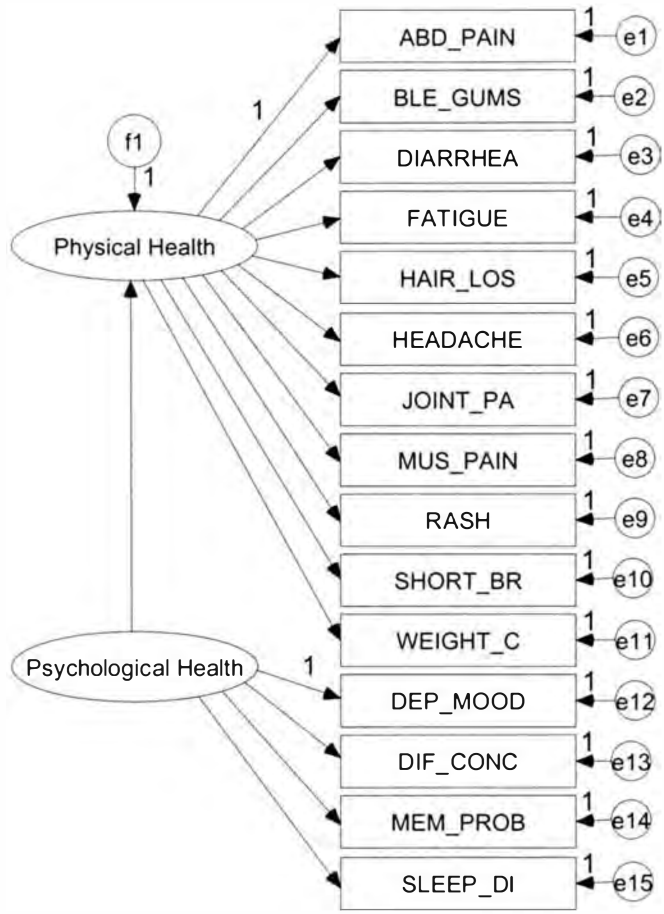

Figure 9: A proposed structural equation model showing how physical health outcomes are affected by psychological health outcomes in a cohort of Gulf War veterans. The model does not have correlated measurement errors.

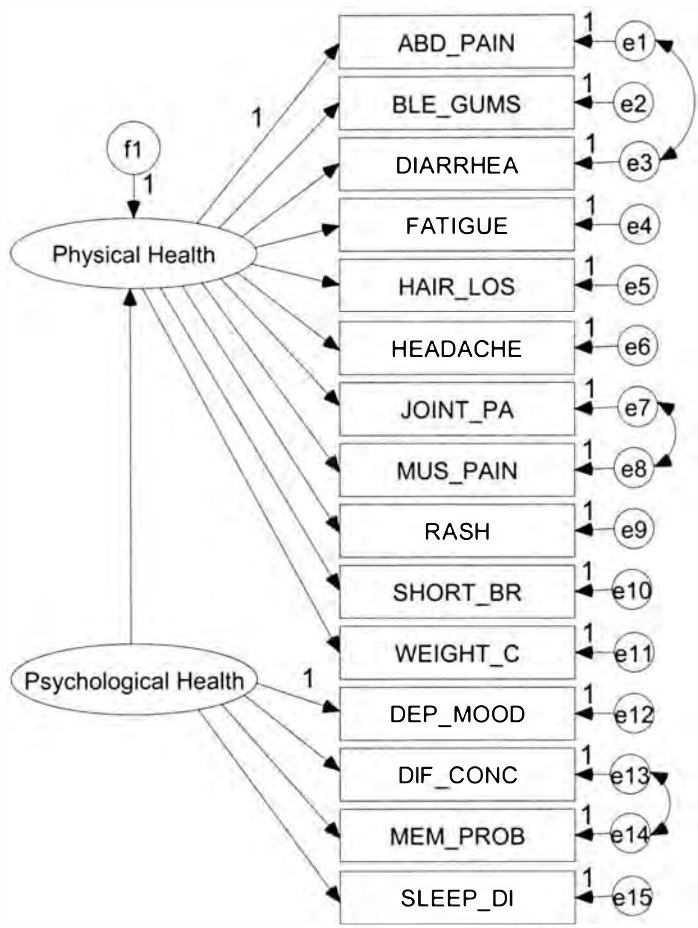

Figure 10: A proposed structural equation model showing how physical health outcomes are affected by psychological health outcomes in a cohort of Gulf War veterans. The model does have correlated measurement errors.

an alpha level of .05 and 3 degrees of freedom. Thus the two models are considered independent of each other. Since the correlated model in Figure 10 is a much better fitting model, it will be used as the model to describe the data. The Goodness-of-Fit results for the respecified model used in analyzing hypothesis 1 are shown in Table 14.

Table 13: A Comparison of the Chi-Square values between the uncorrelated model (Figure 9) and correlated model (Figure 10).

Index	Initial Model	Revised Model
Chi-Square	4179.685	1124.136
Degrees of Freedom (df)	89	86

Table 14 Goodness-of-Fit Results for Respecified Model (Figure 10).

Index	Revised Model
Chi-Square	1124.136
Degrees of Freedom (df)	86
Chi-Square/df	13.071
Goodness-of-Fit Index	0.978
Adjusted Goodness-of-Fit Index	0.983
RMSEA	0.031
Hoelter N (.05)	1180

The results of the model in Figure 10 above support the first hypothesis under consideration, which states that physical health is a function of psychological health. The Goodness-of-Fit Index = 0.978 and the Adjusted Goodness-of-Fit Index = 0.983 are well above the .90 threshold for model fit; the RMSEA = 0.031 is below the .08 maximum allowable figure for model acceptance; and the Hoelter N (.05) = 1180 is well above the value of 200 needed for model fit. Since the next two models testing hypothesis 2 and 3 build upon this core model which has three correlated error terms, the three correlated error terms in Figure 10 will be included in all subsequent model analysis.

Results of Study Hypothesis 2

The second hypothesis that is under consideration for this dissertation is the following: H_0 = physical health = f (psychological health, Gulf War Stress). H_A = physical health ≠ f (psychological health, Gulf War Stress). The graphical representation of this hypothesis is shown in Figure 11. The arrow emanating from psychological health and going to physical health remains the same as in Figure 10. The major difference in this new model and thus new hypothesis is the addition of the variable Gulf War Stress to the equation. Gulf War Stress as quantified by veterans stress scores affects both physical and psychological health and thus has two different arrows emanating from it a going to the two respective latent variables. Table 15 gives the Goodness-of-Fit statistics for Figure 11.

Table 15: Goodness-of-Fit Results (Figure 11).

Index	Revised Model
Chi-Square	1279.604
Degrees of Freedom (df)	99
Chi-Square/df	12.925
Goodness-of-Fit Index	0.987
Adjusted Goodness-of-Fit Index	0.982
RMSEA	0.031
Hoelter N (.05)	1176

The results of the model in Figure 11 support the second hypothesis under consideration, which states that physical health is a function of psychological health and Gulf War Stress. The Goodness-of-Fit Index = 0.987 and the Adjusted-Goodness-of-Fit Index is 0.982 are well above the .90 threshold for model fit; the RMSEA = 0.031 is below the .08 maximum allowable figure for model acceptance; and the Hoelter N (.05) = 1176 is well above the value of 200 needed for model fit.

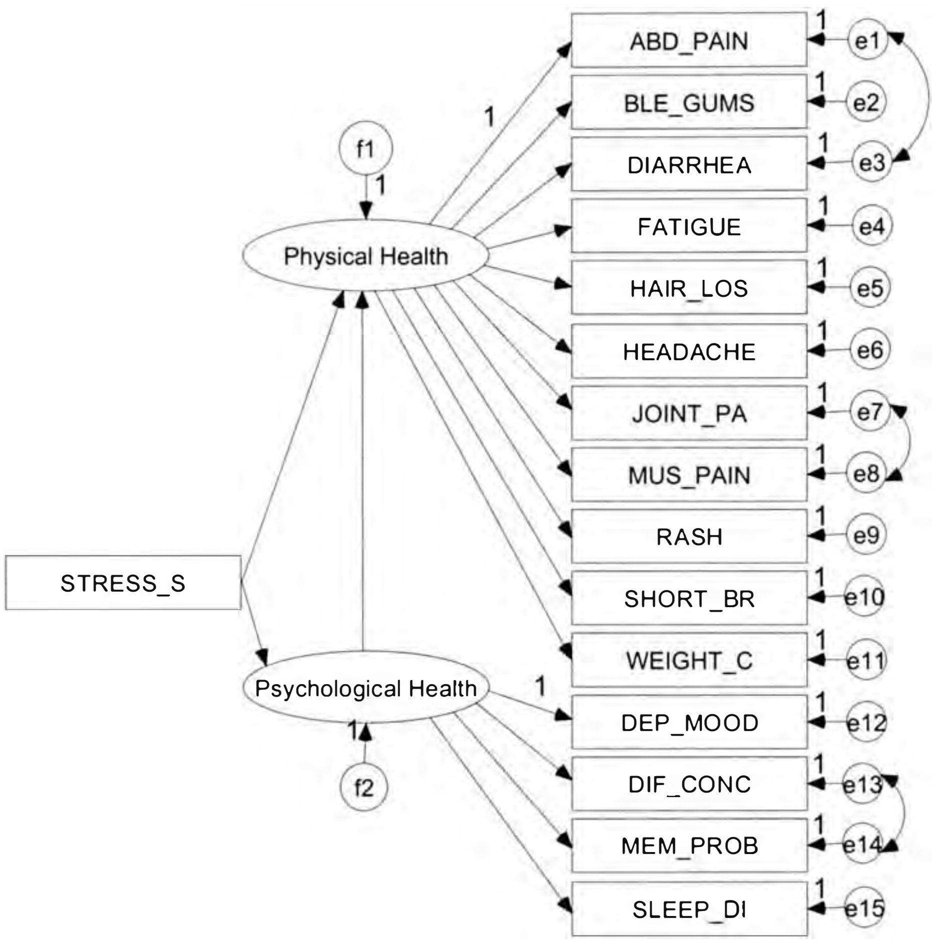

Figure 11: A proposed structural equation model showing the effects of Gulf War stress on two latent variables, physical health and psychological health. The model contains correlated measurement errors.

Results of Study Hypothesis 3

The third hypothesis that is under consideration for this dissertation is the following: H_0 = physical health = f (psychological health, Gulf War Stress, age, gender, race, and marital status). H_A= physical health $\neq$ f (psychological health, Gulf War Stress, age, gender, race, and marital status). The graphical representation of this hypothesis is shown in Figure 12. This model retains the relationships seen between variables in the previous models. The main difference between this model and its predecessors is that it adds the variables age, gender, race, and marital status to the equation to see if these factors have any influence on the way the model fits the data. The results of the model in Figure 12 are as follows: the Goodness-of-Fit Index = 0.983; the Adjusted Goodness-of-Fit Index = 0.978; the RMSEA = 0.030; and Hoelter N (.05) = 1183. All of these figures suggest a reasonably fitting model. The Chi-Square for this model is 1977.974 and the Chi-Square/df is 12.284.

The modification indices taken from the output of the model in Figure 12 indicate that there is probable correlation among the newly added predictor variables. The modification indices for the predictor variables indicate four areas where correlation may improve model fit: 218.649 between marital status and gender; 195.080 between marital status and race; 114.889 between race and gender; and 114.368 between race and age. Conceptually, each of these four relationships makes sense.

Figure 13 shows the shows a respecification of the model in Figure 12 with correlations between the predictor variables marital status and gender, marital status and race, race and gender, and race and age. The respecified Chi-Square value is compared to the original Chi-Square value in Table 16. Taking the difference in Chi-Square

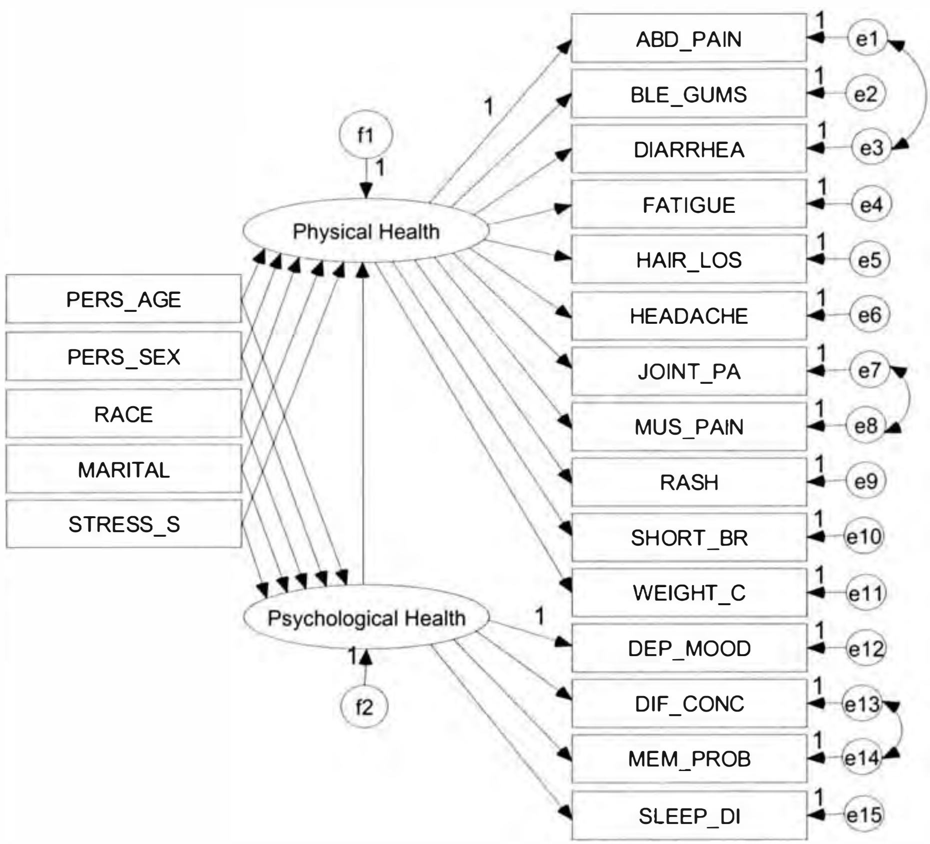

Figure 12: A proposed structural equation model showing the effects of age, gender, race, marital status, and Gulf War stress on two latent variables physical health and psychological health. The model does have correlated measurement errors but not correlated predictor variables.

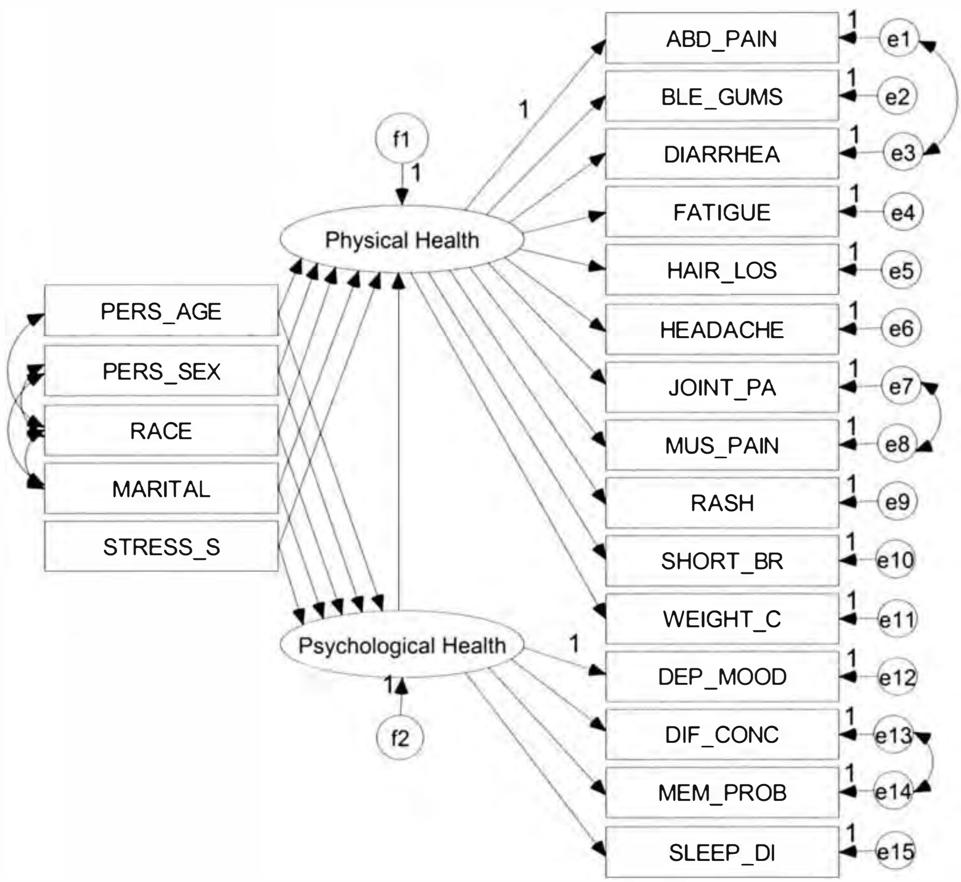

Figure 13: A proposed structural equation model showing the effects of age, gender, race, marital status, and Gulf War stress on two latent variables physical health and psychological health. The model has correlated measurement errors as well as correlated predictor variables.

results between the original and revised models and then dividing by the difference in degrees of freedom gives a Chi-Square value that can be used to test the independence of the models. The resultant value of 150.240 is much greater for the acceptable value for dependence using an alpha level of .05 and 4 degrees of freedom. Thus the two models are considered independent from each other. Since the correlating model in Figure 13 is a much better fit, it will be used to describe the data. The Goodness-of-Fit results for the respecified model used in hypothesis 3 are shown in Table 17.

Table 16: A Comparison of the Chi-Square values between the uncorrelated predictor model (Figure 12) and correlated predictor model (Figure 13).

Index	Initial Model	Revised Model
Chi-Square	1977.974	1377.015
Degrees of Freedom (df)	161	157

Table 17 Goodness-of-Fit Results for Respecified Model (Figure 13).

Index	Revised Model
Chi-Square	1377.015
Degrees of Freedom (df)	157
Chi-Square/df	8.771
Goodness-of-Fit Index	0.988
Adjusted Goodness-of-Fit Index	0.985
RMSEA	0.025
Hoelter N (.05)	1660

The results of the model in Figure 13 support the third hypothesis under consideration, which states that physical health is a function of psychological health, Gulf War Stress, age, gender, race, and marital status. The Goodness-of-Fit Index = 0.988 and the Adjusted Goodness-of-Fit Index are well above the .90 threshold for model fit; the RMSEA = 0.025 is well below the .08 maximum allowable figure for model acceptance; and the Hoelter N (.05) = 1660 is well above the value of 200 needed for model fit.

Summary

The results section provides the answers to the three hypotheses proposed concerning the relationship between psychological health and physical health. In each case, the developed models graphically illustrate that the hypotheses in question fit with the data. When necessary, the models were respecified to show the correlations that exist between the variables. This was done to better fit the models with the data. The results of this chapter indicate that the three hypotheses in question:

Hypothesis 1: H_0 = physical health = f (psychological health);

Hypothesis 2: H_0 = physical health = f (psychological health, Gulf War Stress); and

Hypothesis 3: H_0 = physical health = f (psychological health, Gulf War Stress, age, gender, race, and marital status)

should all be accepted as fitting with the data. Table 18 is a summary of the Goodness of Fit Statistics for hypotheses 1, 2, and 3 respectively. The regression weights for hypothesis 3 are provided in Table 19. The meaning of these results to veterans will be discussed in the next chapter.

Table 18 Summary of Goodness of Fit Statistics (Figures 10, 11, and 13).

Index	Hypothesis 1 Figure 10	Hypothesis 2 Figure 11	Hypothesis 3 Figure 13
Chi-Square	1124.136	1279.604	1377.015
Degrees of Freedom (df)	86	99	157
Chi-Square/df	13.071	12.925	8.771
Goodness-of-Fit Index	0.978	0.987	0.988
Adjusted Goodness-of-Fit Index	0.983	0.982	0.985
RMSEA	0.031	0.031	0.025
Hoelter N (.05)	1180	1176	1660
R^2 (Squared Multiple Correlations)	0.82	0.82	0.670

Table 19 Regression Weights for Figure 13

	Standardized Regression Coefficient	Critical Ratio (*)
Direct Effect of:		
Gulf War Stress on Psychological Health	0.010	22.842*
Marital Status on Psychological Health	-0.006	-0.346*
Race on Psychological Health	-0.004	-0.266*
Gender on Psychological Health	-0.004	-0.136*
Age on Psychological Health	0.001	1.370*
Psychological Health on Physical Health	0.560	43.855*
Gulf War Stress on Physical Health	0.003	13.418*
Marital Status on Physical Health	0.028	2.774*
Race on Physical Health	0.004	0.470*
Gender on Physical Health	-0.002	-0.104*
Age on Physical Health	0.000	0.510*
Psychological Health on Depressed Mood	1.000	
Psychological Health on Difficulty Concentrating	1.321	71.290*
Psychological Health on Memory Problems	1.249	63.896*
Psychological Health on Sleep Disturbances	1.050	52.819*
Physical Health on Abdominal Pain	1.000	
Physical Health on Bleeding Gums	0.688	33.984*
Physical Health on Diarrhea	0.938	46.115*
Physical Health on Fatigue	1.605	50.539*
Physical Health on Hair Loss	0.691	28.761*
Physical Health on Headache	1.229	45.709*
Physical Health on Joint Pain	1.314	43.615*
Physical Health on Muscle Pain	1.371	45.233*
Physical Health on Rash	0.749	28.297*
Physical Health on Shortness of Breath	1.245	44.902*
Physical Health on Weight Control	1.046	39.722*

CHAPTER 5: FINDINGS, DISCUSSIONS, AND CONCLUSIONS

Introduction

Chapter Five summarizes the findings of the statistical analysis used to test the three hypotheses concerning the relationship between physical and psychological health among Gulf War veterans. It presents the results of structural equation models that graphically illustrate the hypotheses under consideration, and states the rational behind the decisions as to accept, reject, or modify those hypotheses. A discussion ensues in this chapter on the meaning of these findings not only as they apply to the hypotheses in question, but also to the larger picture concerning overall veteran health during combat situations.

This chapter next summarizes and discusses the implications of this research in light of the substantive contributions that it veterans gain from it. It likewise discusses the methodological considerations of the research including the use of structural equation modeling techniques to examine the latent variables stress, physical health, and psychological health. Practical considerations of the research to the overall health of veterans are examined, followed by policy considerations that may be drawn from this work. This chapter will finally present the limitations of this study and make recommendations for future research on this topic.

Major Findings and Implications

The results of this research are used to make decisions on three hypotheses concerning the relationship between physical health and psychological health among veterans of the Gulf War. These results are important because they shed light on the question of whether or not psychological health problems do indeed have a causal effect the physical well being of veterans. If it can be shown that a causal relationship exists between the psychological health of veterans and their physical health, focus can be made in the area of veteran psychological health to combat both psychological as well as physical health problems that veterans are facing.

The first step in determining if a causal relationship exists between a veterans' psychological health and their physical health was to set up a hypothesis that would examine this relationship. This was done in hypothesis 1 which asked the question whether or not an individual's physical health was a function of their psychological health or not. It asked:

Hypothesis 1: **H_0 = physical health = f (psychological health).**

H_A= physical health ≠ f (psychological health).

From the results of the Goodness-of-Fit tests on the structural equation model in Figure 9, it is apparent that H_0 = physical health = f (psychological health) fits with the data of Gulf War veterans and thus should be accepted. These results thus add support previous literature that suggests that an individuals' psychological heath has a causal effect on their physical well being.

Once the first hypothesis has been supported by the results of the structural equation model analysis in Figure 9, the next step is to ask the question, "Does this causal relationship between psychological health and physical health hold up when Gulf War

Stress is entered into the equation?" Since veterans of the Gulf War experienced varying degrees of stress, it is important to see if stress could have an influence on this relationship. If Gulf War Stress played a random role in the model (meaning that veterans who experienced high stress had an equal chance of experiencing health problems as veterans experiencing low stress) the results of the Goodness-of-Fit statistics would indicate a poorer model fit, thus arguing that the model does not hold up well with the data it supposedly represents. If, on the other hand, Gulf War Stress played a more structured role (meaning that veterans who had experienced high stress also had a higher chance of experiencing health problems, and vice versa), then the results of the Goodness-of-Fit tests would argue that the model does indeed hold up well with the data.

The second hypothesis was thus:

Hypothesis 2: **H_0 = physical health = f (psychological health, Gulf War Stress).**

H_A = physical health $\neq$ f (psychological health, Gulf War Stress).

From the results of the Goodness-of-Fit tests on the structural equation model in Figure 11, it is apparent that H_0 = physical health = f (psychological health, Gulf War Stress) fits with the data of Gulf War veterans and thus should be accepted. These results thus both add support to the original hypothesis stating that psychological health has a causal effect on physical health among Gulf War veterans, and since Gulf War Stress was found to be more structured, lends support to the idea that stress during the Gulf War may have also had an impact on veterans health.

The third question to be asked when looking at the structural equation model and its relationship with the Gulf War data is "How well does this model hold up when variables such as age, gender, race, and marital status enter into the equation?" Since these personal identifying factors may have an affect on the causal relationship between psychological and physical health, it was important to incorporate them in model to see what affect they might have on that relationship. As with the variable Gulf War Stress, a randomness seen between these variables and health outcomes would indicate a poorer model fit whereas a more structured role between the variables and health outcomes would mean a better-modeled fit. If the data reflected that a veteran's age, for example, was not a factor in influencing the health outcome variables, then a model representing that data would have a poorer overall fit if the variable age were included in the model. The same would apply to the variables gender, race, and marital status.

The third hypothesis was thus:

Hypothesis 3: H_0 = physical health = f (psychological health, Gulf War Stress, age, gender, race, and marital status).

H_A= physical health $\neq$ f (psychological health, Gulf War Stress, age, gender, race, and marital status).

From the results of the Goodness-of-Fit tests on the structural equation model in Figure 13, it is apparent that H_0 = physical health = f (psychological health, Gulf War Stress, age, gender, race, and marital status) fits with the data of Gulf War veterans and should be accepted. These results thus support the causal relationship between psychological health and physical health as well as lend credibility to notion that the variables stress, age, gender, race, and marital status do have an effect on veterans' heath outcomes and are not just random variables.

In each of the three models, which graphically represented the three hypotheses under consideration, an improved model fit occurred when the error terms with the highest modification indices were correlated during model respecification. These error terms were e13 (difficulty concentrating) correlating with e14 (memory problems), e7 (joint pain) correlating with e8 (muscle pain), and e1 (abdominal pain) correlating with e3 (diarrhea). Correlated error terms show where there is high probability that if a person picked one response, they would likely choose another that was correlated to the first response. Thus, for example, individuals who said that they frequently have difficulty concentrating are likely to have memory problems as well. The same goes for muscle pain and joint pain, and abdominal pain and diarrhea.

Substantive Contributions

The results of this study indicate that a veteran's psychological health status has a causal effect upon their physical health. This means that if a veteran has psychological health problems they may wind up having physical health problems as well. These results support those already found in the literature on this subject which show that an individual's psychological health influences their physical health. When the variables Gulf War Stress, age, gender, race, and marital status are added to the equation, the relationship remains true. The variables Gulf War Stress, age, gender, race, and marital status are also shown through structural equation modeling techniques to play a role in affecting the health outcomes in veterans. Since they fit well with the model, an argument can be made that they are not random variables, but do play a role in affecting the vulnerabilities of veterans to health problems.

This study lends support to other studies that suggest that many physical problems have a psychological basis. It also lends support to the literature that states that there are vulnerable groups of veterans who may be more susceptible to having health problems than others. This study would suggest to Gulf War veterans who have physical ailments that they may look to their psychological health status for an explanation of some of the problems they may have or might have been having. It recommends to current veterans who may be in a vulnerable group or are may be asked to experience highly stressful conditions may wish to have a psychological evaluation to see if they are at greater risk of becoming ill. This study is important to veterans because it statistically links their physical well being to their psychological well being. It also supports previous studies, which suggest that there are vulnerable populations of veterans that may be more susceptible to health problems than others.

Methodological Contributions

This study examines the effects of the latent variables psychological health and physical health on health outcomes of Gulf War veterans using structural equation modeling techniques. Without the modeling techniques used in this study, it would be difficult to determine how the latent variables psychological health and physical health affect the health outcomes of veterans. The models used in this study are able to graphically illustrate the hypotheses under question. They can statistically show trends in the data which will help researchers to focus in on the problems that veterans of the Gulf War have been and are facing.

This study is also methodologically important in that it develops a scale similar to that the one produced by Holmes and Rahe to measure the effects of stress on health. The Gulf War Stress survey sent out to veterans and health experts shows how a potentially latent variable, stress can be quantified by a scale to develop measurable stress scores for veterans. These scores can be thus be added to an overall model looking at health outcomes to determine what affect if any Gulf War stress has had on veteran health outcomes.

This study is finally methodologically important because it uses structural equation modeling techniques to examine data from the Comprehensive Clinical Evaluation Program. No other study on Gulf War veterans has used this modeling technique on this very large and important database. By examining this large database using structural equation modeling techniques, trends in the health of Gulf War veteran health, which may have been previously overlooked, can be brought to light.

Practical Utilities

The results of this study can aid veterans who have physical health problems by suggesting a psychological basis for their ailments. One of the major conclusions of this study is that psychological health has a positive association with physical health. This means that when an individual has psychological health problems, they also seem more likely to be at risk for physical health problems. Veterans who have unexplained physical ailments should thus be looked at for underlying psychological health problems. By treating or preventing psychological health problems, physical health problems may be cured or averted.

The results of this study also suggest that stress affects both the psychological health as well as physical health of veterans. It shows that veterans who are highly stressed are more inclined to have health problems than those veterans who are not as much stressed. This study thus lends support to others, which suggest that stress is a causal factor in the health outcomes of veterans. By reducing the level of veteran stress, veteran health may improve. The potential stressors, which surveyed veterans and health experts, deemed the most stressful to Gulf War veterans should be good starting place when looking at a means to lower the stress level of troops in combat situations.

Policy Contributions

The Departments of Defense and Veterans Affairs can aid veterans by increasing the level of funding/research looking into how a veteran's physical health is influenced by their psychological health. If substantial evidence is uncovered suggesting that there is a definite link between an individuals psychological health and their physical well being, changes in how veterans are recruited or handled while in service may be in order. Since stress contributes to both psychological and physical health problems, policies that lower the stress levels of veterans, who should help to alleviate problems experienced by veterans.

Finally, veterans should be made aware of the potential harm that poor psychological heath can have on their physical health. If a veteran is depressed, they should be made aware that there are medications available to offset that depression; if they have family or substance abuse problems, they should be made aware that counseling is available; if they have anger issues, problems relaxing, or any of a host of other psychological heath problems, they should be made aware that treatment is available. By reducing the underlying causes to psychological health problems, both psychological and physical health problems may be averted.

Limitations of the Study

Although a great deal of effort was made to ensure that the study accurately reflected the experiences and health outcomes of Gulf War veterans, this study did have several limitations that should now be brought to light. One of the major study limitations concerned the use of secondary data in the study. The Comprehensive

Clinical Evaluation Program although a large database with lots of useful information was not designed to quantify health outcomes as was done in this study. A factor analysis thus had to be performed among the outcome data so that it could effectively be used in the models. A second limitation to this study was the use of recall data. Veterans who answered question about the Gulf War did so several years after it had ended. They may have over time forgotten exposures/experiences that they encountered while serving in the Gulf. The use of recall data could thus have hampered this study. Finally, this study had to rely on self-report data. Veterans had to be taken on their word as to whether or not they were experiencing health problems as a result of service in the Gulf War. The motive to gain more health benefits may have affected the ways that some veterans responded to question about their health.

Recommendations for Future Research

Future studies on this topic may wish to survey veterans who are currently serving in Iraq and Afghanistan on how their exposures/experiences may have impacted their health outcomes. By surveying veterans who are just coming out of a war zone, you will eliminate the recall bias found in this study. Likewise, a new study on this topic could be designed to use primary data specifically meant to look at psychological heath and physical heath. A more current and better-designed study would improve our knowledge of how the stresses of combat affect both the physical and psychological health of veterans.

Finally, the predictor variables used in this study could be looked at in greater detail in future studies. Race, instead of being either majority or minority could be broken down into more segmented groups. Likewise marital status, instead of being married or not married, could be broken down into more detailed variables such as being married, single, separated, divorced, or widowed.

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APPENDICES

Appendix I: Historical Background

In August 1990, the United States began deploying troops to the Persian Gulf area in response to Iraq's invasion of Kuwait. Between the initial phase, known as Operation Desert Shield, and the end of the armed conflict, known as Operation Desert Storm, approximately 697,000 U.S. military personnel served in Saudi Arabia, Kuwait, and other countries in the Persian Gulf area (IOM, 1996). These Americans who fought in what became known as the Gulf War differed greatly in terms of demographics from any previous U.S. military force. They were on average older, more ethnically diverse, contained more women, and had a larger percentage of troops coming from the National Guard and Reserves than any other force in U.S. history (PACGWVI, 1996). The vast majority of these troops who had never seen combat were now being asked to quickly assemble and take on the worlds fourth largest military force, in the Iraqi army, which had three years prior completed a long and bloody eight year war with neighboring Iran. They were in short, asked to be uprooted from their daily life activities, transplant themselves half way across the world to an unfamiliar land, and prepare to fight a relatively unknown enemy for an unknown length of time.

The deployment of American and Coalition fighting forces to southwest Asia in the fall of 1990 came about as the result of Iraq's aggression into Kuwait, its threat against Saudi Arabia, and its noncompliance to United Nations (U.N.) resolutions that it immediately withdraw its armed forces from Kuwait. Operation Desert Shield, the ordering by President George Bush of U.S. forces to the Persian Gulf began soon after the Iraqi incursion into Kuwait in August of 1990. Its military mission was to prevent further Iraqi aggression into oil rich Saudi Arabia, show the Iraqis that the United States was committed to enforcing the mandated U.N. resolutions, and prepare for a possible military campaign to restore the sovereignty of Kuwait if the crisis could not be solved peacefully.

The Americans and their coalition partners upon arriving in the Persian Gulf found themselves up against a formidable enemy that seemed to be willing to use any means necessary to assert its authority upon the region. Under Saddam Hussein, Iraq had by 1990 built itself up into a powerful military force with an army estimated to be over 500,000 strong, an extensive air-defense network fashioned after the Soviet model, and a large number of aircraft, tanks, and SCUD (see Appendix XVI) missiles. It also had laser-guided bombs, radar-controlled sea skimming antiship missiles, and high performance jet aircraft purchased from Soviet, European, Chinese, and other sources (Blackwell, 1991). Most concerning to U.S. and Coalition officials, however, was the large Iraqi stockpile of chemical and biological weapons (CW/BW) that Iraq was thought to possess and their seemingly indifference in using them (Blackwell, 1991). Since Saddam Hussein had a history of using chemical weapons on both the Iranians in 1982, and against its own Kurdish population in 1988, all indications were that he would do so again against U.S. and Coalition forces if so prompted.

U.S. military and Coalition personnel took the threat of CW/BW attack by Iraq very seriously. Troops arriving in the Gulf region were given a considerable amount of training in both the response to CW/BW alarms and in the use of their protective equipment (Clancy T. & Franks F., 1997). In addition, to protect these troops from such threats, the Department of Defense obtained special permission from the Food and Drug

Administration (FDA) in Interim Rule 55 FR 52814 (see Appendix XVII) to use drugs and vaccines, that were considered "investigational" by the FDA for military purposes. The two most common investigational drugs used by the DoD on U.S. military personnel were the pretreatment drug Pyridostigmine Bromide (PB) and the vaccine Botulinum toxin (BT). Pyridostigmine bromide is a reversible cholinesterase inhibitor that is given in pill form to prevent death in the event of exposure to nerve agents. Botulinum toxin is a vaccine that is used against the pathogenic bacterium Clostridium botulinum, which when aerosolized, is potentially a very dangerous biological weapon. Troops were also vaccinated against the one of the oldest and most feared pathogenic bacteria, Bacillus anthracis commonly known as Anthrax.

By early January 1991 it became apparent that Saddam Hussein would not yield to UN demands that he immediately withdraw his troops from Kuwait and that a military option would be needed. With the passing of the UN established deadline on January 15, 1991 to bring a peaceful conclusion to the crisis in the Gulf, President Bush, along with Coalition nations authorized the onset of Operation Desert Storm, the liberation of Kuwait through military means. At 3 a.m. January 17, 1991 Iraqi time (7 p.m. EST January 16, 1991) Allied forces launched Desert Storm with a massive and devastating bombing campaign against Iraq and her forces in Kuwait. The air campaign, which both damaged Iraq's military infrastructure as well as lowered her morale, continued unabated until late February 1991 when the Coalition forces were ready enter the ground phase of Desert Storm. On February 24, 1991 at 4 a.m. Iraqi time (8 p.m. EST February 23, 1991) General Norman Schwarzkopf, the commander of Desert Storm forces, initiated the ground campaign with a thrust into the heart of the Iraqi forces in central Kuwait. This was immediately followed by a flanking maneuver to the west around Iraqi forces by more mobile troops to cut off lines of supply and avenues of retreat. With no supplies and facing an overpowering force, thousands of Iraqi soldiers simply gave up rather than fight, as the Allies pushed through Iraq's defenses with relative ease. Learning that his army was in full retreat and the liberation of Kuwait on hand, Saddam Hussein in on last act of defiance ordered his troops to set fire to all Kuwaiti oil fields still in Iraqi hands. Despite this atrocious act, Allied leaders were determined to end the war as soon as possible in order to spare further bloodshed. Once Kuwait was completely liberated and the Iraqi army no longer posed a threat to other countries in the region Coalition forces decided to bring the conflict to a conclusion. Thus on February 28, 1991 after securing agreements through the U.N. that Iraq would remove its claim on Kuwait, destroy all weapons of mass destruction, and submit itself to weapons inspections, President George Bush suspended all further U.S. military operations against the Iraqi army.

The fighting, which took place from the middle of January until the cease-fire on February 28, 1991, included 40 days of air warfare and 5 days of ground combat. Although Iraq fired many SCUD missiles at U.S. troops and Israel, none appeared to contain BW/CW that U.S. and Coalition troops so feared. What 6 months prior had seemed to be a daunting task that would claim thousands if not tens of thousands of American lives soon proved to be a great success for such a large-scale military operation. The military objective of freeing Kuwait from its Iraqi aggressors was met with U.S. troops suffering minimal losses, 148 combat deaths, 145 deaths due to disease or accidents, and 467 wounded service personnel, figures far lower than anticipated or occurring in previous large scale U.S. military conflicts (Writer, 1996). In all, the Gulf War was viewed by Americans as a great military success: Kuwait was free, the Iraqi army was defeated, the U.S. had stronger alliances with the nations that had made up the Coalition, and the world had seen the might of U.S. military forces.

Appendix II: International Military Coalition against Iraq

The international military Coalition put together in response to Iraq's failure to abide to U.N. resolutions demanding its withdrawal from Kuwait was the largest to be employed in combat since World War II. The Gulf War Coalition included ground, navel, and air forces from numerous countries. The primary contributors' of troops from outside the Gulf area were the United States (697,000), Britain (35,000), Egypt (35,000), France (25,000), Bangladesh (6,000), Pakistan (5,000), and Morocco (1,500). Substantial forces were also provided by countries in the regions surrounding Iraq and Kuwait, including Syria (20,000), Saudi Arabia (45,000), and the Gulf States – Bahrain, Qatar, Oman, and the United Arab Emirates (17,000). Other countries contributing military forces included Afghanistan, Argentina, Australia, Belgium, Canada, Czechoslovakia, Denmark, Germany, Greece, Hungary, Honduras, Italy, Kuwait, The Netherlands, New Zealand, Niger, Norway, Poland, Portugal, Senegal, South Korea, Spain, and Turkey.

Source: United States General Accounting Office, Report on to the Chairman, Subcommittee on National Security, Veterans' Affairs, and International Relations, House Committee on Government Reform
Coalition Warfare
Gulf War Allies Differed in Chemical and Biological Threats Identified and in Use of Defensive Measures.
April 2001

Appendix III: United Nations Security Council Resolutions

A. United Nations Security Council Resolution 660 2 August 1990

The Security Council, alarmed by the invasion of Kuwait on 2 August 1990 by the military forces of Iraq, determining that there exists a breach of international peace and security as regards the Iraqi invasion of Kuwait, acting under Articles 39 and 40 of the Charter of the United Nations:

1. Condemns the Iraqi invasion of Kuwait;
2. Demands that Iraq withdraw immediately and unconditionally all its forces to the positions in which they were located on 1 August 1990;
3. Calls upon Iraq and Kuwait to begin immediately intensive negotiations for the resolution of their differences and supports all efforts in this regard, and especially those of the League of Arab States.
4. Decides to meet again as necessary to consider further steps to ensure compliance with the present resolution.

Adopted by 14 votes to none, with one abstention (Yemen)

Of the 15 Security members five are permanent: China, France, Soviet Union, United Kingdom, and the United States. In 1990, the remaining members, elected by the General Assembly to serve two-year terms, were: Canada, Colombia, Cuba, Ethiopia, Finland, Ivory Coast, Malaysia, Romania, Yemen, and Zaire.

B. United Nations Security Council Resolution 678 17 December 1990

Noting that, despite all efforts by the United Nations, Iraq refuses to comply with its obligation to implement resolution 660 (1990) and in flagrant contempt of the Security Council, the United Nations:

1. Demands that Iraq comply fully with resolution 660 (1990) and all subsequent relevant resolutions, and decides, while maintaining all its decisions, to allow Iraq one final opportunity, as a pause of goodwill, to do so;
2. Authorizes Member States cooperating with the Government of Kuwait, unless Iraq on or before 15 January 1991 fully implements, as set forth in paragraph 1

above, the foregoing resolutions, to use all necessary means to uphold and implement resolution 660 (1990) and all subsequent relevant resolutions and to restore international peace and security in the area;

3. Requests all States to provide appropriate support for the actions undertaken in pursuance of paragraph 2 of the present resolution;

4. Requests the States concerned to keep the Security Council regularly informed on the progress of actions undertaken pursuant to paragraphs 2 and 3 of the present resolution;

Adopted by 12 votes to two (Cuba and Yemen), with one abstention (China)

Source: http://www.un.org/Docs/scres/1990/scres90.htm

Appendix IV: Timeline

Numbers in timeline correspond to locations on timeline map.

May 28-30, 1990 – Iraqi President Saddam Hussein asserts oil overproduction by Kuwait and United Arab Emirates is "economic warfare" against Iraq. Iraq at the time is trying to recoup economic losses from an 8-year war with Iran (1980-1988).

July 15-17, 1990 – Iraq accuses Kuwait of stealing oil from Rumaylah oil field on Iraq-Kuwait border and warns of military action.

July 22, 1990 – Iraq begins military buildup against Kuwait.

August 2, 1990 #1 – Iraq invades Kuwait and seizes Kuwaiti oil fields. Kuwait's emir flees. Iraq masses troops along the Saudi border. UN condemns Iraq's invasion and demands immediate withdrawal.

August 6, 1990 – UN imposes trade embargo on Iraq.

August 7, 1990 – Saudi Arabia requests U.S. troops to defend against possible Iraqi attack.

August 8, 1990 – Saddam Hussein proclaims annexation of Kuwait.

August 9, 1990 #2– First U.S. military forces arrive in Saudi Arabia. UN declares Iraqi annexation of Kuwait void.

August 10, 1990 – Saddam Hussein declares a "jihad" or holy war against the U.S. and Israel.

August 12, 1990 – Naval blockade of Iraq begins. All shipments of Iraqi oil halted.

August 28, 1990 – Iraq declares Kuwait its 19th province, renames Kuwait City al-Kadhima.

September 14-15 – United Kingdom and France announce deployment of 10,000 troops to Gulf.

December 17, 1990 – UN sets deadline for Iraqi withdrawal on January 15, 1991. Saddam Hussein rejects all UN resolutions.

January 3, 1991 – Defense Department censors war reporting by press.

January 9, 1991 – Talks between US Secretary of State Baker and Iraqi Foreign Minister Tariq Aziz end in stalemate.

January 12, 1991 – Congress grants President Bush authority to wage war.

January 17, 1991 – Operation Desert Storm begins at 3 a.m. Baghdad time.

January 19, 1991 ○ #3– First scud missiles strike Israel.

January 22, 1991 – Iraq begins blowing up Kuwaiti oil wells.

January 25, 1991 ○ #4 – Iraq begins "environmental war" by pumping millions of gallons of crude oil into Gulf.

January 30, 1991 ○ #5 – Iraqi and Coalition forces engage in first important ground battle in Khafji, Saudi Arabia.

February 1, 1991 – Secretary of Defense Richard Cheney warns US will retaliate if Iraq uses chemical or unconventional weapons.

February 8, 1991 – Total U.S. troops in Gulf now over half million.

February 12-13, 1991 – Air bombardment of Baghdad destroys three major bridges and kills 400 people in air-raid shelter.

February 19, 1991 – Soviet-Iraqi peace plan rejected by President Bush. Oil spill in Gulf now estimated at 1.5 million barrels.

February 22, 1991 – President Bush issues 24-hour ultimatum: Iraq must withdraw from Kuwait to avoid start of ground war.

February 24, 1991 #6 – Allied ground campaign begins. Schwarzkopf's warlords carry out Gulf War's critical "left hook" maneuver as conceived by General Grant's 1863 Civil War campaign at Vicksburg.

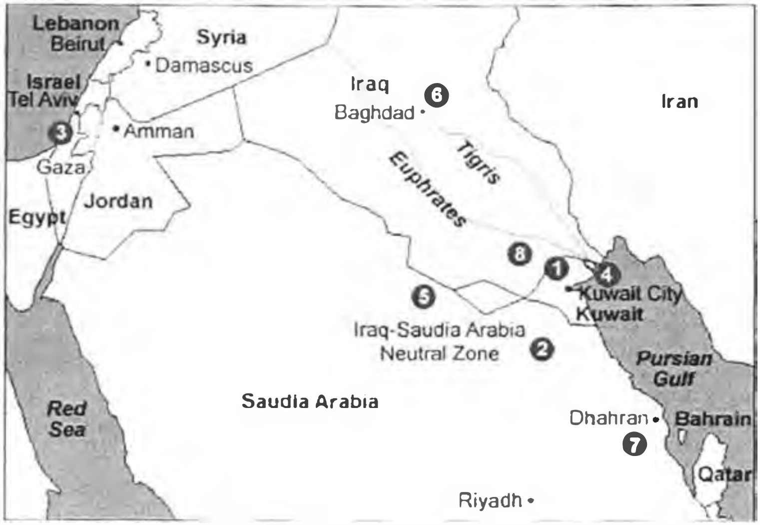
February 25, 1991 #7 – Iraqi Scud missile hits U.S. barracks in Dhahran, Saudi Arabia, killing 28 U.S. soldiers.

February 26, 1991 #8 – Hussein announces Iraq's withdrawal from Kuwait. Iraqi troops exodus from Kuwait City results in "Highway of Death."

February 27, 1991 – Coalition forces enter Kuwait City. U.S. 1st Armored Division fights battle of Medina Ridge against Iraqi Republican Guard in Iraq. President Bush declares Kuwait liberated.

Source: http://www.pbs.org/wgbh/pages/frontline/teach/gulfguide/gwtimeline.html

GULF WAR THEATER OF OPERATIONS



Source: http://www.pbs.org/wgbh/pages/frontline/teach/gulfguide/timelinemap.html

Appendix V: U.S. Military Casualties from WWI through the Gulf War

War/ Conflict	Branch of Service	Number of Serving	Battle Deaths	Other Deaths	Wounds
World War I 1917 – 1918	Total	4,734,991	116,516	63,114	204,002
	Army	4,057,101	106,378	55,868	193,663
	Navy	599,051	7,287	6,856	819
	Marines	78,839	2,851	390	9,520
World War II 1941 – 1946	Total	16,112,566	405,399	113,842	671,846
	Army	11,260,000	318,274	83,400	565,861
	Navy	4,183,466	62,614	25,664	37,778
	Marines	669,100	24,511	4,778	68,207
Korean War 1950 – 1953	Total	5,720,000	36,516	2,830	103,284
	Army	2,834,000	29,861	2,133	77,596
	Navy	1,177,000	647	155	1,576
	Marines	424,000	4,510	242	23,744
	Air Force	1,285,000	1,498	300	368
Vietnam Conflict 1964-1973	Total	8,744,000	58,198	10,788	153,303
	Army	4,368,000	38,212	7,265	96,802
	Navy	1,842,000	2,562	933	4,178
	Marines	794,000	14,840	1,749	51,392
	Air Force	1,740,000	2,584	841	931
Persian Gulf War 1990 – 1991	Total	696,562	148	151	467
	Army	351,080	98	105	354
	Navy	158,148	6	14	9
	Marines	104,006	24	26	92
	Air Force	82,528	20	6	12
	Coast Guard	800	0	0	0

Sources: 1) Table 2-23, Principal Wars in which United States participated, U.S. military personnel serving and casualties. Military Casualty Information, Department of Defense. (1998), Internet site: http://web1.whs.osd.mil/mmid/m01/sms223r.htm. 2) Demographic and Military Characteristics of Participants in Persian Gulf War (1994), Internet sites: http://www.gulflink.osd.mil/dsbrpt/table1.gif, http://web1.osd.mil/mmid/casualty/table10.htm

Appendix VI: Purpose of Research on Gulf War Veterans

Gulf War veterans were exposed to a wide variety of environmental hazards and potential harmful substances during their service in Southwest Asia. The majority who answered their country's call to duty did their jobs and returned home resuming their normal activities with little noticeable difficulty. For others however, there were a wide range of health problems that seemed disproportionate to the brevity of actual combat and the relatively low casualty rate (IOM, 1996). Although it has been almost thirteen years since the Gulf War and many studies have been conducted trying to find the causes and or cures to these health problems, no single or definitive cause or global cure has emerged. Many theories over the years have been supported or disproven, by these continued research efforts, but overall, the causes of Gulf War Illnesses remain undefined (FSRGWVI, 2001). Nonetheless, progress has been made in understanding the health problems of veterans of the Gulf War, and efforts to attempt to remedy these problems will continue to remain a national priority.

There are several reasons why the health concerns of servicemen and women who were deployed to the Gulf are still being studied this after the war has ended. First and foremost among them is our country's national obligation to our veterans. As President Lincoln stated in his second inaugural address:

> *"With malice toward none, with charity for all, with firmness in the right as God gives us to see the right, let us strive on to finish the work we are in, to bind up the nation's wounds, to care for him who shall have borne the battle and for his widow and orphan, to do all which may achieve and cherish a just and lasting peace among ourselves and with all nations."*
>
> *Abraham Lincoln*
> *March 4, 1865*

Today, a pair of metal plaques bearing the words: "To care for him who shall have borne the battle and for his widow and orphan" flank the entrances to the Washington, D.C.

headquarters of the Department of Veterans Affairs (VA) to underscore the government's obligation to care for those injured during wartime and to provide for the families of those who perished on the battlefield. Those servicemen and women who answered their county's call to duty in the Gulf are no different than the long list of fighting men and women of the United States that have preceded them. Those who are having health problems as a result of service to their country, even though they may not be currently diagnosable, deserve the best our country can offer in terms of research into the causes and treatment of their illnesses. President Clinton summed up Americas obligation to her Gulf War veterans in a March 6, 1995 speech to the Veterans of Foreign Wars (VFW):

Caring for veterans is not a national option or a partisan program. It is a national tradition and a national duty...There are thousands of veterans...who served their country in the Gulf War and came home to find themselves ill...Just as we relied on these men and women to fight for our country, they must now be able to rely on us to try to determine what happened to them in the Gulf and to help restore them to full health. We will leave no stone unturned.

Bill Clinton
March 6, 1995

The United States has an obligation to protect and care for our troops not only in the heat of battle, but also before and after the battle when the effects of war might not be as noticeable. Although the war ended almost thirteen years ago, there are still veterans who are experiencing health problems as a result of serving in the Gulf War. These veterans who put their lives on hold and then on the line for this country deserve the best in terms of research and treatment that that this great nation can offer.

Appendix VII: Medical Evaluation Programs for Gulf War Veterans

VA Gulf War Registry

With growing concerns that veterans were having health problems that emanated from their service during the Gulf War, the Department of Veterans Affairs (VA) in 1992 established a Gulf War Registry to both record potential harmful exposures encountered by veterans during deployment as well as track any illnesses that they may be experiencing. The registry, which initially was set up to track veterans who exposed to smoke from the burning Kuwaiti oil fields, soon was expanded to cover any health-related concerns veterans of the Gulf War might be having. Veterans who choose to participate in the registry are offered a free, complete physical examination with basic laboratory studies at VA medical centers around the country. They are asked about their medical history, their experiences in the Gulf War, including possible exposures to environmental hazards, and health problems if any they have had since returning from the Gulf region. Once registered, participants receive priority heath care at VA facilities and are notified of any Gulf War-related medical developments, benefit changes and related matters. To date, more than 75,000 Gulf veterans have received the Registry health examination (VA Fact Sheet, 2000).

Comprehensive Clinical Evaluation Program (CCEP)

In response to continuing concerns about health problems with regard to service in the Persian Gulf, the Department of Defense (DoD), in June of 1994 instituted the Comprehensive Clinical Evaluation Program (CCEP) to provide a thorough, systematic clinical evaluation program for the diagnosis and treatment of Gulf War veterans. The main objective CCEP is to diagnose and treat active-duty military personnel who have medical complaints that they believed could be related to their service in the Persian Gulf. (CCEP Guide, 1995) In the CCEP, each individual receives a comprehensive medical evaluation that is based upon standardized clinical protocols including a medical history, physical examinations, and laboratory tests (CCEP Phase I). Patients are referred to a second phase of the CCEP for further specialty consultations at a regional medical center when it is clinically indicated in the judgment of the primary care physician. (CCEP Phase II). CCEP Phase II consists of targeted symptom specific examinations along with mandated psychiatric evaluations that include the Structured Clinical Interview for DSM III-R and the Clinician Administered PTSD Scale. As of January 2001, over 50,000 veterans of the Gulf War have already registered for evaluation with the CCEP (Deploymentlink, 2001).

Note: Members of the service who are still on active duty or who are still in the Reserves or National Guard should request their medical evaluations through the CCEP. Veterans, who have already left the service, Reserves, or National Guard, request their medical evaluations through the VA Gulf Registry.

Appendix VIII: Holmes and Rahe Social Readjustment Scale

Holmes and Rahe Social Readjustment Scale

Rank	Life event	Mean Value
1.	Death of spouse	100
2.	Divorce	73
3.	Marital separation	65
4.	Jail term	63
5.	Death of a close family member	63
6.	Personal injury or illness	53
7.	Marriage	50
8.	Fired at work	47
9.	Marital reconciliation	45
10.	Retirement	45
11.	Change in health of family member	44
12.	Pregnancy	40
13.	Sex difficulties	39
14.	Gain of new family member	39
15.	Business readjustment	39
16.	Change in financial state	38
17.	Death of close friend	37
18.	Change to different lines of work	36
19.	Change in number of arguments with spouse	35
20.	Mortgage over $100,000	31
21.	Foreclosure of mortgage or loan	30
22.	Change in responsibilities at work	29
23.	Son or daughter leaving home	29
24.	Trouble with in-laws	29
25.	Outstanding personal achievement	28
26.	Wife begins or stops work	26
27.	Begin or end of school	26
28.	Change in living conditions	25
29.	Revision of personal habits	24
30.	Trouble with boss	23
31.	Change in work hours or conditions	20
32.	Change in residence	20
33.	Change in schools	20
34.	Change in recreation	19
35.	Change in church activities	19
36.	Change in social activities	18
37.	Mortgage or loan less than $30,000	17
38.	Change in sleeping habits	16
39.	Change in the number of family get-togethers	15

Holmes and Rahe Social Readjustment Scale Continued:

Rank	Life event	Mean Value
40.	Change in eating habits	15
41.	Vacation	13
42.	Christmas	12
43.	Minor Violations of the Law	11

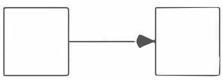
Appendix IX: Symbols for Diagrams of Structural Equation Models

Symbols for Diagrams of Structural Equation Models

Path Modeling Notations

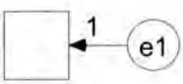
BOXES are used to describe observed measures. Observed measures are sometimes called indicators.

CIRCLES are used to describe theoretical variables. Other terms that are used are latent variables, unmeasured variables, and constructs.

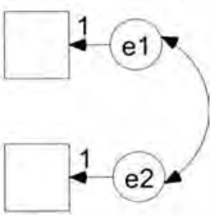


This ARROW, whether between two boxes or two circles represents a causal reoationship from a causal variable to an effect.

This ARROW, which also can connect two boxes or two circles, represents a noncausal relationship between two variables.



This ARROW, which does not originate from a box but rather from a circle with the letter e inside represents a residual to a measure or variable.



This ARROW represents a covariance between two residuals.

Source: Maruyama G.M., 1997.

Appendix X: Goodness-of-Fit Tests and Modification Indexes

The following goodness-of-fit tests will be applied to each model(s):

1) Chi-square value – the chi-square statistic is one of the most common fit test programs. It tests the hypothesis that an unconstrained model fits the covariance/correlation matrix as well as the given model. A chi-square of 0 occurs only with a perfect fit. The more the implied sample covariances differ, the bigger the chi-square statistic, and the stronger the evidence against the null hypothesis (Arbuckle, 1999). The chi-square value is also affected by sample size. The larger the sample size, the larger the chi-square value. Thus when interpreting the chi-square statistic, it is important to look at in context of sample size as well as in conjunction with other model fit statistics.

2) Chi-square/degrees of freedom – chi-square/degrees of freedom is the minimum sample discrepancy divided by the degrees of freedom. Some researchers allow values as large a 5 as being adequate for model fit, but conservative use calls for rejecting models with relative chi-square/degrees of freedom greater than 2 or 3. Like the chi-square, this index generally increases with sample size.

3) Goodness-of-Fit Index (GFI) – the GFI is a measure of the discrepancy between predicted and observed covariances. It varies from 0 (worst) to 1 (best) fit. By convention, the GFI should be equal or greater than .9 to be accepted by the model.

4) Adjusted Goodness-of-Fit Index (AGFI) – the AGFI is a variant of the GFI, which uses mean squares instead of total sums of squares in the numerator and a denominator of 1-GFI. The AGFI is a measure of goodness-of –fit while taking

into account the degrees of freedom available. It too, varies from 0 (worst) to 1 (best) fit. AGFI should be at least .9 for a good model fit.

5) Root Mean Square Error of Approximation (RMSEA) – The RMSEA is the square root of the mean squared amount by which the sample variances and covariances differ from the corresponding estimated variances and covariances, estimated on the assumption that the hypothesized model is correct. The smaller the RMSEA, the better the model fit. An RMSEA equal or less than 0.05 represents a close fit. An RMSEA equal or less than 0.08 is an acceptable fit.

6) Hoelter N – if N is greater or equal to 200 at the alpha level of .05, it suggests that your model fits reasonably well. Hoelter's critical N is the largest sample size for which one would accept the hypothesis that the model is correct.

7) Modification Indices (MI) – the modification indices suggest paths to add to the hypothesized model to improve its fit. The modification indices represent the expected drop in overall chi-square value if the parameter under question were to be freely estimated in a subsequent run. Large modification indices indicate poorly fitting areas of the model.

Appendix XI: Iraqi Chemical Weapons

CHEMICAL AGENTS

The pre-Gulf War Iraqi arsenal contained chemical agents that were designed to kill, seriously injure, or incapacitate persons due to their physiological effects. Among the most worrisome to Coalition forces were the nerve agents' tabun, sarin, soman, cyclosarin and VX (methylphosphonothioic acid) and the vesicant (blistering) agents' sulfur mustard and nitrogen mustard (PAC Final Report, 1996). These chemical agents, which are hard to recognize without detectors until clinical symptoms appear, are capable of being delivered by ballistic missiles, aerial bombs, short-range rockets, mines, or sprayed from aircraft, trucks, or tanks. According to the U.S. General Accounting Office, Iraq had already delivered mustard gas and tabun with artillery shells, aerial bombs, missiles, rockets, grenades, and bursting smoke munitions during the Iran-Iraq war. (GAO, Coalition Warfare, 2001)

Nerve Agents

History and Significance

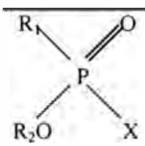
The first nerve agent (NA) discovered was tabun by Dr. Gerhard Schrader in Germany during the mid-1930s who at the time was in charge of a program to develop new types of insecticides (Paxman, 1982). He and his colleagues found tabun to not only be an effective as an insecticide, but also noticed that it had properties that were very damaging on humans. In 1935, the Nazis had passed a decree that required all inventions of possible military significance to be reported to the ministry of war. A sample of tabun was sent to the chemical warfare of the Army weapons office in May 1937, and Schrader summoned to Berlin to give a demonstration. As a result, in 1939 a pilot plant for tabun as a military weapon was set up and later in 1942 a full plant was made. At the same time Nazi scientists discovered the related nerve agents sarin (1938) and soman (1944).

Nerve Agents fortunately were never used as a military weapon by Germany during World War II (WWII), most likely due to fear of an in kind retaliation by the Allies. President Roosevelt had in fact announced a no-first-use policy but had promised instant retaliation for any Axis use of chemical agents. After the war, with the Soviets capturing both a full-scale tabun plant and a pilot sarin plant intact and the United States and Britain gaining knowledge from German chemists, both sides of the Cold War had Nerve Agent technology. Through separate research programs, an even more lethal nerve agent VX ("V" stands for venomous) was discovered simultaneously in the mid-50s by both the Soviets and the British who shared their knowledge with the Americans. (USAMRICD, 1995)

Chemical Structure

The Nerve Agents listed above are phosphoric acid esters, structurally related to the larger family of organophosphate compounds. They are highly toxic chemical agents that poison the nervous system and disrupt bodily functions that are vital to an individual's survival. Their chemical structures are given below:

Chemical Structure of Nerve Agents



Agent	X	R_1	R_2
Tabun	CN	$N(CH_3)_2$	C_2H_5
Sarin	F	CH_3	$CH(CH_3)_2$
Soman	F	CH_3	$CH(CH_3)C(CH)_3$
Cyclosarin	F	CH_3	Cyclohexyl
VX	$SCH_2CH_2N[CH(CH_3)_2]_2$	CH_3	C_2H_5

Source: SIPRI (1973)

Mechanism of Action

The effects of nerve agents are mainly due a common mechanism that inhibits the enzyme acetylcholinesterase (AChE), which hydrolyses acetylcholine (ACh) wherever it is released. Acetylcholine is a neurotransmitter that activates specialized receptors at the nerve synaptic junction, promoting the discharge of the nerve on the other side of the synapse and stimulating the action of the nerve. Normally, as a nerve impulse arrives at a synapse, ACh is liberated in packets from storage vesicles, crosses the synaptic cleft, and stimulates specialized receptors of the adjacent neuron, depolarizing the postsynaptic membrane. The enzyme AChE then, almost immediately, inactivates ACh so that transmission of the impulse ceases and the membrane can repolarize itself and be ready to respond to another stimulus. As a consequence of NA inhibition of AChE, ACh accumulates at synapses, giving rise to uncoordinated bursts of signals, initially stimulating function, and then paralyzing it.

The nerve agents tabun and sarin are quite volatile, representing a considerable respiratory threat but with low persistence. Their volatility makes them less of a threat from dermal exposure. Soman and cyclosarin are somewhat less volatile and more persistent, and both pose significant dermal and respiratory threats. VX in not very volatile and is very persistent. It represents a serious dermal threat as well as dangerous one when delivered by aerosol. All are subject to hydrolysis and degradation in the environment lasting hours to a few days (Augerson, 2000).

Signs and Symptoms

Signs and symptoms of NA poisoning from the NATO Handbook on the Medical Aspects of NBC (Nuclear, Biological, and Chemical) Defensive Operations include the following:

Mild Poisoning: (1) Unexplained runny nose, (2) Unexplained sudden headache, (3) Sudden drooling, (4) Pinpointed pupils (if exposure to NA vapour has occurred), (5) Tightness of chest or difficulty breathing, (6) Localized sweating and muscular twitching, (7) Stomach cramps, (8) Nausea.

Severe Poisoning: (1) Strange or confused behavior, (2) Wheezing, dyspnoea (severe difficulty in breathing), and coughing, (3) Severely pin-pointed pupils, (4) Red eyes with tearing, (5) Vomiting, (6) Severe muscular twitching and general weakness, (7) Involuntary urination and defecation, (8) Convulsions, (9) Unconsciousness, (10) Respiratory failure, (11) Bradycardia.

Source: NATO Handbook on the Medical Aspects of NBC Defensive Operations, 1996

Prevention and Treatment

A combination of pretreatment and post exposure therapy may combat the lethal effects of Nerve Agent poisoning. Pretreatment therapy includes the administration of protective equipment and or drugs in advance of the poisoning that are designed to either increase the efficiency of treatment post-exposure or make post-exposure therapy unnecessary. During the Gulf War, troops were given and trained in the use of wearing all-enveloping protective clothing including masks, suits, gloves, and boots specifically designed to protect an individual against a chemical or nerve attack. Many were also given a widely used pretreatment drug for NA exposure, the carbonate anticholinesterase pyridostigmine bromide (PB). Post exposure therapy includes the immediate masking of Nerve Agent casualties if the atmosphere is still contaminated, prompt removal of any liquid NA from the skin, clothing, or eyes if present, and the administration of the antidote atropine if any signs or symptoms are noted (Virtual Navy Hospital, 1995). Atropine is an essential drug in the treatment of nerve agent poisoning. It acts by blocking the effects of acetylcholine at receptors and produces relief from many of the symptoms previously listed.

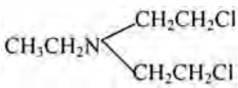
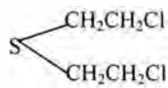
Vesicant (Blistering) Agents

History and Significance

Vesicants are so named because of the vesicles (blisters) they cause on the skin; however, these agents also damage the eyes and airways by direct contact and have other effects. Sulfur Mustard and Nitrogen mustard are the most feared vesicants historically, because of their chemical stability, their persistency in the field, the insidious character of their effects by attacking the skin as well as eyes and respiratory tract. (Pechura and Rall, 1993) Sulfur mustard was one of the most dreaded chemical weapons of World War I and was often used as a terror weapon meant to instill confusion and panic among the enemy prior to an offensive. Nitrogen mustard, which was developed in the 1930s as a modification of sulfur mustard, was found to have greater systemic toxicity than sulfur mustard, and was found to be particularly potent on cells that are actively proliferating, including the lymphoid tissue, bone marrow, and certain cells lining the gastrointestinal tract (OSRD, 1946). While both sulfur and nitrogen mustards had low lethality, their ability to cause incapacitating eye, respiratory, and skin injuries make them an effective military weapon.

Chemical Structure

The chemical structures of Nitrogen and Sulfur mustard are given below:

Structure of Nitrogen Mustard	Structure of Sulfur Mustard
	

Mechanism of Action

At the cellular level, sulfur and nitrogen mustards are able to exert their effects upon an individual due to their lipophilic nature, which allows them to readily penetrate the cell and eventually nuclear membranes, and their chloroethyl arms readily react with cellular DNA and RNA. Both mustards have a binding affinity for the nitrogen base guanine, which is a critical component of both DNA and RNA. The binding of mustard agent to guanine causes problems with cellular replication and protein development leading to mutations and/or the synthesis of non-functional proteins. Mustards eventually cause death at the cellular level through energy loss following DNA breakage, loss of cell membrane integrity, or perturbation of cytoskeletal organization (Smith et al. 1995).

Signs and Symptoms

According to the Environmental Protection Agency (EPA), the symptoms of acute exposure to mustard gas may include dyspnea (difficult or labored breathing), cough, fever, headache, severe eye irritation, photophobia (sensitivity to light), lacrimation (tearing), and blindness. Irritation or ulceration of the respiratory tract may occur from inhalation; lesions may be fatal. Dizziness, malaise (body discomfort), anorexia, and lethargy can occur after acute exposure. Arrhythmias and CNS excitation with convulsions followed by CNS depression may occur. Nausea, vomiting, and diarrhea may be caused by ingestion or by systemic absorption. Hemorrhage and anemia may develop several days after exposure. *Taken from the EPA*, www.epa.gov.

Prevention and Treatment

Besides putting on protective equipment, there is no practical treatment available for preventing the effects of mustard exposure. The aim of therapy should therefore be to (1) relieve symptoms, (2) prevent infections, and (3) promote healing (NATO, 1996). Decontaminating the patient from the mustard agent is a high priority of treatment. This includes removing contaminated clothing and washing the infected areas several times with water. Open blisters could cause secondary infections and thus must be treated with antibiotics. If respiratory problems are detected, air-purifying or supplied-air respiratory equipment should also be worn.

Appendix XII: Iraqi Biological Weapons

BIOLOGICAL AGENTS

Prior to and during the Gulf War, U.S. and Coalition officials were very fearful that Saddam Hussein would resort to using his biological and chemical warfare program in attempt to stave of any retaliatory strike against his forces in Kuwait. Since the mid-eighties, he had spent close to $100 million on a biological warfare program that was concentrated on producing an aerosolized (airborne) form of the active spores of the naturally occurring bacteria anthrax (*Bacillus anthracis*) and on developing a botulinum toxin, formed by another bacterium *Clostridium botulinum* (Tucker, J.B. 1993). Both biological warfare agents, once produced, could exert their effects very rapidly, almost instantaneously incapacitate any unprotected persons, and if untreated result in a high probability of dying an excruciating death within days. In announcing in a speech in Baghdad in January of 1991 that he had no intention of relinquishing Kuwait and was ready for the 'mother of all wars' Saddam Hussein implied that he would use any means necessary including biological weapons if war came about (DoD, 1992). This was the first time since World War II that the United States had faced a military adversary with a highly probable biological warfare capability and the resolve to use it (Tucker, J.B. 1993).

The two most likely biological agents thought to be used against U.S. and Coalition forces in the Gulf were aerosolized anthrax and botulinum toxin (Gulf War Review, 2000). Further information on each is given below.

Bacillus anthracis

History and Significance

Anthrax is a naturally occurring zoonotic disease caused by the rod shaped bacterium Bacillus anthracis which occurs primarily in of plant eating animals (goats, sheep, cattle, horses etc.). For centuries, it has caused disease in animals and, uncommonly serious illness in humans throughout the world. Most human infections were caused by direct (cutaneous) contact with infected animals or contaminated animal products and had a low mortality rate if treated immediately with antibiotics. A rare aerosol form of anthrax, often called inhalation anthrax, was recognized a century ago among woolen mill workers who processed contaminated animal wool or hair usually in confined spaces. This aerosol form of anthrax was found to be so highly lethal that research soon began on using it as a potential biological weapon. It is now estimated that several countries, including Iraq are able to produce a weaponized form of anthrax (Zilinskas, 1998).

Threat

Anthrax, in the minds of most military and counterterrorism planners, represents the single greatest biological warfare threat (Cieslak, 1999). Not only is anthrax extremely lethal in its aerosolized form, but an attack can occur very quietly without any bombs going off or any observable "clouds" being present. With limited abilities to rapidly detect an aerosolized anthrax attack, the first sign that an attack may be thousands of people rushing to the hospital after a few days of exposure. In 1970, a World Health Organization (WHO) expert committee estimated that casualties following the theoretical aircraft release of 50 kg of anthrax over a developed urban population of 5 million would be 250,000, 100,000 of whom would be expected to die without treatment (WHO, 1970). A 1993 report by the U.S. Congressional Office of Technology Assessment estimated that between 130,000 and 3 million deaths could follow the aerosolized release of 100kg of anthrax spores upwind of the Washington D.C. area – lethality matching or exceeding that of a hydrogen bomb (OTA, 1993). An economic model developed by the Center for Disease Control (CDC) suggested that an aerosolized anthrax attack would cost $26.2 billion per 100,000 persons exposed (Kaufmann, 1997).

Mechanism of Action

The disease occurs with the inhalation of anthrax spores usually less than 5 microns in size into the pulmonary alveolus of the lungs. Here they are engulfed by alveolar macrophages, which transport them to the regional tracheobronchial lymph nodes, where they germinate, multiply, and produce toxins (See Figure 14). These toxins cause massive hemorrhage and edema in the lymph nodes and mediastinum. Anthrax bacilli, which arose from the germinated spores, can next spread to the blood, leading to septicemia, the seeding of other organs, and frequently hemorrhagic meningitis (Friedlander, 1997). Death is the result of respiratory failure associated with pulmonary edema, overwhelming bacteremia, and often meningitis.

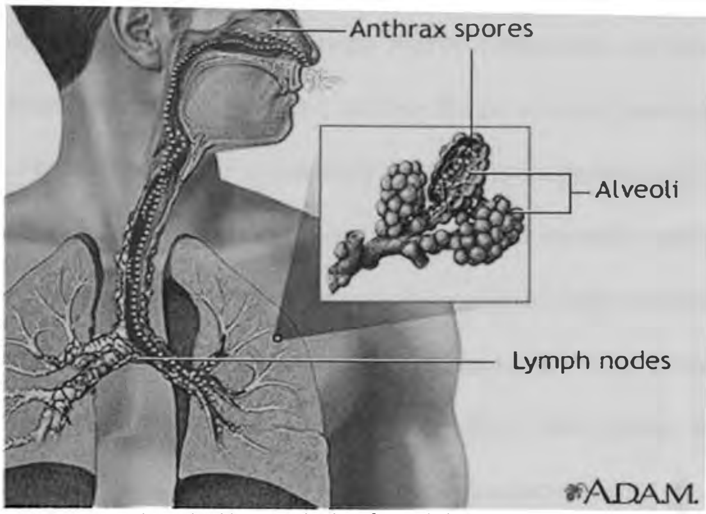


Figure 14 reproduced with permission from Adam.com

Figure 14: Anthrax Spores attaching to the lymph nodes of the lungs

Signs and Symptoms

The symptoms of inhalational anthrax begin after a 1 to 6 day incubation period following exposure. Initial symptoms are non-specific and include malaise, fever, myalgia and non-productive cough. These are often followed after a period of 2-3 days by a sudden onset of severe respiratory distress associated with diaphoresis, cyanosis and increased chest pain. Chest X-ray examination usually shows a characteristic widening of the mediastinum and often pleural effusion (Inglesby, 1999). Meningitis is present as a complication in up to 50% of cases, and some patients may present with seizures (Friedlander, 1999). Death usually follows in 24-36 hours following the onset of respiratory distress.

Prevention and Treatment

The only currently approved vaccine for the prevention of anthrax is manufactured and distributed by the BioPort Corporation, in Lansing, Michigan (GAO, Anthrax Vaccine, 2001). It is a cell-free filtrate vaccine (meaning that it does not contain dead or live bacteria in its preparation) of a nonencapsulated attenuated strain of *B anthracis.* Although the safety and efficacy of the currently used anthrax vaccine have never been established either for cutaneous or inhalation exposure in humans (Nass, 2002) trials using the vaccine on experimental monkeys have rendered them up to 88% immune to aerosol spore challenge (Ivins, 1996). This standard anthrax vaccine which is currently approved by the Food and Drug Administration is routinely administered to persons at risk for exposure to anthrax spores (Dixon, 1999). It is DoD policy to vaccinate all forces unless medically (due to adverse reaction, pregnancy, etc.) or administratively (retiring military personnel, military contractors etc.) exempted (http://www.anthrax.mil/). Since the existing anthrax vaccine supplies are currently limited, it in now only required that those military personnel assigned now or rotating to designated high threat areas be required to take the vaccine.

A high index of clinical suspicion and rapid administration of effective antimicrobial therapy are essential for prompt diagnosis and effective treatment of anthrax. If an inhalational anthrax attack is suspected, treatment should immediately be started on persons who potentially were at risk of exposure. Given the difficulty in achieving rapid microbiologic diagnosis of anthrax, all persons with fever or systemic disease in an area where anthrax cases are occurring should be treated for anthrax until the disease is excluded (Inglesby, 1999). Limited clinical experience is available and no controlled trials in humans have been performed to validate current treatment recommendations, however, nonhuman primate studies and other animal in vitro data point to the use of ciprofloxacin or doxycycline as the appropriate antimicrobial prophylaxis to use until antimicrobial susceptibility tests are known (CDC, 2001). Once it is determined whether or not anthrax is present and concerns regarding the antibiotic resistance in the particular strain are met, the most widely available, efficacious, and least toxic antibiotic should be administered to patients and persons requiring postexposure prophylaxis (Inglesby, 1999). Because of the potential persistence of spores following a possible aerosol exposure, antibiotic therapy should be continued for at least 30 days if used alone, and although supporting data are less definitive, longer antibiotic therapy (up to 42--60 days) might be indicated (CDC, 2000).

Clostridium botulinum

History and Significance

Botulism is a rare but serious paralytic illness caused by a nerve toxin that is produced by the bacterium *Clostridium botulinum.* The bacterium, which is a gram-positive spore-forming anaerobe, can be found in soil samples and marine sediments throughout the world. Seven toxigenic types (designated by the letters A through G) of the organism exist, each producing an immunologically distinct form of botulinum toxin. Types A, B, E and F are the toxins most often responsible for disease in humans, while types C and D only cause disease in other animals (e.g., nonhuman mammals, birds, fish). Although type G has been isolated from soil in Argentina, no outbreaks involving it have been recognized (FDA, 1992). Botulism is generally seen in 3 clinical scenarios, as follows: (1) the ingestion of pre-formed toxins in food contaminated with *C botulinum*, (2) contamination of wounds by *C botulinum*, and (3) colonization of the intestine by *C botulinum* in infants younger than 1 year (CDC Facts about Botulism, 2001). A fourth, man-made form that results from aerosolized botulinum toxin is inhalational botulism. This man-made inhalational botulism is the one that has significance as a biological weapon.

Historically, the botulism toxin has been known to be effective as a biological weapon since the early days of World War II. The head of the Japanese biological warfare group (Unit 731) admitted to feeding cultures of *C botulinum* to prisoners with lethal effect during that country's occupation of Manchuria (Arnon, 2001). Likewise, Allied intelligence information indicated that Germany was attempting to develop botulinum toxin as a cross-channel weapon to be used against invasion forces (Middlebrook, 1997). From these concerns that Germany had weaponized botulinum toxin, more than a million doses of botulinum vaccine were made for Allied troops preparing to invade Normandy on D-Day (Arnon, 2001). Although botulinum toxin was never widely used as an offensive weapon during World War II, its potency and potential were recognized around the world. Soon many nations including the United States began biological weapons programs. With the recognition that the use of biological weapons potentially could have catastrophic effects on all of humanity, 144 nations have since 1972 have been signatories to the Biological and Toxin Weapons Convention (BTWC) which prohibits the development, production and stockpiling of biological and toxin weapons for offensive purposes.

Threat

Botulinum toxin poses a major bioweapons threat because of its extreme potency and lethality; its ease of production, transport, and misuse; and the need for prolonged intensive care in affected persons (Arnon, 2001). It is the most poisonous substance known, with an estimated toxic dose (serotype A) of only 0.01ug/kg if body weight (Gill, 1982) and is 15,000 times more toxic than the nerve agent VX and 100,000 times more toxic than sarin (Franz, 1997). A single gram of crystalline toxin, evenly dispersed and inhaled has the potential to kill more that one million people (Arnon, 2001). Although the, 1972 BTWC prohibited the development, production and stockpiling of bacteriological (Biological) and toxin weapons, signatories Iraq and the Soviet Union had been known to be producing botulinum toxin (Arnon, 2001). With the economic difficulties in Russia after the demise of the Soviet Union, some thousands of scientists formerly employed by its bioweapons program have been recruited by nations attempting to develop biological weapons (Arnon, 2001).

Mechanism of Action

The mechanism of action for botulism is similar for each of for each of the four types listed. Once the toxin is absorbed and enters the bloodstream, it travels to the presynaptic nerve terminal at the neuromuscular junction and at the cholinergic autonomic sites. There it binds to a to a receptor or acceptor on the surface of the target neuron where it prepares for internalization by the neuron. A substantial body of evidence indicates that the botulism toxin enters neurons by the general pathway used by several other bacterial toxins, a number of polypeptide hormones or growth factors, and even some viruses known as the receptor mediated endocytosis (RME) (Middlebrook, 1997). RME is the process by which substances (ligands) concentrated on the cell surface by virtue of binding receptors invaginate to become vesicles within the cell so as to be transported to one or more sites in the cell interior carrying along the contents. At various stages of vesicle trafficking, some of the cellular contents escape or are released into the cytoplasm. In the case of botulism, the toxins released from the vesicles cleaves at least one of three proteins that are involved in bringing the neurotransmitter acetylcholine to the nerve synapse (the location where nerve to nerve transmission of information occurs) (Hilbourne, 2001). Cleavage by the neurotoxin inhibits acetylcholine release from the synapse (Schiavo, 1997). With the loss of communication, nerve paralysis results.

Symptoms

Clinically, botulism presents as a symmetric, descending flaccid paralysis that begins in the head and face and spreads downward. Initial findings may include drooping eyelids, blurred vision, double vision, dry mouth, slurred speech and difficulty swallowing, followed by loss of muscle tone, generalized weakness, and loss of the gag reflex, which may require intubation to protect the airway. As paralysis extends beyond bulbar musculature, loss of head control, hypotonia, and generalized weakness become prominent. Deep tendon reflexes may be present initially but diminish or disappear in the ensuing days, and constipation may occur. In untreated persons, death results from airway obstruction (pharyngeal and upper airway muscle paralysis) and inadequate tidal volume (diaphragmatic and accessory respiratory muscle paralysis) (Arnon, 2001).

Treatment

The treatment of botulism is to give antitoxin, which is available from the health department, and to support aggressively, preferably in an ICU. The licensed antitoxin contains antibodies against three of the seven types of botulinum toxin (A, B, and E), which cause most cases of human disease. The US Army holds an investigational antitoxin, which is active against all seven types. Because botulinum antitoxin is derived from horses, hypersensitivity reactions, including hives, serum sickness, and anaphylaxis occur in a significant minority of patients. Timely administration of neutralizing antibody will minimize subsequent nerve damage but will not reverse the existing paralysis (Tacket, 1984). If the respiratory system fails, mechanical ventilator support becomes necessary, often for many weeks. The recovery period reflects the time for the body to regenerate damaged nerve fibers (Hilbourne, 2001).

Appendix XIII: Vaccines against Chemical and Biological Weapons

Botulinum Toxoid

The threat of a botulism aerosol attack by the Iraqi army prompted the Department of Defense to investigate the using of a botulism toxoid as a means of protecting troops. At the time of the Gulf War, a botulinum toxoid existed that covered many of the serotypes of botulism harmful to humans. This toxoid, which was a modified bacterial toxin that is made nontoxic but has the capacity to stimulate the formation of antibodies, was distributed to several U.S. combat units prior to and during the Gulf War. According to the Department of Veterans Affairs, approximately 137,850 doses of botulinum toxoid were sent to the Gulf, and it is estimated that 8,000 individuals vaccinated (Committee on Veterans Affairs, 1998). Since the efficacy of this toxoid had never been proven due to the ethics involved in such testing, the toxoid was labeled as an Investigational New Drug (IND). Due to the military extingencies of the Gulf War, the FDA commissioner waived the informed consent requirements that go along with INDs so that troops could be protected. This thus meant that Gulf War military personnel who received the botulism toxoid were given an unapproved FDA pre-treatment vaccine without the ability to refuse taking it.

Anthrax Vaccine

Concerns that Iraq would use inhalational anthrax as a biological weapon against U.S. forces in the Gulf prompted the military to administer Anthrax Vaccine Adsorbed (AVA) to estimated 150,000 service members during Operations Desert Storm and Desert Shield (Hilborne, 2001). The AVA vaccine given to these U.S. military personnel was licensed in 1970 and had previously been used mainly to protect at-risk populations such as textile mill workers, veterinarians, laboratory scientists, and other workers with occupational risk, from acquiring anthrax. The recommended dosage schedule for these workers called for six injections over an 18-month period with booster shots occurring annually. Since 1967 (when the vaccine was in its IND stage) to just prior to the Gulf War, more than 20,000 inoculations had routinely been administered to these at risk populations (PACGWVI, 1996). The known overall effectiveness of the vaccine, prior to Operation Desert Shield was 92.5 percent (lower 95 percent confidence interval = 65 percent): 91.4 percent in the high-risk group of workers and 100 percent in the low risk group of workers (Jollenbeck, 2002). It was not possible to evaluate the efficacy of the vaccine against inhalational anthrax separately because of the small number of cases (Jollenbeck, 2002). Thus, although the AVA vaccine was approved for general use at the time of the Gulf War and did not require consent for administration, its effectiveness for protecting an individual from an aerosolized attack had not been determined. This coupled with the unknown long-term effects of taking the AVA vaccine plus the possibility of becoming ill during wartime as result of taking the vaccine became a concern to a number of troops.

Appendix XIV: Pyridostigmine Bromide

Pyridostigmine bromide is a reversible cholinesterase inhibitor that was used during the Gulf War as a pretreatment for exposure to nerve agents. Its action is similar to that of nerve agents that bind to AChE and cause harm to the nervous system. The major difference between pyridostigmine bromide and nerve agents in terms of mechanism of action are that Pyridostigmine bromide binds reversibly to AChE whereas the binding of nerve agents is permanent. In theory, and demonstrated by animal models, pyridostigmine bromide administered as a pretreatment drug will compete with nerve agents in binding with AChE. Pyridostigmine bromide can thus prevent the permanent disabling of AChE by nerve agents by binding with it until the nerve agents have bound with something else or left the body. Since it binds to AChE like nerve agents, administration of pyridostigmine bromide will give off symptoms of nerve agent attack but over time with the release of pyridostigmine bromide from AChE, a person's nervous system will return to normal. Pyridostigmine bromide also is a preferred drug against nerve agent attack because it has been shown to usually not cross into the central nervous system and thus have a harmful impact on brain function or mental performance (Golomb, 1998).

The FDA initially licensed pyridostigmine bromide in 1955 to treat persons with myasthenia gravis, an autoimmune disease characterized by increased weakness and fatigability of muscles (De Fraites, 1996). Though Pyridostigmine bromide is approved by the FDA for use in treating patients with myasthenia gravis, it remains an investigational new drug (IND) for nerve agent pretreatment by the military (Rettig, 1999). Human studies demonstrating the efficacy of Pyridostigmine bromide against nerve agent lethality would clearly be unethical. Thus in order for it to be used as a pretreatment drug against chemical agents during the Gulf War, an FDA waiver regarding informed consent (Appendix XVII) was needed so that it could be used for military purposes. An estimated 250,000 to 300,000 U.S. veterans of Operation Desert Shield/Operation Desert Storm took pyridostigmine bromide (PB) as a pretreatment adjunct to protect themselves from nerve agent attack (Golomb, 1998).

Appendix XV: Overview of Federally Sponsored Research on Gulf War Veterans' Illnesses

The Federal research effort with regard to Gulf War Veterans Illnesses are sponsored by the Departments of Defense (DoD), Health and Human Services (HHS), and Veterans Affairs (VA) and include scientists from Federal, academic, and private institutions. From 1994, when the federal government started funding research efforts that looked into the health concerns of Gulf War veterans, through 2001, these Departments have sponsored 211 distinct research projects on Gulf War veterans' illnesses with a cumulative expenditure of 196.1 million dollars (See Table 20).

Table 20: Funding for research for Fiscal Years '94-'01 in $millions

Dept.	FY'94	FY'95	FY'96	FY'97	FY'98	FY'99	FY'00	FY'01	FY'94-01
DoD	$ 6.5	$11.0	$11.9	$28.9	$13.2	$23.5	$24.8	$22.0	$141.8
VA	$ 1.2	$ 2.3	$ 3.9	$ 2.8	$ 4.7	$ 9.0	$12.0	$ 8.4	$ 44.3
HHS	$ 0.0	$ 2.5	$ 1.6	$ 0.0	$ 1.6	$ 1.6	$ 1.6	$ 1.0	$ 10.0
Total	$ 7.7	$15.8	$17.4	$31.7	$19.5	$34.2	$38.4	$31.4	$196.1

Source: Department of Veterans Affairs Annual Report to Congress on Federally Sponsored Research on Gulf War Veterans Illnesses for 2001.

While the majority of research projects on Gulf War veterans' illnesses are directly affiliated with the federal agencies sponsoring them, many projects are contracted out to medical schools, laboratories, scientific organizations, and universities in order to capture a wide array of scientific expertise for different areas of study. Sponsor federal agencies oversee the work of both in house and contracting agencies through a "peer review" process in which a panel of recognized medical experts periodically review the workplace facilities, the background of the scientists, and the project methodology, to ensure that competent work is done. Every year, each project that is still ongoing is required to send a written update on project progress to their individual sponsoring federal agency. These sponsoring federal agencies in turn act together with the Research Working Group (RWG) of the Persian Gulf War Coordinating

Board, (a panel of medical researchers from government agencies that has expertise regarding health issues stemming from the Gulf War), to create an Annual Report to Congress updating it on all the research progress that is being made and identifying any gaps in the research that may exist.

The portfolio of federally sponsored research projects is broad, spanning from small-scale pilot studies that may look at the health outcomes of hundreds of veterans to large-scale epidemiology studies that look at tens of thousands of veterans. Topics that are researched are determined by the Research Working Group and are divided into four distinct types of research: clinical research, epidemiological research, mechanistic research, and developmental research. Figure 4 shows the diversity of research approaches that have been funded by Department of Defense, Health Human Services, and Veterans Administration since 1994. The greatest numbers of research projects thus far have been in the area of clinical research, which uses the application of an intervention such as case-control study to define risk factors. This has been followed by epidemiological research which looks at population based studies that focus on health outcomes such as mortality, symptoms, hospitalization, etc., using such devises as postal surveys, interviews, and medical reviews. Thirdly research has focused in on mechanistic research which looks at the underlying mechanisms of disease using in vitro and in vivo modeling techniques. Finally, there have been a small number of research projects that focus specifically on developing new prevention and treatment measures.

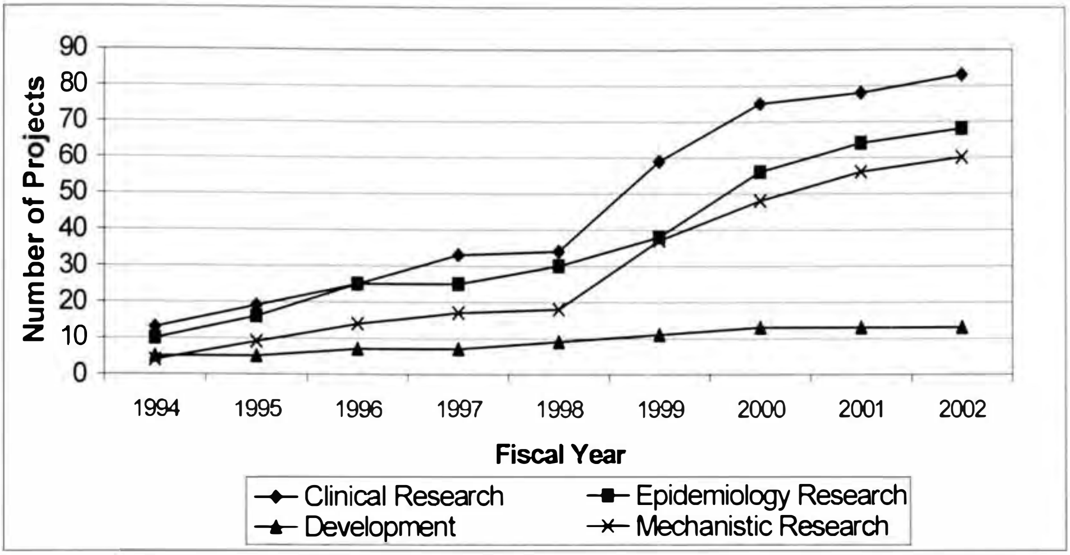


Figure 15: Cumulative number of federally funded research projects by research type (1994-2002).

Source: Department of Veterans Affairs Annual Report to Congress on Federally Sponsored Research on Gulf War Veterans Illnesses for 2002.

Of the original 211 research projects regarding Gulf War veterans' illnesses, 124 have already been completed by the year 2001. Table 21 shows the number of new research projects that have been started and the number of research projects that have been completed for the years 1994 through 2001.

Table 21: Number of new and completed projects by year

Fiscal Year	New	Completed
1992-1994	62	3
1995	21	8
1996	16	4
1997	36	10
1998	17	15
1999	30	16
2000	14	42
2001	15	26
Total	211	124

* For programs/centers with multiple projects, each project is counted as an individual project for accounting purposes.

Source: Department of Veterans Affairs Annual Report to Congress on Federally Sponsored Research on Gulf War Veterans Illnesses for 2000.

Since the September attacks, military and veterans issues have gained a new priority in Congress. Before asking troops to be sent all over the world to fight the war on terrorism, Congressional officials want to make sure that they have incorporated all the lessons of past deployments so as not to repeat any mistakes in the future. One area of concern that has that has not been completely resolved is that the illnesses surrounding veterans of the Gulf War. In order to try to resolve or gain as much knowledge as possible on this issue, Congress has, as of October 2002, authorized a nearly doubling of the VA budget to fund studies into finding the causes and cures of these illnesses (VA press release, 2002). The agency will now plan to make available up to $20 million for research into Gulf War illnesses during fiscal year 2004, an amount that is considerably larger than previous years.

Appendix XVI: Iraqi Scud Missile Threat

Iraq began launching short-range ballistic missiles (known as Scuds, See Figure 12) at Israel and Coalition forces soon after the Coalition's Gulf War air campaign began on January 17, 1991. Many Gulf War veterans observed or became aware of incoming or overflying Scud missiles and or Patriot missiles fired in defense. American and other Coalition forces in the Kuwait Theater of operations were well aware that Iraq had the capability to use chemical and biological weapons, and that a means of delivering them was through use of Scud missiles. This threat represented a significant cause for concern for anyone within their range.

Iraq's Scud attacks involved 88 missiles; of which 46 reached Coalition countries in the Kuwait Theater of operations and 42 reached or closely approached Israel. A few more probably failed early in flight and struck within Iraq's borders. Iraq told United Nations inspectors after the war that they launched 93 ballistic missiles, 50 against the Coalition in the Kuwait theater of operations and 43 against Israel. Scuds, while inaccurate, nonetheless damaged area targets and caused 28 of the 148 United States battle deaths during the Gulf War. Scuds often broke up on reentry, dispersing propellant that sometimes caused burning sensations of the skin and throat, nausea, headaches, breathing difficulties and other symptoms in some United States service members. Also, Scud attacks and precautionary alerts disrupted lives and operations by forcing passive defense measures and generating stress.

Source: Information Paper: Iraq's Scud Ballistic Missiles. Released July 25, 2000. Department of Defense; web:

http://www.iraqwatch.org/government/US/Pentagon/dodscud.htm

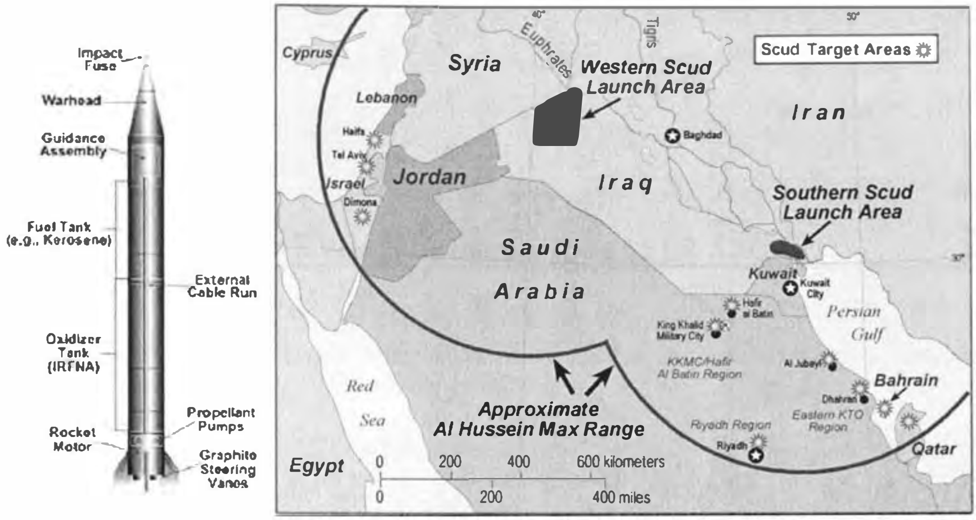


Figure 16: Iraqi Scud missile range during the Gulf War.

Appendix XVII: FDA Interim Rule 55 FR 52814

In the shadow of the impeding Gulf War Department of Defense officials became increasingly concerned about how to protect U.S. military forces against Iraqi CW/BW agents. Protective vaccines against Botulinum Toxin and nerve agents had been developed at the time of the Gulf War but had not been approved by the FDA for the purpose which the DoD had intended their use. They were considered Investigational New Drugs (IND), a term the FDA placed on drugs that had completed pre-clinical testing but had not yet completed their clinical trials on human subjects. Pyridostigmine Bromide (PB) and Botulinum Toxoid (BT) were two of the most promising pharmaceuticals available for defending against CW/BW agents. At the time of the Gulf War, the FDA had classified both as INDs. Since INDs are subject to stringent FDA regulations that require strict guidelines of voluntary informed consent for human subjects the Department of Defense in order to comply with FDA regulations would be required to obtain informed consent for use of Pyridostigmine bromide and Botulinum toxoid from every service member deployed to the Gulf (Rettig, 1999). This posed a serious problem for Department of Defense because if they complied with FDA regulations and permitted troops to refuse the vaccines intended for their own protection, refusing troops may inadvertently put other troops at risk in the event of a CW/BW attack. Those troops refusing vaccine protection would either have to leave the combat field or stay and fight without protection in the event of a CW/BW attack. In either event, they would decrease the likelihood of a successful mission and increase the danger to all service personnel.

In response to the Iraqi CW/BW threat, Department of Defense concluded that it needed to be prepared to use Pyridostigmine bromide and Botulinum toxoid for troop protection. It felt that it should seek FDA approval for using these investigational products for treatment and pretreatment purposes and that allowing informed consent to service members in the Gulf would not be feasible (Rettig, 1999). It therefore requested on October 30, 1990 that the FDA establish authority to waive the requirement of informed consent in the use of investigational drugs during certain military extingencies such as the conflict in the Gulf. The FDA responded by issuing Interim Rule 55 FR 52814 on December 21, 1990 that permitted Department of Defense to waive informed consent requirements under specific military operations. The ruling gave the commissioner of the FDA the authority to waive informed consent requirements for Department of Defense personnel who were involved in combat or the immediate threat of combat. It required that Department of Defense include a written justification supporting the conclusions of the physician(s) responsible for medical care of the military personnel involved and a duly constituted institutional review board approval of the investigational drugs to be administered without informed consent. Under these rules, Department of Defense requested and was granted informed consent waivers for the two investigational drugs Pyridostigmine Bromide and Botulinum toxoid on January 8, 1991. The following is the text of the Interim Rule of December 21, 1990:

> Section 50.23 [21 CFR Part 50], "Exception from general requirements," is amended by adding new paragraph (d) to read as follows: d)(1) The commissioner may also determine that obtaining informed consent is not feasible when the Assistant Secretary of Defense (Health Affairs) requests such a determination in connection with the use of an investigational drugs (including an antibiotic or biological product) in a specific protocol under an investigational new drug application (IND) sponsored by the Department of Defense (DOD). DOD's request for a determination that obtaining informed consent from military personnel is not feasible must be limited to a specific military operation involving combat or the immediate threat of combat. The request must also include a written justification supporting the conclusions of the physician(s) responsible for the medical care of the military personnel involved and the investigator(s) identified in the IND that a military combat exigency exists because of special military

combat (actual or threatened) circumstances in which, in order to facilitate the accomplishment of the military mission, preservation of the health of the individual and the safety of other personnel require that a particular treatment be provided to a specified group of military personnel, without regard to what might be any individual's personal preference for no treatment or for some alternative treatment. The written request must also include a statement that a duly constituted institutional review board has reviewed and approved the use of the investigational drug without informed consent. The Commissioner may find that informed consent is not feasible only when withholding treatment would be contrary to the best interests of military personnel and there is no available satisfactory alternative therapy. (2) In reaching a determination under paragraph (d)(1) of this section that obtaining informed consent is not feasible and withholding treatment would be contrary to the best interests of military personnel, the Commissioner will review the request submitted under paragraph (d)(1) of this section and take into account all pertinent factors, including, but not limited to: (i) The extent and strength of the evidence of the safety and effectiveness of the investigational drug for the intended use; (ii) The context in which the drug will be administered, e.g., whether it is intended for use in a battlefield or hospital setting or whether it will be self-administered or will be administered by a health professional; (iii) The nature of the disease or condition for which the preventive or therapeutic treatment is intended; and (iv) The nature of the information to be provided to the recipients of the drug concerning the potential benefits and risks of taking or not taking the drug. (3) The Commissioner may request a recommendation from appropriate experts before reaching a determination on a request submitted under paragraph (d)(1) of this section. (4) A determination by the Commissioner that obtaining informed consent is not feasible and withholding treatment would be contrary to the best interests of military personnel will expire at the end of 1 year, unless renewed at DOD's request, or when DOD informs the Commissioner that the specific military operation creating the need for the use of the investigational drug has ended, whichever is earlier. The Commissioner may also revoke this determination based on changed circumstances.

James S. Benson
Deputy Commissioner of Food and Drugs
Louis W. Sullivan
Secretary of Health and Human Services
Friday, December 21, 1990

(Source, 55 Federal Register 52814, "Informed Consent for Human Drugs and Biologics; Determination That Informed Consent is Not Feasible," December 21, 1990.)

Appendix XVIII: UN Security Council Resolution Establishing Terms for Cease Fire

United Nations Security Council Resolution 687 3 April 1991

The United Nations (UN) Security Council passed Resolution 687 on April 3, 1991 to dictate the terms of the Gulf War cease-fire. Resolution 687 required Iraq to declare and destroy its stockpile of weapons of mass destruction and their ballistic missile delivery systems as well as establish a UN Special Commission (UNSCOM) to monitor and verify the elimination of Iraq's weapons. UNSCOM was given the responsibility of ensuring the destruction of Iraq's chemical and biological weapons, confirming the destruction of ballistic missiles with a range greater than 150 km, verifying the control and removal of nuclear materials, and conducting long-term monitoring of Iraqi compliance. The precise terms are laid out in paragraphs 7 to 14 of the resolution below:

7. Invites Iraq to reaffirm unconditionally its obligations under the Geneva Protocol for the Prohibition of the Use in War of Asphyxiating Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925, and to ratify the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, of 10 April 1972;

8. Decides that shall unconditionally accept the destruction, removal, or rendering harmless, under international supervision, of:
   a. All chemical and biological weapons and all stocks of agents and all related subsystems and components and all research, development, support and manufacturing facilities;
   b. All ballistic missiles with a range greater than 150 kilometers and related major parts, and repair and production facilities;

9. Decides, for the implementation of paragraph 8 above, the following:
   a. Iraq shall submit to the Secretary-General, within fifteen days of the adoption of the present resolution, a declaration of the locations, amounts and types of all items specified in paragraph 8 and agree to urgent, on-site inspection as specified below;
   b. The Secretary-General, in consultation with the appropriate Governments and, where appropriate, with the Director-General of the World Health Organization, within forty-five days of the passage of the present resolution, shall develop, and submit to the Council for approval, a plan calling for the completion of the following acts within forty-five days of such approval:

i. The forming of a Special Commission, which shall carry out immediate on-site inspection of Iraq's biological, chemical and missile capabilities, based on Iraq's declarations and the designation of any additional locations by the Special Commission itself;

ii. The yielding by Iraq of possession to the Special Commission for destruction, removal or rendering harmless, taking into account the requirements of public safety, of all items specified under paragraph 8 (a) above, including items at the additional locations designated by the Special Commission under paragraph 9 (b) (i) above and the destruction by Iraq, under the supervision of the Special Commission, of all its missile capabilities, including launchers, as specified under paragraph 8 (b) above;

iii. The provision by the Special Commission of the assistance and cooperation to the Director-General of the International Atomic Energy Agency required in paragraphs 12 and 13 below;

10. Decides that Iraq shall unconditionally undertake not to use, develop, construct or acquire any of the items specified in paragraphs 8 and 9 above and requests the Secretary-General, in consultation with the Special Commission, to develop a plan forth future ongoing monitoring and verification of Iraq's compliance with this paragraph; to be submitted to the Security Council for approval within one hundred and twenty days of the passage of this resolution;

11. Invites Iraq to reaffirm unconditionally its obligations under the Treaty on the Non-Proliferation of Nuclear Weapons of 1 July 1968;

12. Decides that Iraq shall unconditionally agree not to acquire or develop nuclear weapons or nuclear-weapons-usable material or any subsystems or components or any research, development, support or manufacturing facilities related to the above; to submit to the Secretary-General and the Director-General of the International Atomic Energy Agency within fifteen days of the adoption of the present resolution a declaration of the locations, amounts, and types of all items specified above; to place all of its nuclear-weapons-usable materials under the exclusive control, for custody and removal, of the International Atomic Energy Agency, with the assistance and cooperation of the Special Commission as provided for in the plan of the Secretary-General discussed in paragraph 9 (b) above; to accept, in accordance with the arrangements provided for in paragraph 13 below, urgent on-site inspection and the destruction, removal or rendering harmless as appropriate of all items specified above; and to accept the plan discussed in paragraph 13 below for the future ongoing monitoring and verification of its compliance with these undertakings;

13. Requests the Director-General of the International Atomic Energy Agency, through the Secretary-General, with the assistance and cooperation of the Special Commission as provided for in the plan of the Secretary-General in paragraph 9 (b) above, to carry out immediate on-site inspection of Iraq's nuclear capabilities based on Iraq's declarations and the designation of any additional locations by the

Special Commission; to develop a plan for submission to the Security Council within forty-five days calling for the destruction, removal, or rendering harmless as appropriate of all items listed in paragraph 12 above; to carry out the plan within forty-five days following approval by the Security Council; and to develop a plan, taking into account the rights and obligations of Iraq under the Treaty on the Non-Proliferation of Nuclear Weapons of 1 July 1968, for the future ongoing monitoring and verification of Iraq's compliance with paragraph 12 above, including an inventory of all nuclear material in Iraq subject to the Agency's verification and inspections of the International Atomic Energy Agency to confirm that the Agency's safeguards cover all relevant nuclear activities in Iraq, to be submitted to the Security Council for approval within one hundred and twenty days of the passage of the present resolution;

14. Takes note that the actions to be taken by Iraq in paragraphs 8, 9, 10, 11, 12 and 13 of the present resolution represent steps towards the goal of establishing in the Middle East a zone free from weapons of mass destruction and all missiles for their delivery and the objective of a global ban on chemical weapons.

Source: http://www.un.org/Docs/scres/1991/scres91.htm

Appendix XIX: Gulf War Veteran Stress Survey Cover Letter

Gulf War Veteran Stress Survey

Dear Veteran: This is a request for your help. I am completing my dissertation on Gulf War illnesses and would very much appreciate your answers to this survey. Please click on the following link to respond:

http://www.phd.sahp.vcu.edu/Dissertation/FrankKenny/

Username: GulfWar
Password: myveteran

This survey is not affiliated with the government or any veteran's organization in any way. It is being done as part of my Ph.D. research at Virginia Commonwealth University.

The results will help to correlate stressful wartime exposures with subsequent health outcomes among Gulf War veterans. It will provide useful information with regard to how deployment stress impacts the health of our military personnel.

All responses to this survey will be kept confidential and sent to a secure location at Virginia Commonwealth University prior to analysis.

For questions or comments, please email me at fjkenny@hsc.vcu.edu <mailto:fjkenny@hsc.vcu.edu>. A quick response would be greatly appreciated.

Thank you.
Frank Kenny (Ph.D. candidate, Virginia Commonwealth University)

Appendix XX: Gulf War Veteran Survey

Are you a Gulf War Veteran?

Yes No

If you are a Gulf War Veteran, which branch of the military did you serve with?

U.S. Army

Please rank each of the following exposures experienced by you in the Gulf War from 0 (least stressful) to 10 (most stressful).

If you were NOT exposed to a particular event, please rank the appropriate stress level you think may apply from 0 (least stressful) to 10 (most stressful).

Please click on an exposure item for a detailed definition.

Passive Cigarette Smoke:
(least stressful) (most stressful)
0 1 2 3 4 5 6 7 8 9 10

Oil Fire Smoke:
(least stressful) (most stressful)
0 1 2 3 4 5 6 7 8 9 10

Tent Heater Smoke:
(least stressful) (most stressful)
0 1 2 3 4 5 6 7 8 9 10

CARC Paint:
(least stressful) (most stressful)
0 1 2 3 4 5 6 7 3 9 10

Other Paints:
(least stressful) (most stressful)
0 1 2 3 4 5 6 7 8 9 10

Solvents:
(least stressful) (most stressful)
0 1 2 3 4 5 6 7 8 9 10

Diesel Fuel:
(least stressful) (most stressful)
◌ 0 ◌ 1 ◌ 2 ◌ 3 ◌ 4 ◌ 5 ◌ 6 ◌ 7 ◌ 8 ◌ 9 ◌ 10

Other Petrochemicals:
(least stressful) (most stressful)
◌ 0 ◌ 1 ◌ 2 ◌ 3 ◌ 4 ◌ 5 ◌ 6 ◌ 7 ◌ 8 ◌ 9 ◌ 10

Depleted Uranium:
(least stressful) (most stressful)
◌ 0 ◌ 1 ◌ 2 ◌ 3 ◌ 4 ◌ 5 ◌ 6 ◌ 7 ◌ 8 ◌ 9 ◌ 10

Nerve Gas:
(least stressful) (most stressful)
◌ 0 ◌ 1 ◌ 2 ◌ 3 ◌ 4 ◌ 5 ◌ 6 ◌ 7 ◌ 8 ◌ 9 ◌ 10

Mustard Gas:
(least stressful) (most stressful)
◌ 0 ◌ 1 ◌ 2 ◌ 3 ◌ 4 ◌ 5 ◌ 6 ◌ 7 ◌ 8 ◌ 9 ◌ 10

Microwaves (Strong Radar):
(least stressful) (most stressful)
◌ 0 ◌ 1 ◌ 2 ◌ 3 ◌ 4 ◌ 5 ◌ 6 ◌ 7 ◌ 8 ◌ 9 ◌ 10

PB (Pyridostigmine Bromide) Pills:
(least stressful) (most stressful)
◌ 0 ◌ 1 ◌ 2 ◌ 3 ◌ 4 ◌ 5 ◌ 6 ◌ 7 ◌ 8 ◌ 9 ◌ 10

Insect Repellents:
(least stressful) (most stressful)
◌ 0 ◌ 1 ◌ 2 ◌ 3 ◌ 4 ◌ 5 ◌ 6 ◌ 7 ◌ 8 ◌ 9 ◌ 10

Botulism Immunization:
(least stressful) (most stressful)
◌ 0 ◌ 1 ◌ 2 ◌ 3 ◌ 4 ◌ 5 ◌ 6 ◌ 7 ◌ 8 ◌ 9 ◌ 10

Anthrax Immunization:
(least stressful) (most stressful)
◌ 0 ◌ 1 ◌ 2 ◌ 3 ◌ 4 ◌ 5 ◌ 6 ◌ 7 ◌ 8 ◌ 9 ◌ 10

Malaria Prevention:
(least stressful) (most stressful)
0 1 2 3 4 5 6 7 8 9 10

Food Contamination:
(least stressful) (most stressful)
0 1 2 3 4 5 6 7 8 9 10

Water Contamination:
(least stressful) (most stressful)
0 1 2 3 4 5 6 7 8 9 10

Combat Exposure:
(least stressful) (most stressful)
0 1 2 3 4 5 6 7 8 9 10

Wounded in Action:
(least stressful) (most stressful)
0 1 2 3 4 5 6 7 8 9 10

Witnessing of Casualties:
(least stressful) (most stressful)
0 1 2 3 4 5 6 7 8 9 10

Scud Attacks:
(least stressful) (most stressful)
0 1 2 3 4 5 6 7 8 9 10

Chemical Alarms:
(least stressful) (most stressful)
0 1 2 3 4 5 6 7 8 9 10

Thank you for your participation in this survey. This survey is being performed to fulfill requirements for my Ph.D. in Health Administration at Virginia Commonwealth University.

Questions or comments? E-Mail: Frank J. Kenny

Submit Form | Reset Form

Appendix XXI: Gulf War Veteran Stress Survey Links

Gulf War Veteran Stress Survey Links

1) Passive Cigarette Smoke

During the Gulf War, living conditions for many troops were often quickly assembled and crowded. With smokers and nonsmokers sharing close quarters that were often poorly ventilated, the chances of exposure to passive or second hand tobacco smoke were greatly increased for a number of troops that were not normally used to this type of exposure. These crowded living conditions coupled with that fact that smokers tend to increase the amount they smoke as a means of reducing wartime stress and as a means of combating boredom increased dramatically the potential for exposure. Since second hand smoke at minimum is an annoyance and at worst may be linked to several types of cancer, exposure can often lead to an increase in the overall stress level that an individual experiences.

2) Oil Fire Smoke

At the end of the Gulf War, more than 600 Kuwaiti oil wells and several pools of spilled oil were left burning after being ignited by retreating Iraqi troops. Huge, dramatic plumes of billowing smoke from these fires rose high into the atmosphere. These oil well fires produced dense clouds of soot, liquid, aerosols, and gases that were both harmful to the environment as well as individuals coming into contact with them. U.S. service personnel in the Gulf who were close to these plumes of smoke could have been exposed to hazardous substances contained within them.

The burning Kuwaiti crude oil produced a wide range of harmful combustion products including a high concentration of potentially noxious gases and coated carbon particles. Some of the known harmful combustion products included carbon monoxide (CO), sulfur dioxide (SO2), oxides of nitrogen (NOx), volatile organic compounds (VOCs), ozone (O3), various polycyclic aromatic hydrocarbons (PAHs), and acid aerosols. In addition, hydrogen sulfide (H2S), a major component of natural gas, was present at various concentrations at some of the affected oil fields.

The known immediate health effects from inhaling large amounts of smoke and particulates are primarily respiratory in nature. They include coughing, wheezing, increased airway resistance, and the development of respiratory infections. Toxic gases that can be found in oil-well fire smoke-such as H2S and SO2-can cause eye and nose irritation, decreased pulmonary function, and increased airway reactivity. Benzene and PAHs, which are also contained in oil-well fire smoke, are known to be human carcinogens.

(Source: Presidential Advisory Committee on Gulf War Veterans' Illnesses, 1997)

3) Tent Heater Smoke

During the Gulf War tents were quickly set up to temporarily house a large number of military personnel in preparation for the upcoming battle to liberate Kuwait. These tents although serving their purpose of housing troops were often poorly ventilated. When fuels were used inside these tents for heaters, cooking stoves, and/or portable generators, the fumes and exhausts produced by these fuels exposed many service members to the vapors benzene, toluene, xylene, ethyl benzene, as well as the combustion products carbon monoxide, sulfur dioxide, nitrogen dioxide, lead and other pollutants.

Among the most serious concerns for troops would be lead toxicity due to the burning of leaded fuels and carbon monoxide poisoning. Excessive exposure to lead has been associated with subjective signs of neurotoxicity such as forgetfulness, lethargy, and weakness and has been shown to cause brain and kidney damage. Carbon monoxide likewise is a very serious problem for exposed troops because of its absence of smell, taste or color. Formed by incomplete fuel oil combustion, carbon dioxide levels can build up in a poorly ventilated room causing an individual to experience drowsiness, nausea, and even asphyxiation. During the war, four hospitalizations in U.S. Army field hospitals occurred because of asphyxiation from carbon monoxide poisoning.

(Source: Presidential Advisory Committee on Gulf War Veterans' Illnesses, 1997)

4) Chemical Agent-Resistant Coating (CARC) Paint

Several thousand vehicles and pieces of equipment deployed to the Gulf region had to be quickly repainted from the tree-colored woodland camouflage paint scheme to desert camouflage prior to the start of the Gulf War. The desert paint was a urethane-based chemical CARC, which makes up the largest category of paint applied to the U.S. military vehicles and equipment. CARC is resistant to a variety of chemicals and solvents and has a unique quality for preventing chemical warfare agents, such as blister and nerve agents, from penetrating into the coating.

Inhaling high concentrations of some of the compounds and solvents in CARC can cause some short-term symptoms like coughing, shortness of breath and watery eyes. Long-term exposure could lead to respiratory problems, including asthma. Paint fumes are the factor that presents the most potential risk to users.

CARC paint emits very little in the way of harmful fumes when applied with a brush or roller, but when it is aerosolized during spray-painting applications, the risk of inhaling high concentrations of harmful components rises significantly. CARC paint contains no carcinogenic compounds and presents no health risks when dry unless the painted surface is sanded or welded.

(Source: Office of the Special Assistant for Gulf War Illnesses, Environmental Exposure Final Report CARC, 2000, www.gulflink.osd.mil)

5) Other Paints

Due to the urgent massing of combat power in tactical assembly areas CARC paints used to camouflage and protect vital military equipment were initially in short supply. To protect military equipment until more CARC paint arrived, locally procured paints of varying quality were used during the Gulf War to camouflage military equipment. Individuals who were responsible for painting military equipment often worked as much as 16 hour days and oftentimes had serious deficiencies in the type and quantity of personal protective equipment available. Many of these soldiers also had not received sufficient training and information regarding the potential respiratory hazards of breathing in paint fumes.

6) Solvents

Early desert maneuvers during Operation Desert Shield in Saudi Arabia uncovered a problem for American troops. The sand and microscopic sand dust changed the tolerances in their M-16A rifles and caused malfunctions. Likewise the harsh desert environment adversely affected other military equipment essential for the liberation of Kuwait. With a potential ground war looming, it was imperative that coalition forces keep their weapons and sensitive military equipment ready for combat. This required that coalition troops constantly use degreasing solvents to clean their equipment to ensure that they would function correctly. Health hazards associated with solvent exposure include toxicity to the nervous system, reproductive damage, liver and kidney damage, respiratory impairment, cancer, and dermatitis.

7) Diesel Fuel

U.S. forces used diesel fuel to power military vehicles, as a means of waste incineration, and for fueling stoves, heaters, and generators during the Gulf War. Diesel fuel was also widely used as a means of suppressing the regions fine sand and dust that often caused problems for military operations. It was often sprayed on roadways, runways, and even inside tents to suppress the blowing sand. As a consequence of its use, many Gulf War troops were exposed to either the vapors of the diesel fuel used or its combustion products.

According to the Occupational Safety and Health Administration (OSHA), prolonged breathing of diesel fuel vapors can damage kidneys and/or lower blood clotting ability. Prolonged exposure to diesel exhaust can lead individuals to experience adverse health effects ranging from headaches and nausea to cancer and respiratory disease.

(Source: U.S. Department of Labor, Occupational Safety and Health Administration)

8) Other Petrochemicals

U.S. service members in certain jobs were occupationally exposed to petroleum fuel vapors and combustion products, such as toluene, xylene, benzene, ethyl benzene, carbon monoxide, sulfur dioxide, nitrogen dioxide, particulates, lead, and other pollutants during the Gulf War. Troops involved with fueling vehicles or aircraft or in charge of burning waste and trash were often most at risk. The vapors of these petroleum fuels as well as their combustion products produced a variety of potentially serious medical conditions. Benzene, for example, which makes up about one percent of U.S. gasoline and up to five percent of European formulations is a known human carcinogen that is associated with certain types of leukemia. Likewise, the inhalation of petroleum combustion products has been associated with fatigue, headache, nausea, blurred vision, dizziness, convulsions, paralysis, and loss of consciousness depending on the dose. U.S. service members could have been exposed to petroleum fuels by inhalation, ingesting contaminated water or dust, and skin contact.

The fuel used most widely during the war for both vehicles and equipment was Jet A-1, an internationally used kerosene-based aviation fuel provided at no cost by the Saudi Arabian government. Of the 1.8 billion gallons of fuel used during Operations Desert Shield/Desert Storm, roughly 75 percent was jet fuel (mostly Jet A-1), 24 percent was diesel fuel, and 1 percent was gasoline. The gasoline used during Operations Desert Shield/Desert Storm was commercial leaded gasoline refined to Saudi Arabia's national standard.

(Source: Presidential Advisory Committee on Gulf War Veterans' Illnesses Final Report, 1997)

9) Depleted Uranium

Depleted uranium (DU) is derived from the heavy metal uranium, which occurs naturally as mineral deposits that are mined and processed for use in nuclear power plants or nuclear weapons. DU is the natural uranium left over after more of the highly radioactive uranium isotopes used in these power plants and weapons are extracted. DU contains about half of the radioactivity of natural uranium. It is considered a very low-level radioactive material. However, as with other heavy metals, such as lead, uranium can be toxic to the kidneys and other organs including the lungs.

Depleted uranium was first used in the development of major weapon systems because of its high density and superior mechanical properties, and because it is relatively abundant and cost effective. Allied forces used DU in tank armor and in penetrators of various antitank munitions during the Gulf War where they fired a total of 320 tons (290,300 kilograms) of DU projectiles at Iraqi military forces.

Although Iraq did not possess DU rounds, friendly-fire incidents exposed some U.S. soldiers to DU following impact of DU rounds to their own or others' vehicles or to damaged vehicles they inspected, recovered, or repaired. When a DU penetrator hits an armored target, it disintegrates due to the resulting kinetic energy transfer that results in extreme heat and formation of uranium oxide particles. The uranium oxide particles that form are usually small, and due to their high density they settled quickly onto vehicles, bunkers and onto the surrounding sand where they could be easily inhaled. Soldiers with the highest exposures were in, on, or near vehicles when they were struck.

(Sources: Department of Veterans Affairs Gulf War web page www.va.gov.gulfwar and Office of the Special Assistant for Gulf War Illnesses, Depleted Uranium Information page.)

10) Nerve Gas

The pre-Gulf War Iraqi arsenal contained nerve agents that were designed to kill, seriously injure, or incapacitate persons due to their physiological effects. Among the most worrisome to Coalition forces were the nerve agents' tabun, sarin, soman, cyclosarin, and VX (methylphosphonothioic acid). These agents, which are hard to recognize without detectors until clinical symptoms appear, posed a real and imminent threat to coalition forces in the Gulf region. They act by inhibiting the vital enzyme acetylcholinesterase (AChE), which is responsible for breaking down the neurotransmitter acetylcholine (Ach) at the nerve synaptic junctions. The resultant state is physiological-pathological overstimulation by excessive ACh resulting in neurologic and respiratory problems that if left untreated could result in death.

At the time of the Gulf War, coalition forces fully had expected Saddam Hussein to use his known supply of nerve agents. He had had a history of doing so both against the Iranians during the Iran-Iraq war and against his own people the Kurds and was thought likely to do so against coalition forces. During the Gulf War, coalition forces were very worried about Saddam delivering these weapons of mass destruction through ballistic missiles, aerial bombs, short-range rockets, mines, or even having them sprayed from aircraft, trucks, or tanks.

(Source: RAND, A Review of the Scientific Literature as It Pertains to Gulf War Illnesses, Volume 5 Chemical and Biological Warfare Agents).

11) Mustard Gas

Mustard Gas had been a worry of armed forces since its destructive use in World War I. It was such a terrible weapon that neither side was willing to use it in World War II for fear that the other side would retaliate in kind. When coalition forces deployed in the Gulf in 1990, there was concern that Iraq might use mustard agents in their defense of Kuwait. They had already used aircraft and artillery to deliver mustard in their war with Iran and it was widely thought that mustard gas would be a chief weapon in the Iraqi arsenal against coalition forces. Iraq at the time of the Gulf war had the capacity of delivering mustard gas via mortar rounds, artillery, free rockets, aerial bombs, aerosol and liquid spray tanks.

Mustard gas can be absorbed into the body either by breathing its vapors or by skin contact. Exposure then can cause severe irritation and tissue damage including blistering to the eyes, skin, respiratory, and digestive tracts. At the cellular level mustard gas has a binding affinity for the nitrogenous base guanine, which is a critical component of both DNA and RNA. The binding of mustard gas to guanine causes problems with cellular replication and protein development leading to mutations and/or the synthesis of non-functional proteins. Mustards eventually cause death at the cellular level through energy loss following DNA breakage, loss of cell membrane integrity, or the perturbation of cycloskeletal organization.

(Source: Gulf War Review, October 2000)

12) Microwaves (Strong RADAR)

Microwaves are a form of non-ionizing radiation extremely common in most of the world. The radio frequencies of interest in the Persian Gulf extend from about 300GHz to 30 MHz. The upper portion of this range includes the wavelengths used for radar, radio, television, microwave ovens, and diathermy. During the Gulf War, microwaves were used to communicate among units, eavesdrop on Iraqi communications, and to jam enemy radar installations.

The biological effects of microwaves on troops were primarily those of molecular agitation, that is, heat production. The heating effect is obvious, but other, less detectible biological effects have been described and debated for years. Human studies, as well as animal experiments, support an increase in cataracts after exposure to high intensity microwaves and changes in hearing have been described in experimental animals. These have been described as non-thermal effects but this idea has been challenged.

(Source: Department of Veterans Affairs Gulf War web page www.va.gov/gulfwar)

13) PB (Pyridostigmine Bromide) Pills

Pyridostigmine bromide (PB) is a reversible cholinesterase inhibitor that was used during the Gulf War as a pretreatment for exposure to the nerve agent soman. Its action is similar to that of nerve agents that bind to the vital enzyme acetylcholinesterase (AChE) and cause harm to the nervous system. The major difference between Pyridostigmine bromide and nerve agents in terms of mechanism of action is that Pyridostigmine bromide binds reversibly to AChE whereas the binding of nerve agents is permanent. In theory, and demonstrated by animal models, Pyridostigmine bromide administered as a pretreatment drug will compete with nerve agents in binding with AChE. Pyridostigmine bromide can thus prevent the permanent disabling of AChE by nerve agents by binding with it until the nerve agents have bound with something else or left the body. Since it binds to AChE like nerve agents, administration of Pyridostigmine bromide will give off symptoms of nerve agent attack but over time with the release of Pyridostigmine bromide from AChE, a person's nervous system will return to normal. PB also is a preferred drug against nerve agent attack because it has been shown to usually not cross into the central nervous system and thus have a harmful impact on brain function or mental performance.

During the Gulf War Pyridostigmine bromide was given to U.S. troops in pill form so that it could be self-administered upon a unit commander's order. Most U.S. troops were give blister packs containing Pyridostigmine bromide pills during the Gulf War and DoD estimates that approximately 250,000 personnel took at least some of the PB pills. The controversy surrounding PB lies in the fact that although it had been authorized by the FDA to treat Myasthenia Gravis (an autoimmune disorder) since 1955, it was still considered an investigational new drug (IND) by the Food and Drug Administration (FDA) for other uses. Under FDA rules, INDs require the informed consent of the persons who take the drugs. In December 1990, just a few months prior to the Gulf War, the FDA granted Department of Defense a waiver from the informed consent requirement due to the immediate threat of combat. Many troops at this time were concerned about being forced to a drug that under other circumstances would not have been approved by the FDA for its use. They were worried both about the long-term health implications as well as the possible adverse reactions of taking the drug.

(Source: Institute of Medicine, Gulf War and Health Volume 1, Depleted Uranium, Pyridostigmine Bromide, Sarin, Vaccines)

14) Insect Repellents

During the Gulf War, preventive medicine personnel anticipated the need to control the regions ubiquitous insect and rodent populations. They were especially concerned with sand flies and mosquitoes which carry several infectious diseases, including leishmaniasis, sand fly fever, and malaria. To combat these potential infectious disease threats, U.S. health officials used numerous insect repellant products, including sprays, powders, baits, pest strips, and flypaper.

Although these insect repellent products were EPA approved and not considered harmful when used according to instructions, potential product misuse and service members who spent long times in areas where insect repellents were used may have had exposures higher than recommended amounts.

Potential troops at risk for over exposure to insect repellents included repellent applicators that may have lacked sufficient training or protective equipment and troops who were exposed to insect repellents used improperly. Most repellents were intended for outdoor use only, but many repellents were used indoors in areas where military personnel worked, ate, and slept. This thus exposed troops to higher amounts of insect repellent than the EPA recommended as safe.

(Source: Deployment Health Support, Information Paper Pesticides, http://deploymentlink.osd.mil)

15) Botulism Immunization

One of the most feared biological weapons that Iraq was thought and later proved to have had in its arsenal during the Gulf War was the botulinum toxin produced by the anaerobic bacterium *Clostridium botulinum*. The botulinum toxin, which according to the CDC is the most potent lethal substance known to man (lethal dose 1ng/kg), is the cause to potentially fatal muscle paralytic disease botulism. For U.S. forces in the Gulf, this toxin posed a major bioweapons threat due to its extreme potency and lethality, its ease of production, and the threats of Iraq to use any means necessary to defend Kuwait. Although the 1972 Biological and Toxin Weapons Convention, to which Iraq was a signatory, prohibited offensive research and production of biological weapons, U.S. intelligence believed Saddam Hussein to be in possession of significant quantities of this highly lethal toxin in a weaponized form ready to be used on U.S. forces.

Concerns regarding Iraq's capabilities of using the deadly botulinum toxin as an offensive weapon led to the decision that all available vaccines against it should be used to protect U.S. service members. At the time of the Gulf War, a botulinum toxoid existed that covered many of the serotypes of botulism harmful to humans. This toxoid, a modified bacterial toxin made nontoxic but continuing to have the capacity to stimulate the formation of antibodies, was distributed to several U.S. combat units prior to and during the Gulf War. According to the Department of Defense, it is estimated that 8,000 U.S. service men and women were vaccinated with botulinum toxoid during the war. Since the efficacy of this toxoid had never been proven due to the ethics involved in such testing, the Food and Drug Administration (FDA) labeled the toxoid as an Investigational New Drug (IND). Due to the military extingencies of the Gulf War, the FDA commissioner waived the informed consent requirements that go along with INDs so that troops could be protected. This thus meant that Gulf War military personnel who received the botulism toxoid were given an unapproved FDA pre-treatment vaccine without the ability to refuse taking it.

(Sources: Gulf War and Health, Volume 1, Depleted Uranium, Pyridostigmine Bromide, Sarin, Vaccines; Center for Disease Control www.bt.cdc.gov, Botulism Toxin as a Biological Weapon, JAMA. 2001; 285:1059-1070).

16) Anthrax Immunization

Anthrax is a naturally occurring zoonotic disease caused by the rod shaped bacterium *Bacillus anthracis* that occurs primarily in plant eating animals (goats, sheep, cattle, horses etc.). For centuries, it has caused disease in animals and, uncommonly serious illness in humans throughout the world. In the past century, a rare aerosol form of anthrax, often called inhalation anthrax, was recognized to be such a highly lethal form of the disease that research was soon undertaken to turn it into a biological weapon. In 1972, recognizing the danger of the spread of weapons of mass destruction, including the biological warfare agent inhalational anthrax, 144 countries including Iraq signed a biological warfare treaty which outlawed the possession of all biological weapons.

Concerns prior to the Gulf War regarding Iraq's offensive biological warfare capabilities, led to decisions that available vaccines should be utilized as preventive measures against biological warfare agents. Military planners and health officials were worried that Iraq had secretly possessed supplies of weaponized inhalational anthrax in violation of the 1972 treaty. They therefore ordered U.S. forces to take the Food and Drug Administration (FDA) approved vaccine for anthrax as a preventative measure. The Department of Defense (DoD) estimated that 310,680 doses of the anthrax vaccine licensed by the FDA were distributed to the Gulf War theatre and that 150,000 U.S. troops received at least on vaccination. Many troops were concerned about taking the anthrax vaccine during the Gulf War since the there was a possibility of an adverse reaction and since the long term affects of the anthrax vaccine were unknown.

(Source: Gulf War and Health, Volume 1, Depleted Uranium, Pyridostigmine Bromide, Sarin, Vaccines, Institute of Medicine, 2000)

17) Malaria Prevention

Malaria is life threatening parasitic disease that is transmitted from person to person from the bite of an infective female Anopheles mosquito, which requires blood to nurture her eggs. While biting a target individual, an infected Anopheles mosquito will inject protozoan parasites of the genus Plasmodium into that individual's bloodstream.

These parasites will intern invade that individuals red blood cells (RBCs) where they will multiply and cause the RBCs to change shape, stick together, or even rupture. The RBCs, which are responsible for carrying oxygen to vital organs, will less be able to perform their task and the infected individual will suffer as a consequence. Some of the major symptoms of malaria are chills, high fever, and anemia. If left untreated, infected RBCs can block blood vessels supplying the brain (cerebral malaria), or damage other vital organs and cause death in the infected individual.

Malaria affects primarily the populations of tropical and subtropical regions however it has been known to exist in both Kuwait and Iraq. Although it is unlikely to be found in a desert environment, it may be present focally in river valleys, salt marshes, and in irrigated areas. Outbreaks have been known to occur whenever major displacements of people occur, such as during military conflicts, social upheavals, or natural disasters.

To combat the malaria threat during the Gulf War, many U.S. forces were given antimalarial drugs for preventative purposes. Among the common antimalarial drugs used were chloroquine (Aralen), mefloquine (Lariam), primaquine, pyrimethamine (Daraprim), and quinine, which came in tablet, capsule, and injectable forms. Recommended dosage depended on the type of antimalarial drug, its strength, the form in which it is being used (such as tablet or injection) and if drug resistant strains of malaria are known to be in the area. Dosages were given on a set schedule for maximum protective effect.

Possible worries to U.S. forces when taking malarial medications were the side effects often experienced when using them. Antimalarial drugs often cause lightheadedness, dizziness, blurred vision and other vision changes. They have also been implicated in causing panic attacks, hallucinations, anxiety, depression, paranoia, and other mental and mood changes, sometimes lasting for months after the last dose. Troops in the region wanted to be at their best when facing the enemy. Taking antimalarial medications and possibly experiencing side effects was a cause for concern to them.

(Sources: RAND, A Review of the Scientific Literature As It Pertains to Gulf War Illnesses, Volume 1, Infectious Diseases, 2001, and http://www.principalhealthnews.com/topic/malariadrugs)

18) Food Contamination

Experience with previous wars in the Middle East led military and civilian experts to predict that a number of U.S. forces would come down with food borne diseases endemic to the Persian Gulf region. Among the most worrisome were Escherichia coli, Shigella, Salmonella, Campylobacter, Hepatitis A, and Brucellosis. Each of these diseases may be transmitted through the ingestion of undercooked infected food or contaminated food that is the result of poor sanitation. Most of these diseases concerned health officials because they not only disable the individual inflicted, but also they may lead to outbreaks that could spread the illness to other individuals.

Although most U.S. troops were given prepackaged food and advised not to eat locally produced food, it was difficult to keep all troops just eating the assigned rations. Many troops consumed locally grown food or cooked for themselves and for others. Since sanitation was often primitive in the desert camps with strains on latrines and communal washing facilities, there was always a high potential that a food borne outbreak would occur. An outbreak during time of war a concern to both troops as well as those in command.

(Source: RAND, A Review of the Scientific Literature As it Pertains to Gulf War Illnesses, Volume 1, Infectious Diseases, 2001).

19) Water Contamination

Military planners and health officials were concerned that troops exposed to poor sanitation conditions and unknown local water supplies during their deployment to the gulf might end up acquiring water borne illnesses such as cholera, typhoid, and giardia. These illnesses along with others like them could have seriously impacted the readiness of affected units and in turn caused logistical problems for all troops in the region. Health officials felt that crowded makeshift living quarters with primitive sanitation facilities, would become the breeding grounds for water borne illnesses. This coupled with the fact that many troops were using unknown local water supplies for bathing, cleaning, and cooling off purposes, made them very concerned with regards to troops becoming afflicted with borne illnesses.

During the first two months of troop deployment (August and September, 1990) troops deployed to the gulf were in particular exposed to contracting water borne illnesses. Most troops had just arrived and sanitation facilities were just being set up and thus basic at best. With air temperatures as high as 115 ^{0}F and temperatures of the sand reaching 150 ^{0}F troops had to drink large quantities of water to prevent dehydration. Many troops took their chances with unknown local drinking supplies to cool off and prevent dehydration at the risk of acquiring water borne illnesses. The water situation became better in the winter months after the outside temperatures fell, sanitation improved, and more bottled water became available, however many troops were still concerned about their health.

With the lighting of the Kuwaiti oil fields by Iraqi soldiers prior to their departure of Kuwait a new problem emerged for U.S. troops in terms of water consumption. Local water supplies were now contaminated with the fallout of the oil fires. Persons drinking any water besides the supplied bottled water were at risk on ingesting unknown quantities of fuel contaminants. With troops on the move chasing the Iraqi army out of Kuwait, it was difficult to keep supplies in line. Thus many troops may out of necessity have been forced to consume potentially contaminated water.

(Source: RAND, A Review of the Scientific Literature As It Pertains to Gulf War Illnesses, Volume 1, Infectious Diseases, 2001).

20) Combat Exposure

Going into the combat phase of the Gulf War, troops were concerned about confronting a formidable enemy that was "battle hardened" by an extended conflict with Iran. The Iraqi army, which had just overrun Kuwait, was at the time the fourth largest in the world and equipped with some of the most sophisticated weaponry of the Soviet military arsenal. Many troops had heard of high U.S. casualty estimates predicted by world news organizations and of Saddam Hussein's threat that the battle for Kuwait would be the "mother of all battles". They had known about the chemical and biological weapons threat and were now hearing debates raging in the media with regards to the usefulness or effectiveness of gear they had to protect themselves from that threat. They had a lot to worry about and were concerned that once actual combat began, the predictions of a high casualty war may indeed come true.

Once the air war had started troops had to worry about Iraqi SCUD missiles that could hit their positions at any time with little or no warning. Facing an enemy leader that had shown no mercy in using weapons of mass destruction to brutalize his own people many thought that if Saddam was going to use these types of weapons, he would certainly do so once the war began. Saddam had the capacity to load any number of nerve or chemical warheads onto his missiles and send them off against U.S. forces. Many troops believed that the more desperate Saddam became, the more likely he would resort to using weapons of mass destruction.

The actual ground war produced its own source of stress for U.S. forces in the Gulf region. No one knew how long the war would last, how determined the enemy would be, or what ends Saddam would go to in order to hold on to Kuwait. Troops had to fear being subject to ground and artillery attacks, possibly being captured and tortured, and to losing their friends to enemy or friendly fire. They also had to put up with the stress of possibly having to shoot or be shot at by enemy troops. On top of this was the real possibility that they would wind up injured or die in combat.

(Source: RAND, Psychological and Psychosocial Consequences of Combat and Deployment with Special Emphasis on the Gulf War, 2001).

21) Wounded in Action

An injury or wound suffered in battle can be can be a traumatic experience to the individual involved. Seriously injured or wounded persons must endure the pain of their injury, worry about living or dying, and stress about the possibility of suffering a permanent loss or long term disability from their injury. Oftentimes several people are wounded at once, so there is the added worry about the safety of friends who were nearby. There is additional stress involved being removed from the battlefield and receiving adequate medical attention. A wounded or injured person is oftentimes in a vulnerable position and thus has to worry about being wounded again or even captured. Once in a secure location, a wounded person has to worry about the possibility that the wound could become infected and lead to other problems such as a fever or other illness.

They are concerned not only about the length of time for recovery, but also if a full recovery can be achieved. Being far from home, away from the support loved ones, can be particularly is difficult on the wounded person. A wounded individual must finally worry about how the injury may impact their future life. Some disabling injuries could impact future military service or may have an effect on ones ability to return to civilian work.

22) Witnessing of Casualties

Nothing can fully prepare a soldier for what he or she may see on the battlefield after an encounter with the enemy. In this age of highly technical warfare where missiles can be fired for miles and the enemy can barely be seen prior to an attack, the casualties of war are often only truly recognized in the aftermath of battle. It is always an unpleasant sight to witness up close the carnage and destructiveness of war including its human casualties. Whether they were friend or foe, the images of casualties on a recently fought battlefield will be hard to ever forget.

In the aftermath of the highly successful air and ground offensives, many personnel – including noncombatants – were exposed to evidence of widespread devastation, including the deaths of tens of thousands of Iraqis. The cold reality of war suddenly was thrust into the faces of those who witnessed these casualties. Charred and dismembered bodies were seen throughout Kuwait and on the roadways heading back to Iraq. Many of these enemy troops had little chance against the overwhelming firepower of the coalition forces. Although there were few, coalition and civilian casualties were also witnessed by U.S. forces during the Gulf War. The visualization of these as well as Iraqi casualties had a profound impact on many of the troops who served.

(Source: RAND, A Review of the Scientific Literature As It Pertains to Gulf War Illnesses, Volume 4, Stress, 1999).

23) SCUD Attacks

One of the most feared weapons in the Iraqi arsenal during the Gulf War were Soviet made short range ballistic missiles known as Scuds. Pre-war intelligence judged that Iraq might have modified these conventional ballistic missiles by arming them with chemical or biological warheads thus making them far more dangerous to Coalition troops. At the time of the Gulf War it was estimated that Iraq had 150 of these modified Scud missiles ready for use. According to the Defense Intelligence Agency (D.I.A.), the most likely agents in Iraq's warheads were the nerve agent VX, and the blister agent mustard.

Many U.S. troops observed or became aware of incoming or overflying Scud missiles, Patriot missiles fired in defense, and Scud missile or debris impacts. They knew that Iraq had the capability to use chemical and biological weapons, and of Saddam Hussein's past with regards to weapons of mass destruction. With each Scud attack or perceived Scud attack U.S. troops were forced to take defensive measures such as heading for cover and going to full chemical protection mode. Such precautionary measures disrupted lives and generated stress among U.S. forces.

(Source: Information Paper, Iraq's Scud Ballistic Missiles, http://www.gulflink.osd.mil/scud_info_ii/)

24) Chemical Alarms

Since Saddam Hussein had a history of using chemical weapons against Iran and in suppressing his own people there was widespread concern among U.S. forces prior to the Gulf War that he would attempt to use similar weapons in his defense of Kuwait. In light of this threat U.S. forces were supplied and trained in the use of numerous types of chemical detectors that would sound alarms when and if chemical agents were detected. These detectors were used to alert troops that a chemical attack may be underway so that defensive measures such as taking cover, putting on protective gear, and taking prophylactic agents aimed at mitigating the consequences of exposure to chemical weapons could be taken.

Although troops in the gulf region underwent extensive training and mock drills to prepare themselves for possible chemical attacks, apprehension and uncertainty about possible attacks, the effectiveness of defensive suits, and the possible side effects of prophylactic agents weighed heavily on the minds of many soldiers. Constant training for a chemical attack and the numerous alarms indicating possible chemical detections increased the salience of this potential threat. For many troops being forced to wear both a protective mask and suit at a moments notice was a cause for both physical as well as mental strain.

(Source: RAND, A Review of the Scientific Literature As It Pertains to Gulf War Illnesses, Volume 4, Stress, 1999).

Appendix XXII: Gulf War Stress Survey Results

	Exposure/Experience	Veteran 1st e-mail N	Mean	Veteran 2nd e-mail N	Mean	Veteran mail/inter N	Mean	Veteran Total N	Mean
1	Passive Cigarette Smoke	118	2.73	60	3.25	32	2.19	210	2.8
2	Oil Fire Smoke	118	6.11	60	6.85	32	5.28	210	6.2
3	Tent Heater Smoke	118	2.94	60	2.82	32	1.91	210	2.75
4	CARC Paint	118	2.46	60	2.68	32	2.03	210	2.46
5	Other Paints	118	2.29	60	2.78	32	1.97	210	2.38
6	Solvents	118	3.29	60	4.03	32	3.09	210	3.47
7	Diesel Fuel	118	4.69	60	5.32	32	4.56	210	4.85
8	Other Petrochemicals	118	4.31	60	4.12	32	3.94	210	4.2
9	Depleted Uranium	118	3.67	60	3.62	32	4.41	210	3.77
10	Nerve Gas	118	5.14	60	4.55	32	4.97	210	4.94
11	Mustard Gas	118	4.19	60	3.58	32	4.59	210	4.08
12	Microwaves	118	3.64	60	4.23	32	3.53	210	3.8
13	PB Pills	118	6.34	60	6.03	32	7.03	210	6.36
14	Insect Repellents	118	4.47	60	4.45	32	3.47	210	4.31
15	Botulism Immunization	118	4.89	60	4.82	32	6	210	5.04
16	Anthrax Immunization	118	6.25	60	5.97	32	6.09	210	6.15
17	Malaria Prevention	118	4.26	60	4.1	32	4.34	210	4.23
18	Food Contamination	118	3.87	60	3.4	32	3.06	210	3.61
19	Water Contamination	118	4.14	60	3.78	32	3.63	210	3.96
20	Combat Exposure	118	6.67	60	5.95	32	7.06	210	6.52
21	Wounded in Action	118	3.25	60	2.67	32	5.03	210	3.35
22	Witnessing of Casualties	118	5.14	60	5.13	32	6.09	210	5.29
23	SCUD Attacks	118	6.3	60	6.1	32	7.03	210	6.35
24	Chemical Alarms	118	7.07	60	7.42	32	7.09	210	7.17

Veteran 1st email – a group e-mail sent out to 1600 veterans on October 28, 2003 and November 6, 2003 containing a Gulf War Stress Survey.

Veteran 2nd email – a group e-mail sent out to 800 different veterans on November 17, 2003 and November 24, 2003 containing a Gulf War Stress Survey.

Veteran mail/inter – Gulf War Stress Survey results that were obtained either by mailing the survey to veterans of personally interviewing them.

Veteran Total – the total results of the Gulf War Stress Survey sent out to veterans.

	Exposure/Experience	Veteran Total N	Veteran Total Mean	Health Expert e-mail N	Health Expert e-mail Mean	Combined Total Mean
1	Passive Cigarette Smoke	210	2.8	22	2.27	2.54
2	Oil Fire Smoke	210	6.2	22	5.95	6.08
3	Tent Heater Smoke	210	2.75	22	2.23	2.49
4	CARC Paint	210	2.46	22	1.86	2.16
5	Other Paints	210	2.38	22	3.09	2.74
6	Solvents	210	3.47	22	3.18	3.33
7	Diesel Fuel	210	4.85	22	3.55	4.2
8	Other Petrochemicals	210	4.2	22	3.95	4.08
9	Depleted Uranium	210	3.77	22	6.14	4.96
10	Nerve Gas	210	4.94	22	5.45	5.2
11	Mustard Gas	210	4.08	22	5.23	4.66
12	Microwaves	210	3.8	22	2.86	3.33
13	PB Pills	210	6.36	22	6.68	6.52
14	Insect Repellents	210	4.31	22	3.18	3.75
15	Botulism Immunization	210	5.04	22	4.32	4.68
16	Anthrax Immunization	210	6.15	22	6.23	6.19
17	Malaria Prevention	210	4.23	22	4.91	4.57
18	Food Contamination	210	3.61	22	3.14	3.38
19	Water Contamination	210	3.96	22	3.55	3.76
20	Combat Exposure	210	6.52	22	6.95	6.74
21	Wounded in Action	210	3.35	22	5.95	4.65
22	Witnessing of Casualties	210	5.29	22	5.77	5.53
23	SCUD Attacks	210	6.35	22	6.91	6.63
24	Chemical Alarms	210	7.17	22	7.59	7.38

Veteran Total – the total results of the Gulf War Stress Survey sent out to veterans.
Health Expert e-mail – the results of the Gulf War Stress Survey sent out to health experts.
Combined Total – the average of the mean results for the Gulf War Stress Survey for both veterans and health experts.

Appendix XXIII: Comprehensive Clinical Evaluation Program Exposure/Experience Questionnaire

Comprehensive Clinical Evaluation Program (CCEP)

Before you begin, the administrator will take you through a tutorial that includes several instruction screens to demonstrate how the CCEP questionnaire works. Please read each screen carefully and follow the instructions. If you have any problems or questions, ask the administrator to assist you.

BEGIN CCEP QUESTIONNAIRE

Q169 — Introduction

Welcome to the CCEP Patient Questionnaire.

Please read each screen completely and carefully before making your selections. Provide a response for each screen. Do not skip screens.

If you do not understand a question - ask the administrator.

Q171 — Demographics

Sponsor relationship

- ☐ I am the sponsor *[145]*
- ☐ I am married to the sponsor *[513]*
- ☐ I am a child of the sponsor *[514]*

Q172

Gulf War duty status

- ☐ *I served in an Active unit during the Gulf War [Q155]*

  If Yes, Branch to Q155
- ☐ *I served in a National Guard unit during the Gulf War [Q173]*

  If Yes, Branch to Q173
- ☐ *I served in a Reserve unit during the Gulf War [Q174]*

  If Yes, Branch to Q174
- ☐ *All others [Q175]*

  If Yes, Branch to Q175

Q155

Gulf War service (select ONLY one)

- ☐ I served in the active Army during the Gulf War *[502]*
- ☐ I served in the active Air Force during the Gulf War *[503]*
- ☐ I served in the active Marine Corps during the Gulf War *[504]*
- ☐ I served in the active Navy during the Gulf War *[505]*
- ☐ I served in the active Coast Guard during the Gulf War *[506]*
- ☐ I served in another active branch during the Gulf War *[520]*
- ☐ I was not in the service during the Gulf War *[507]*

Branch to Q176

Q173

Gulf War service (select ONLY one)

- ☐ I served in the Army National Guard during the Gulf War *[171]*
- ☐ I served in the Air National Guard during the Gulf War *[170]*
- ☐ I served in another branch of the Nat Guard during Gulf War *[524]*
- ☐ I was not in the service during the Gulf War *[507]*

Branch to Q176

Q174

Gulf War service (select ONLY one)

- ☐ I served in the Army Reserves during the Gulf War *[525]*
- ☐ I served in the Air Force Reserves during the Gulf War *[526]*
- ☐ I served in the Marine Corps Reserves during the Gulf War *[527]*
- ☐ I served in the Navy Reserves during the Gulf War *[528]*
- ☐ I served in the Coast Guard Reserves during the Gulf War *[529]*
- ☐ I served in another branch of the Reserves during Gulf War *[530]*
- ☐ I was not in the service during the Gulf War *[507]*

Branch to Q176

Q175

Gulf War service (select ONLY one)

- ☐ I was a civilian employee during the Gulf War *[531]*
- ☐ I was the spouse of a soldier who served during the Gulf War *[532]*
- ☐ I was the spouse of a civilian who served the Gulf War *[533]*
- ☐ I was the child of a soldier who served during the Gulf War *[534]*
- ☐ I was the child of a civilian who served the Gulf War *[535]*
- ☐ I was associated with the Gulf War in some other way *[536]*

Q176

Service history (select ALL that apply)

- ☐ I have served in armed conflicts in Vietnam *[282]*
- ☐ I have served in armed conflicts in Grenada *[284]*
- ☐ I have served in armed conflicts in Panama *[285]*
- ☐ I have served in armed conflicts in Somalia *[286]*
- ☐ I have served in armed conflicts in Haiti *[287]*
- ☐ I have served in armed conflicts in Bosnia *[288]*
- ☐ I have served in other armed conflicts not listed above *[283]*

Q88 — General Health

In general, would you say your health is

- ☐ Excellent *[289]*
- ☐ Very good *[290]*
- ☐ Good *[291]*
- ☐ Fair *[292]*
- ☐ Poor *[293]*

Q89

Compared to 1 year ago,

- ☐ my general health is Much better now *[294]*
- ☐ my general health is Somewhat better now *[295]*
- ☐ my general health is About the same now *[296]*
- ☐ my general health is Somewhat worse now *[297]*
- ☐ my general health is Much worse now *[298]*

Q93

Days lost from work in last 90 days

- ☐ 0 days lost from work *[308]*
- ☐ 1-6 days lost from work *[309]*
- ☐ 7-15 days lost from work *[310]*
- ☐ 16-30 days lost from work *[311]*
- ☐ 31-60 days lost from work *[312]*
- ☐ 61-90 days lost from work *[313]*

Q1

Cigarette use

- ☐ *YES, I smoke cigarettes now [Q2]*

  If Yes, Branch to Q2
- ☐ *YES, I used to smoke cigarettes, but I have quit [Q3]*

  If Yes, Branch to Q3
- ☐ NO, I have never smoked cigarettes *[147]*

  If No, Branch to Q100

Q2

Current smoker

- ☐ YES, I smoke LESS THAN 1 PACK of cigarettes PER DAY *[1]*
- ☐ YES, I smoke 1-2 PACKS of cigarettes PER DAY *[2]*
- ☐ YES, I smoke MORE THAN 2 PACKS of cigarettes PER DAY *[3]*

  Branch to Q100

Q3

Former smoker

- ☐ YES, I USED to smoke LESS THAN 1 PACK of cigarettes PER DAY *[4]*
- ☐ YES, I USED to smoke 1-2 PACKS of cigarettes PER DAY *[5]*
- ☐ YES, I USED to smoke MORE THAN 2 PACKS of cigarettes PER DAY *[6]*

Q100 — Duty Status

Duty Status

- ☐ *I am currently on active duty status [Q94]*

  If Yes, Branch to Q94
- ☐ *I am not currently on active duty status [Q85]*

  If Yes, Branch to Q85

Q94

Physical fitness testing

- ☐ YES, I have passed my physical fitness test within last year *[344]*
- ☐ NO, I did not pass my latest physical fitness test *[345]*
- ☐ I have NOT TAKEN a physical fitness test within last year *[21]*

Q95

Medical boards

- ☐ YES, I am currently undergoing a medical board *[346]*
- ☐ NO, I am not currently undergoing a medical board *[347]*

Q96

Duty limitations

- ☐ YES, I am currently on a profile or light duty *[348]*
- ☐ NO, I am not currently on a profile or light duty *[349]*

Q97

Active duty status (within next year)

- ☐ YES, I am facing possible termination from active duty *[350]*
- ☐ NO, I am not facing possible termination from active duty *[351]*
- ☐ NOT SURE if I'm facing possible termination from active duty *[20]*

Q85 — Medical Complaints/Symptoms

YES, I have experienced one or more of these symptoms: abdominal pain, bleeding gums, depressed mood, diarrhea, difficulty concentrating, fatigue, hair loss, headaches, joint pain, memory problem, muscle pain, rash, shortness of breath, sleep disturbance, weight change, or OTHER symptoms.

- ☐ *Click here if you HAVE experienced ANY symptoms [Q54]*

  If Yes, Branch to Q54
- ☐ Click here if you HAVE NOT experienced ANY of these symptoms *[300]*

  If Have Not, Branch to Q90

Q54

Abdominal pain

- ☐ *YES, I have experienced abdominal pain [Q131]*
- ☐ NO, I have not experienced any abdominal pain *[321]*

  If No, Branch to Q55

Q131

Abdominal pain - currency

- ☐ I am currently experiencing abdominal pain *[465]*
- ☐ I have experienced abdominal pain in the past but not now *[466]*

Q41

Abdominal pain - onset

- ☐ onset more than 3 months PRIOR to Gulf War Service *[117]*
- ☐ onset within 3 months PRIOR to Gulf War Service *[118]*
- ☐ onset during Gulf War Service *[119]*
- ☐ onset within 3 months AFTER Gulf War Service *[120]*
- ☐ onset more than 3 months AFTER Gulf War Service *[121]*

Q42

Abdominal pain - duration

- ☐ less than one month *[122]*
- ☐ one to six months *[123]*
- ☐ six months to one year *[124]*
- ☐ one to three years *[125]*
- ☐ greater than three years *[126]*

Q43

Abdominal pain - frequency

- ☐ rarely *[130]*
- ☐ some of the time *[354]*
- ☐ most of the time *[355]*
- ☐ all of the time *[356]*

Q44

Abdominal pain - impairment

- ☐ This has minimal effect on me performing my daily activities *[127]*
- ☐ This limits me from performing my daily activities *[128]*
- ☐ This prevents me from performing my daily activities *[129]*

Q55

Bleeding gums

- ☐ *YES, I have experienced bleeding gums [Q132]*
- ☐ NO, I have not experienced any bleeding gums *[322]*

If No, Branch to Q56

Q132

Bleeding gums - currency

- ☐ I am currently experiencing bleeding gums *[352]*
- ☐ I have experienced bleeding gums in the past but not now *[353]*

Q45

Bleeding gums - onset

- ☐ onset more than 3 months PRIOR to Gulf War Service *[82]*
- ☐ onset within 3 months PRIOR to Gulf War Service *[83]*
- ☐ onset during Gulf War Service *[84]*
- ☐ onset within 3 months AFTER Gulf War Service *[85]*
- ☐ onset more than 3 months AFTER Gulf War Service *[86]*

Q46

Bleeding gums - duration

- ☐ less than one month *[87]*
- ☐ one to six months *[88]*
- ☐ six months to one year *[89]*
- ☐ one to three years *[90]*
- ☐ greater than three years *[91]*

Q47

Bleeding gums - frequency

- ☐ rarely *[115]*
- ☐ some of the time *[116]*
- ☐ most of the time *[357]*
- ☐ all of the time *[358]*

Q48

Bleeding gums - impairment

- ☐ This has minimal effect on me performing my daily activities *[92]*
- ☐ This limits me from performing my daily activities *[93]*
- ☐ This prevents me from performing my daily activities *[114]*

Q56

Depressed mood

- ☐ *YES, I have experienced a depressed mood [Q133]*
- ☐ NO, I have not experienced any depressed moods *[323]*

If No, Branch to Q57

Q133

Depressed mood - currency

- ☐ I am currently experiencing a depressed mood *[467]*
- ☐ I have experienced a depressed mood in the past but not now *[468]*

Q49

Depressed mood - onset

- ☐ onset more than 3 months PRIOR to Gulf War Service *[94]*
- ☐ onset within 3 months PRIOR to Gulf War Service *[95]*
- ☐ onset during Gulf War Service *[96]*
- ☐ onset within 3 months AFTER Gulf War Service *[97]*
- ☐ onset more than 3 months AFTER Gulf War Service *[98]*

Q50

Depressed mood - duration

- ☐ less than one month *[99]*
- ☐ one to six months *[100]*
- ☐ six months to one year *[101]*
- ☐ one to three years *[102]*
- ☐ greater than three years *[103]*

Q51

Depressed mood - frequency

- ☐ rarely *[359]*
- ☐ some of the time *[360]*
- ☐ most of the time *[361]*
- ☐ all of the time *[362]*

Q52

Depressed mood - impairment

- ☐ This has minimal effect on me performing my daily activities *[104]*
- ☐ This limits me from performing my daily activities *[105]*
- ☐ This prevents me from performing my daily activities *[106]*

Q57

Diarrhea

- ☐ *YES, I have experienced diarrhea [Q134]*
- ☐ NO, I have not experienced any diarrhea *[324]*

If No, Branch to Q58

Q134

Diarrhea - currency

- ☐ I am currently experiencing diarrhea *[469]*
- ☐ I have experienced diarrhea in the past but not now *[470]*

Q53

Diarrhea - onset

- ☐ onset more than 3 months PRIOR to Gulf War Service *[107]*
- ☐ onset within 3 months PRIOR to Gulf War Service *[108]*
- ☐ onset during Gulf War Service *[109]*
- ☐ onset within 3 months AFTER Gulf War Service *[110]*
- ☐ onset more than 3 months AFTER Gulf War Service *[111]*

Q67

Diarrhea - duration

- ☐ less than one month *[112]*
- ☐ one to six months *[113]*
- ☐ six months to one year *[173]*
- ☐ one to three years *[174]*
- ☐ greater than three years *[175]*

Q68

Diarrhea - frequency

- ☐ rarely *[176]*
- ☐ some of the time *[177]*
- ☐ most of the time *[178]*
- ☐ all of the time *[179]*

Q69

Diarrhea - impairment

- ☐ This has minimal effect on me performing my daily activities *[363]*
- ☐ This limits me from performing my daily activities *[364]*
- ☐ This prevents me from performing my daily activities *[365]*

Q58

Difficulty concentrating

- ☐ *YES, I have experienced difficulty concentrating [Q135]*
- ☐ NO, I have not experienced any difficulty concentrating *[325]*

If No, Branch to Q37

Q135

Difficulty concentrating - currency

- ☐ I am currently experiencing difficulty concentrating *[471]*
- ☐ I have exper'd difficulty concentrating in past but not now *[472]*

Q70

Difficulty concentrating - onset

- ☐ onset more than 3 months PRIOR to Gulf War Service *[180]*
- ☐ onset within 3 months PRIOR to Gulf War Service *[181]*
- ☐ onset during Gulf War Service *[182]*
- ☐ onset within 3 months AFTER Gulf War Service *[183]*
- ☐ onset more than 3 months AFTER Gulf War Service *[184]*

Q71

Difficulty concentrating - duration

- ☐ less than one month *[185]*
- ☐ one to six months *[186]*
- ☐ six months to one year *[187]*
- ☐ one to three years *[188]*
- ☐ greater than three years *[189]*

Q72

Difficulty concentrating - frequency

- ☐ rarely *[190]*
- ☐ some of the time *[191]*
- ☐ most of the time *[192]*
- ☐ all of the time *[193]*

Q73

Difficulty concentrating - impairment

- ☐ This has minimal effect on me performing my daily activities *[366]*
- ☐ This limits me from performing my daily activities *[367]*
- ☐ This prevents me from performing my daily activities *[368]*

Q37

Fatigue

- ☐ *YES, I have experienced fatigue [Q9]*
- ☐ NO, I have not experienced any fatigue *[244]*

If No, Branch to Q60

Q9

Fatigue - currency

- ☐ I am currently experiencing fatigue *[65]*
- ☐ I have experienced fatigue in the past but not now *[275]*

Q38

Fatigue - onset

- ☐ onset more than 3 months PRIOR to Gulf War Service *[302]*
- ☐ onset within 3 months PRIOR to Gulf War Service *[248]*
- ☐ onset during Gulf War Service *[249]*
- ☐ onset within 3 months AFTER Gulf War Service *[247]*
- ☐ onset more than 3 months AFTER Gulf War Service *[246]*

Q39

Fatigue - duration

- ☐ less than one month *[245]*
- ☐ one to six months *[250]*
- ☐ six months to one year *[251]*
- ☐ one to three years *[252]*
- ☐ greater than three years *[253]*

Q33

Fatigue - frequency

- ☐ rarely *[303]*
- ☐ some of the time *[304]*
- ☐ most of the time *[305]*
- ☐ all of the time *[306]*

Q36

Fatigue - impairment

- ☐ This has minimal effect on me performing my daily activities *[132]*
- ☐ This limits me from performing my daily activities *[134]*
- ☐ This prevents me from performing my daily activities *[136]*

Q60

Hair loss

- ☐ *YES, I have experienced hair loss [Q136]*
- ☐ NO, I have not experienced any hair loss *[327]*

If No, Branch to Q61

Q136

Hair loss - currency

- ☐ I am currently experiencing hair loss *[473]*
- ☐ I have experienced hair loss in the past but not now *[474]*

Q74

Hair loss - onset

- ☐ onset more than 3 months PRIOR to Gulf War Service *[208]*
- ☐ onset within 3 months PRIOR to Gulf War Service *[209]*
- ☐ onset during Gulf War Service *[210]*
- ☐ onset within 3 months AFTER Gulf War Service *[211]*
- ☐ onset more than 3 months AFTER Gulf War Service *[212]*

Q75

Hair loss - duration

- ☐ less than one month *[213]*
- ☐ one to six months *[214]*
- ☐ six months to one year *[215]*
- ☐ one to three years *[216]*
- ☐ greater than three years *[217]*

Q76

Hair loss - frequency

- ☐ rarely *[218]*
- ☐ some of the time *[219]*
- ☐ most of the time *[220]*
- ☐ all of the time *[221]*

Q77

Hair loss - impairment

- ☐ This has minimal effect on me performing my daily activities *[369]*
- ☐ This limits me from performing my daily activities *[370]*
- ☐ This prevents me from performing my daily activities *[371]*

Q61

Headaches

- ☐ *YES, I have experienced headaches [Q137]*
- ☐ NO, I have not experienced any headaches *[328]*

If No, Branch to Q62

Q137

Headaches - currency

- ☐ I am currently experiencing headaches *[475]*
- ☐ I have experienced headaches in the past but not now *[476]*

Q78

Headaches - onset

- ☐ onset more than 3 months PRIOR to Gulf War Service *[222]*
- ☐ onset within 3 months PRIOR to Gulf War Service *[223]*
- ☐ onset during Gulf War Service *[224]*
- ☐ onset within 3 months AFTER Gulf War Service *[225]*
- ☐ onset more than 3 months AFTER Gulf War Service *[226]*

Q79

Headaches - duration

- ☐ less than one month *[227]*
- ☐ one to six months *[228]*
- ☐ six months to one year *[229]*
- ☐ one to three years *[230]*
- ☐ greater than three years *[231]*

Q101

Headaches - frequency

- ☐ rarely *[232]*
- ☐ some of the time *[233]*
- ☐ most of the time *[234]*
- ☐ all of the time *[235]*

Q102

Headaches - impairment

- ☐ This has minimal effect on me performing my daily activities *[372]*
- ☐ This limits me from performing my daily activities *[373]*
- ☐ This prevents me from performing my daily activities *[374]*

Q62

Joint pain

- ☐ *YES, I have experienced joint pain [Q138]*
- ☐ NO, I have not experienced any joint pain *[329]*

If No, Branch to Q63

Q138

Joint pain - currency

- ☐ I am currently experiencing joint pain *[477]*
- ☐ I have experienced joint pain in the past but not now *[478]*

Q103

Joint pain - onset

- ☐ onset more than 3 months PRIOR to Gulf War Service *[236]*
- ☐ onset within 3 months PRIOR to Gulf War Service *[237]*
- ☐ onset during Gulf War Service *[238]*
- ☐ onset within 3 months AFTER Gulf War Service *[239]*
- ☐ onset more than 3 months AFTER Gulf War Service *[240]*

Q104

Joint pain - duration

- ☐ less than one month *[241]*
- ☐ one to six months *[242]*
- ☐ six months to one year *[243]*
- ☐ one to three years *[137]*
- ☐ greater than three years *[138]*

Q105

Joint pain - frequency

- ☐ rarely *[139]*
- ☐ some of the time *[140]*
- ☐ most of the time *[141]*
- ☐ all of the time *[142]*

Q106

Joint pain - impairment

- ☐ This has minimal effect on me performing my daily activities *[143]*
- ☐ This limits me from performing my daily activities *[378]*
- ☐ This prevents me from performing my daily activities *[379]*

Q63

Memory problem

- ☐ *YES, I have experienced a memory problem [Q139]*
- ☐ NO, I have not experienced any memory problems *[330]*

If No, Branch to Q145

Q139

Memory problem - currency

- ☐ I am currently experiencing a memory problem *[479]*
- ☐ I have experienced a memory problem in the past but not now *[480]*

Q107

Memory problem - onset

- ☐ onset more than 3 months PRIOR to Gulf War Service *[380]*
- ☐ onset within 3 months PRIOR to Gulf War Service *[381]*
- ☐ onset during Gulf War Service *[382]*
- ☐ onset within 3 months AFTER Gulf War Service *[383]*
- ☐ onset more than 3 months AFTER Gulf War Service *[384]*

Q108

Memory problem - duration

- ☐ less than one month *[385]*
- ☐ one to six months *[386]*
- ☐ six months to one year *[387]*
- ☐ one to three years *[388]*
- ☐ greater than three years *[389]*

Q109

Memory problem - frequency

- ☐ rarely *[390]*
- ☐ some of the time *[391]*
- ☐ most of the time *[392]*
- ☐ all of the time *[393]*

Q110

Memory problem - impairment

- ☐ This has minimal effect on me performing my daily activities *[394]*
- ☐ This limits me from performing my daily activities *[395]*
- ☐ This prevents me from performing my daily activities *[396]*

Q145

Muscle pain

- ☐ *YES, I have experienced muscle pain [Q140]*
- ☐ NO, I have not experienced muscle pain *[491]*

If No, Branch to Q64

Q140

Muscle pain - currency

- ☐ I am currently experiencing muscle pain *[481]*
- ☐ I have experienced muscle pain in the past but not now *[482]*

Q111

Muscle pain - onset

- ☐ onset more than 3 months PRIOR to Gulf War Service *[397]*
- ☐ onset within 3 months PRIOR to Gulf War Service *[398]*
- ☐ onset during Gulf War Service *[399]*
- ☐ onset within 3 months AFTER Gulf War Service *[400]*
- ☐ onset more than 3 months AFTER Gulf War Service *[401]*

Q112

Muscle pain - duration

- ☐ less than one month *[402]*
- ☐ one to six months *[403]*
- ☐ six months to one year *[404]*
- ☐ one to three years *[405]*
- ☐ greater than three years *[406]*

Q113

Muscle pain - frequency

- ☐ rarely *[407]*
- ☐ some of the time *[408]*
- ☐ most of the time *[409]*
- ☐ all of the time *[410]*

Q114

Muscle pain - impairment

- ☐ This has minimal effect on me performing my daily activities *[411]*
- ☐ This limits me from performing my daily activities *[412]*
- ☐ This prevents me from performing my daily activities *[413]*

Q64

Rash

- ☐ *YES, I have experienced a rash [Q141]*
- ☐ NO, I have not experienced any rash *[331]*

If No, Branch to Q59

Q141

Rash - currency

- ☐ I am currently experiencing a rash *[483]*
- ☐ I have experienced a rash in the past but not now *[484]*

Q115

Rash - onset

- ☐ onset more than 3 months PRIOR to Gulf War Service *[414]*
- ☐ onset within 3 months PRIOR to Gulf War Service *[415]*
- ☐ onset during Gulf War Service *[416]*
- ☐ onset within 3 months AFTER Gulf War Service *[417]*
- ☐ onset more than 3 months AFTER Gulf War Service *[418]*

Q116

Rash - duration

- ☐ less than one month *[419]*
- ☐ one to six months *[420]*
- ☐ six months to one year *[421]*
- ☐ one to three years *[422]*
- ☐ greater than three years *[423]*

Q117

Rash - frequency

- ☐ rarely *[424]*
- ☐ some of the time *[425]*
- ☐ most of the time *[426]*
- ☐ all of the time *[427]*

Q118

Rash - impairment

- ☐ This has minimal effect on me performing my daily activities *[428]*
- ☐ This limits me from performing my daily activities *[429]*
- ☐ This prevents me from performing my daily activities *[430]*

Q59

Shortness of breath

- ☐ *YES, I have experienced shortness of breath [Q142]*
- ☐ NO, I have not experienced any shortness of breath *[326]*

If No, Branch to Q65

Q142

Shortness of breath - currency

- ☐ I am currently experiencing shortness of breath *[485]*
- ☐ I have experienced shortness of breath in past but not now *[486]*

Q119

Shortness of breath - onset

- ☐ onset more than 3 months PRIOR to Gulf War Service *[194]*
- ☐ onset within 3 months PRIOR to Gulf War Service *[195]*
- ☐ onset during Gulf War Service *[196]*
- ☐ onset within 3 months AFTER Gulf War Service *[197]*
- ☐ onset more than 3 months AFTER Gulf War Service *[198]*

Q120

Shortness of breath - duration

- ☐ less than one month *[199]*
- ☐ one to six months *[200]*
- ☐ six months to one year *[201]*
- ☐ one to three years *[202]*
- ☐ greater than three years *[203]*

Q121

Shortness of breath - frequency

- ☐ rarely *[204]*
- ☐ some of the time *[205]*
- ☐ most of the time *[206]*
- ☐ all of the time *[207]*

Q122

Shortness of breath - impairment

- ☐ This has minimal effect on me performing my daily activities *[377]*
- ☐ This limits me from performing my daily activities *[375]*
- ☐ This prevents me from performing my daily activities *[376]*

Q65

Sleep disturbance

- ☐ *YES, I have experienced sleep disturbance [Q143]*
- ☐ NO, I have not experienced any sleep disturbance *[332]*

If No, Branch to Q66

Q143

Sleep disturbance - currency

- ☐ I am currently experiencing sleep disturbance *[487]*
- ☐ I have experienced sleep disturbance in the past but not now *[488]*

Q164

Snore loudly

- ☐ I never snore loudly or have someone tell me I do *[135]*
- ☐ I sometimes snore loudly or have someone tell me I do *[152]*
- ☐ I often snore loudly or have someone tell me I do *[159]*
- ☐ I always snore loudly or have someone tell me I do *[161]*

Q165

Stop breathing while sleeping

- ☐ I never stop breathing or have someone tell me I do *[163]*
- ☐ I sometimes stop breathing or have someone tell me I do *[165]*
- ☐ I often stop breathing or have someone tell me I do *[167]*
- ☐ I always stop breathing or have someone tell me I do *[169]*

Q123

Sleep disturbance - onset

- ☐ onset more than 3 months PRIOR to Gulf War Service *[431]*
- ☐ onset within 3 months PRIOR to Gulf War Service *[432]*
- ☐ onset during Gulf War Service *[433]*
- ☐ onset within 3 months AFTER Gulf War Service *[434]*
- ☐ onset more than 3 months AFTER Gulf War Service *[435]*

Q124

Sleep disturbance - duration

- ☐ less than one month *[436]*
- ☐ one to six months *[437]*
- ☐ six months to one year *[438]*
- ☐ one to three years *[439]*
- ☐ greater than three years *[440]*

Q125

Sleep disturbance - frequency

- ☐ rarely *[441]*
- ☐ some of the time *[442]*
- ☐ most of the time *[443]*
- ☐ all of the time *[444]*

Q126

Sleep disturbance - impairment

- ☐ This has minimal effect on me performing my daily activities *[445]*
- ☐ This limits me from performing my daily activities *[446]*
- ☐ This prevents me from performing my daily activities *[447]*

Q66

Weight change of more than 10 lbs

- ☐ *YES, I have experienced a weight change of more than 10 lbs [Q144]*
- ☐ NO, I have not experienced a wt. change of more than 10 lbs *[333]*

If No, Branch to Q90

Q144

Weight change - currency

- ☐ I am currently experiencing a weight GAIN *[489]*
- ☐ I have experienced a weight GAIN in the past but not now *[490]*
- ☐ I am currently experiencing a weight LOSS *[515]*
- ☐ I have experienced a weight LOSS in the past but not now *[516]*

Q163

Weight change - cause

- ☐ I am trying or have tried to gain or lose weight on purpose *[517]*
- ☐ my weight changes are or have been due to a pregnancy *[518]*
- ☐ my weight changes are unexplained *[519]*

Q127

Weight change - onset

- ☐ onset more than 3 months PRIOR to Gulf War Service *[448]*
- ☐ onset within 3 months PRIOR to Gulf War Service *[449]*
- ☐ onset during Gulf War Service *[450]*
- ☐ onset within 3 months AFTER Gulf War Service *[451]*
- ☐ onset more than 3 months AFTER Gulf War Service *[452]*

Q128

Weight change - duration

- ☐ less than one month *[453]*
- ☐ one to six months *[454]*
- ☐ six months to one year *[455]*
- ☐ one to three years *[456]*
- ☐ greater than three years *[457]*

Q129

Weight change - frequency

- ☐ rarely *[458]*
- ☐ some of the time *[459]*
- ☐ most of the time *[460]*
- ☐ all of the time *[461]*

Q130

Weight change - impairment

- ☐ This has minimal effect on me performing my daily activities *[462]*
- ☐ This limits me from performing my daily activities *[463]*
- ☐ This prevents me from performing my daily activities *[464]*

Q90

Other symptoms

- ☐ YES, I have OTHER symptoms to discuss with a provider *[299]*
- ☐ NO, I do NOT have OTHER symptoms to discuss with a provider *[301]*

Q25 — Reproductive History

Conception (1988-1994)

- ☐ *YES, children were conceived between 1988-1994 [Q11]*
- ☐ NO, children were not conceived between 1988-1994 *[158]*

If No, Branch to Q32

Q11

Conception (select ALL that apply)

- ☐ 1 child conceived in 3 years BEFORE Gulf service *[33]*
- ☐ 2 children conceived in 3 years BEFORE Gulf service *[34]*
- ☐ 3 or more children conceived in 3 years BEFORE Gulf service *[35]*
- ☐ 1 child conceived in 3 years AFTER Gulf service *[37]*
- ☐ 2 children conceived in 3 years AFTER Gulf service *[38]*
- ☐ 3 or more children conceived in 3 years AFTER Gulf service *[39]*

Q32

Infertility (1988-1994)

- ☐ *YES, infertility problems occurred between 1988-1994 [Q30]*
- ☐ NO, infertility problems did not occur between 1988-1994 *[168]*

If No, Branch to Q26

Q30

Infertility (select ALL that apply)

- ☐ YES, infertility problems in the 3 years BEFORE Gulf service *[41]*
- ☐ YES, infertility problems in the 3 years AFTER Gulf service *[43]*

Q26

Miscarriage (1988-1994)

- ☐ *YES, miscarriages occurred between 1988-1994 [Q13]*
- ☐ NO, miscarriages did not occur between 1988-1994 *[160]*

If No, Branch to Q27

Q13

Miscarriage (select ALL that apply)

- ☐ 1 miscarriage in 3 years BEFORE Gulf service *[42]*
- ☐ 2 miscarriages in 3 years BEFORE Gulf service *[44]*
- ☐ 3 or more miscarriages in 3 years BEFORE Gulf service *[45]*
- ☐ 1 miscarriage in 3 years AFTER Gulf service *[46]*
- ☐ 2 miscarriages in 3 years AFTER Gulf service *[47]*
- ☐ 3 or more miscarriages in 3 years AFTER Gulf service *[48]*

Q27

Stillbirth (1988-1994)

- ☐ *YES, stillbirths occurred between 1988-1994 [Q15]*
- ☐ NO, stillbirths did not occur between 1988-1994 *[162]*

If No, Branch to Q28

Q15

Stillbirth (select ALL that apply)

- ☐ 1 stillbirth in 3 years BEFORE Gulf service *[49]*
- ☐ 2 stillbirths in 3 years BEFORE Gulf service *[50]*
- ☐ 3 or more stillbirths in 3 years BEFORE Gulf service *[51]*
- ☐ 1 stillbirth in 3 years AFTER Gulf service *[52]*
- ☐ 2 stillbirths in 3 years AFTER Gulf service *[53]*
- ☐ 3 or more stillbirths in 3 years AFTER Gulf service *[54]*

Q28

Infant death (1988-1994)

☐ *YES, infant deaths occurred between 1988-1994 [Q17]*

☐ NO, infant deaths did not occur between 1988-1994 *[164]*

If No, Branch to Q29

Q17

Infant death (select ALL that apply)

☐ 1 infant death in 3 years BEFORE Gulf service *[55]*

☐ 2 infant deaths in 3 years BEFORE Gulf service *[56]*

☐ 3 or more infant deaths in 3 years BEFORE Gulf service *[172]*

☐ 1 infant death in 3 years AFTER Gulf service *[57]*

☐ 2 infant deaths in 3 years AFTER Gulf service *[58]*

☐ 3 or more infant deaths in 3 years AFTER Gulf service *[144]*

Q29

Birth defects (1988-1994)

☐ *YES, birth defects occurred between 1988-1994 [Q19]*

☐ NO, birth defects did not occur between 1988-1994 *[166]*

If No, Branch to Q86

Q19

Birth defects (select ALL that apply)

☐ 1 birth with defects in 3 years BEFORE Gulf service *[59]*

☐ 2 births with defects in 3 years BEFORE Gulf service *[60]*

☐ 3 or more births with defects in 3 years BEFORE Gulf service *[61]*

☐ 1 birth with defects in 3 years AFTER Gulf service *[62]*

☐ 2 births with defects in 3 years AFTER Gulf service *[63]*

☐ 3 or more births with defects in 3 years AFTER Gulf service *[64]*

Q86 — Gulf War Service

Service during Gulf War

☐ *YES, I served in the Gulf War [Q31]*

☐ *NO, I did not serve in the Gulf War [Q40]*

If No, Branch to Q40

Q31 — Wartime Exposures/Experiences

Passive cigarette smoke

☐ YES, I was exposed to passive cigarette smoke *[7]*

☐ NO, I was not exposed to passive cigarette smoke *[148]*

☐ I DON'T KNOW if I was exposed to passive cigarette smoke *[317]*

Q98

Oil fire smoke

- ☐ YES, I was exposed to smoke from oil fires *[8]*
- ☐ NO, I was not exposed to smoke from oil fires *[315]*
- ☐ I DON'T KNOW if I was exposed to smoke from oil fires *[318]*

Q99

Tent heater smoke

- ☐ YES, I was exposed to smoke from a tent heater *[9]*
- ☐ NO, I was not exposed to smoke from a tent heater *[316]*
- ☐ I DON'T KNOW if I was exposed to smoke from a tent heater *[319]*

Q4

CARC paint

- ☐ YES, I was exposed to CARC paint being applied to vehicles *[10]*
- ☐ NO, I was not exposed to CARC painting *[146]*
- ☐ I DON'T KNOW if I was exposed to CARC painting *[256]*

Q22

Other paints

- ☐ YES, I was exposed to painting (other than CARC paint) *[11]*
- ☐ NO, I was not exposed to other painting *[254]*
- ☐ I DON'T KNOW if I was exposed to other painting *[257]*

Q21

Solvents

- ☐ YES, I was exposed to solvents *[12]*
- ☐ NO, I was not exposed to solvents *[255]*
- ☐ I DON'T KNOW if I was exposed to solvents *[258]*

Q34

Diesel fuel

- ☐ YES, I was exposed to diesel fuel *[13]*
- ☐ NO, I was not exposed to diesel fuel *[157]*
- ☐ I DON'T KNOW if I was exposed to diesel fuel *[261]*

Q20

Other petrochemicals

- ☐ YES, I was exposed to other petrochemical substances *[14]*
- ☐ NO, I was not exposed to other petrochemical substances *[259]*
- ☐ I DON'T KNOW if I was exposed to other petrochemicals *[262]*

Q18

Depleted uranium

- ☐ YES, I was exposed to depleted uranium *[15]*
- ☐ NO, I was not exposed to depleted uranium *[260]*
- ☐ I DON'T KNOW if I was exposed to depleted uranium *[263]*

Q35

Nerve gas

- ☐ YES, I was exposed to nerve gas or other nerve agents *[16]*
- ☐ NO, I was not exposed to nerve gas or other nerve agents *[149]*
- ☐ I DON'T KNOW if I was exposed to nerve gas or nerve agents *[266]*

Q16

Mustard gas

- ☐ YES, I was exposed to mustard gas or other blistering agents *[17]*
- ☐ NO, I was not exposed to mustard gas or blistering agents *[264]*
- ☐ I DON'T KNOW if I was exposed to mustard gas or other agents *[267]*

Q14

Microwaves (strong radar)

- ☐ YES, I was exposed to microwaves *[22]*
- ☐ NO, I was not exposed to microwaves *[265]*
- ☐ I DON'T KNOW if I was exposed to microwaves *[268]*

Q5

PB (pyridostigmine) pills

- ☐ YES, I took PB (pyridostigmine bromide) pills *[19]*
- ☐ NO, I did not take PB (pyridostigmine bromide) pills *[155]*
- ☐ I DON'T KNOW if I took PB (pyridostigmine bromide) pills *[270]*

Q12

Insect repellents and flea collars

- ☐ YES, I used insect repellents or flea collars *[18]*
- ☐ NO, I did not use insect repellents or flea collars *[269]*
- ☐ I DON'T KNOW if I used insect repellents or flea collars *[271]*

Q23

Botulism immunization

- ☐ *YES, I was immunized against botulism [Q147]*
- ☐ NO, I was not immunized against botulism *[156]*

  If No, Branch to Q10
- ☐ I DON'T KNOW if I was immunized against botulism *[273]*

  If Don't Know, Branch to Q10

Q147

Botulism route of administration

- ☐ I received 1 shot *[497]*
- ☐ I received 2 shots *[498]*
- ☐ I received more than 2 shots *[499]*
- ☐ I took pills *[501]*
- ☐ I do not recall how I was immunized *[500]*

Q10

Anthrax immunization

- ☐ *YES, I was immunized against anthrax [Q146]*
- ☐ NO, I was not immunized against anthrax *[272]*

  If No, Branch to Q91
- ☐ I DON'T KNOW if I was immunized against anthrax *[274]*

  If Don't Know, Branch to Q91

Q146

Anthrax route of administration

- ☐ I received 1 shot *[492]*
- ☐ I received 2 shots *[493]*
- ☐ I received more than 2 shots *[494]*
- ☐ I took pills *[495]*
- ☐ I do not recall how I was immunized *[496]*

Q91

Malaria prevention

- ☐ *YES, I was protected against malaria [Q159]*
- ☐ NO, I was not protected against malaria *[133]*
  If No, Branch to Q6
- ☐ I DON'T KNOW if I was protected against malaria *[307]*
  If Don't Know, Branch to Q6

Q159

Malaria route of administration

- ☐ I took 1 pill *[508]*
- ☐ I took 2 pills *[509]*
- ☐ I took more than 2 pills *[510]*
- ☐ I received shots *[511]*
- ☐ I do not recall how I was protected *[512]*

Q6

Food

- ☐ YES, I ate food other than that provided by services *[23]*
- ☐ NO, I did not eat food other than that provided *[151]*
- ☐ I DON'T KNOW if I ate food other than that provided *[277]*

Q7

Food

- ☐ YES, I ate food contaminated w/smoke, oil, or chemicals *[25]*
- ☐ NO, I did not eat contaminated food *[276]*
- ☐ I DON'T KNOW if I ate contaminated food *[278]*

Q24

Water

- ☐ YES, I bathed in/drank water other than provided by services *[24]*
- ☐ NO, I did not bathe in/drink water other than that provided *[150]*
- ☐ I DON'T KNOW if I bathed in/drank water other than provided *[280]*

Q81

Water

- ☐ YES, I bathed in/drank water contaminated w/smoke, oil, chemical *[153]*
- ☐ NO, I did not bathe in/drink contaminated water *[279]*
- ☐ I DON'T KNOW if I bathed in/drank contaminated water *[281]*

Q8

Combat

- ☐ YES, I was involved in actual combat *[28]*
- ☐ NO, I was not involved in actual combat *[154]*
- ☐ I DON'T KNOW if I was involved in actual combat *[320]*

Q80

Wounded in action

- ☐ YES, I was wounded in action *[29]*
- ☐ NO, I was not wounded in action *[334]*
- ☐ I DON'T KNOW if I was wounded in action *[335]*

Q82

Casualties witnessed

- ☐ YES, I witnessed casualties *[30]*
- ☐ NO, I did not witness casualties *[336]*
- ☐ I DON'T KNOW if I witnessed casualties *[337]*

Q83

SCUD attacks

- ☐ YES, I witnessed SCUD attacks *[31]*
- ☐ NO, I did not witness SCUD attacks *[338]*
- ☐ I DON'T KNOW if I witnessed SCUD attacks *[339]*

Q84

Chemical alarms

- ☐ YES, I witnessed chemical alarms *[32]*
- ☐ NO, I did not witness chemical alarms *[340]*
- ☐ I DON'T KNOW if I witnessed chemical alarms *[341]*

Q92

Other exposures or experiences

- ☐ YES, I have OTHER exposures/experiences to discuss *[342]*
- ☐ NO, I do NOT have OTHER exposures/experiences to discuss *[343]*

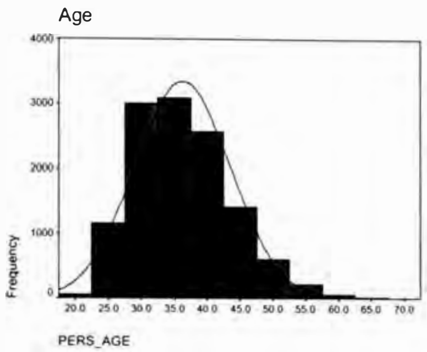
Q40

END OF QUESTIONNAIRE

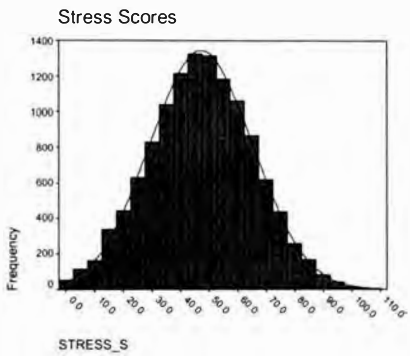
The questionnaire is now complete. Thank you for your attention. Please notify the administrator that you have finished.

Appendix XXIV: Comprehensive Clinical Evaluation Program Exposure/Experiences Descriptive Statistics

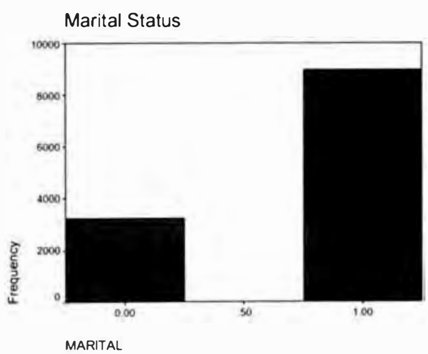
Table 22: Descriptive Variable Statistics



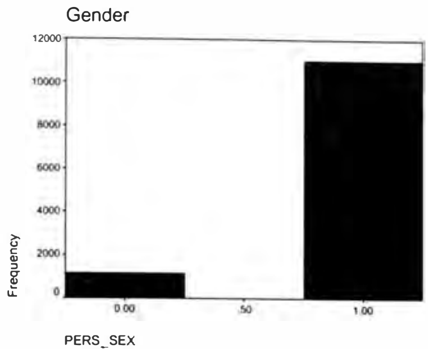
Age
N = 12,205
Min = 18
Max = 69
Mean = 36.25
Standard Deviation = 7.26
1st Quartile = 31.00
2nd Quartile = 35.00
3rd Quartile = 41.00



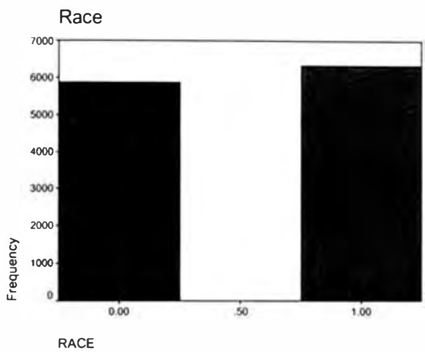
Stress Scores
N = 12,205
Min = .00
Max = 109.55
Mean = 47.26
Standard Deviation = 18.08
1st Quartile = 34.89
2nd Quartile = 47.31
3rd Quartile = 59.69



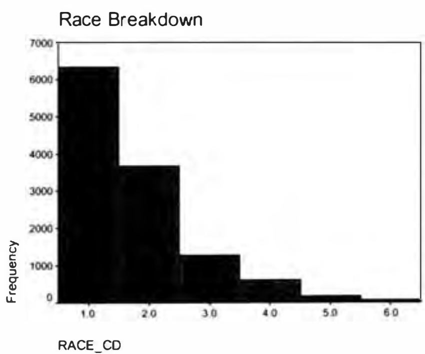
Marital Status
N = 12,205
# Married = 8,972
# Not Married = 3,233
Max (married) = 1
Min (not married) = 0
Mean = .74



Gender
N = 12,205
# Males = 11,047
# Females = 1,158
Max (males) = 1
Min (females) = 0
Mean = .91

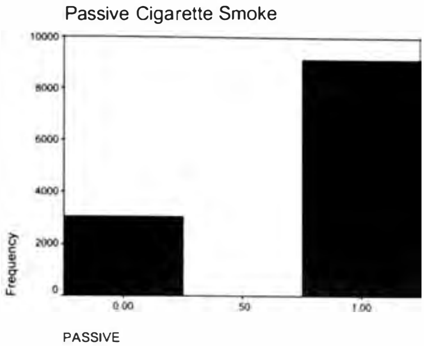


Race*
N = 12,205
# Majority = 6,328 (51.8 %)
# Minority = 5,877 (48.2 %)
Max (majority) = 1
Min (minority) = 0
Mean = .52

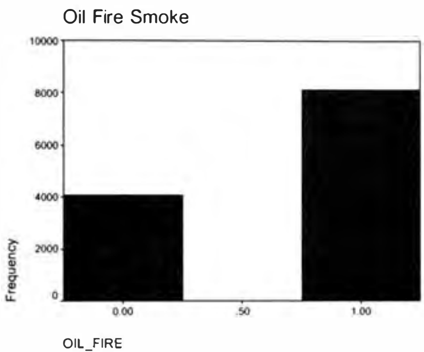


*Race Breakdown:
White = 6,328 (51.8 %)
Black = 3,692 (30.2 %)
Unknown/Other = 1,297 (10.6 %)
Hispanic = 628 (5.1 %)
Asian/Pacific Islander = 186 (1.5 %)
Native American = 74 (.6 %)

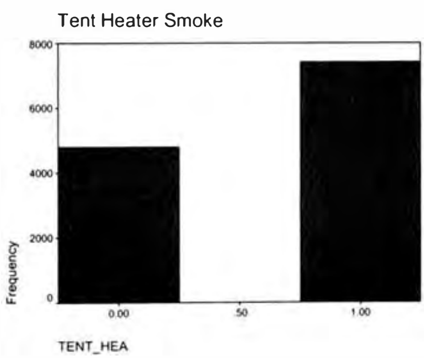
Table 23: Descriptive Statistics on Exposure data



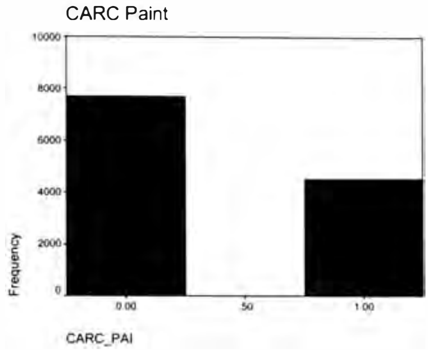
1) Passive Cigarette Smoke
N = 12,205
# Exposed = 9,148 (75 %)
# Not Exposed = 3,057 (25 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .75



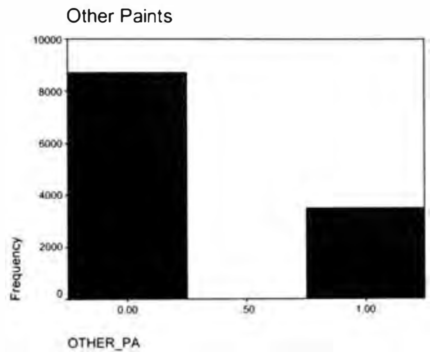
2) Oil Fire Smoke
N = 12,205
# Exposed = 8,120 (66.5 %)
# Not Exposed = 4,085 (33.5 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .67



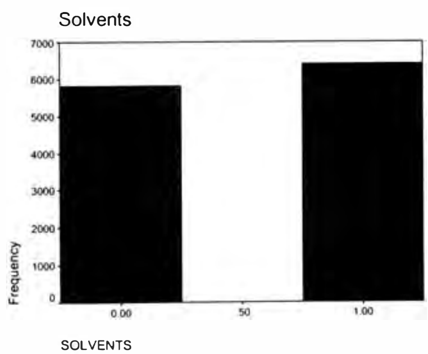
3) Tent Heater Smoke
N = 12,205
# Exposed = 7,409 (60.7 %)
# Not Exposed = 4,796 (39.3 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .61



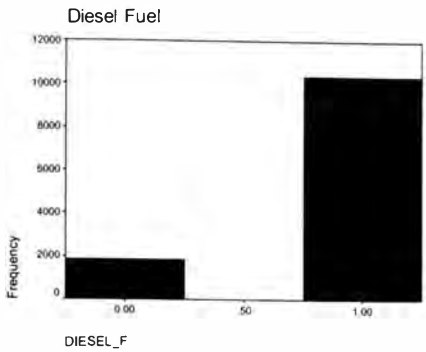
4) CARC Paint
N = 12,205
# Exposed = 4,517 (63 %)
# Not Exposed = 7,688 (37 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .37



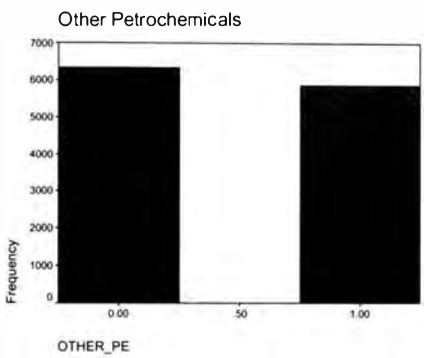
5) Other Paints
N = 12,205
# Exposed = 3,487 (28.6 %)
# Not Exposed = 8,718 (71.4 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .29



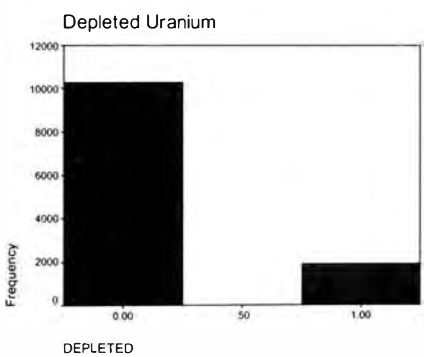
6) Solvents
N = 12,205
# Exposed = 6,401 (52.4 %)
# Not Exposed = 5,804 (47.6 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .52



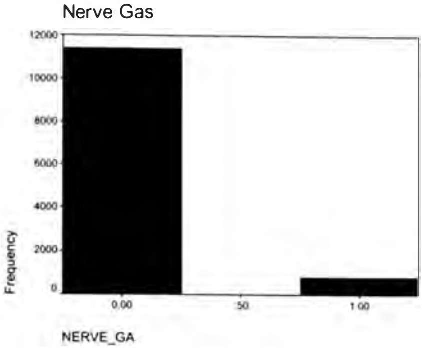
7) Diesel Fuel
N = 12,205
# Exposed = 10,362 (84.9 %)
# Not Exposed = 1,843 (15.1 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .85



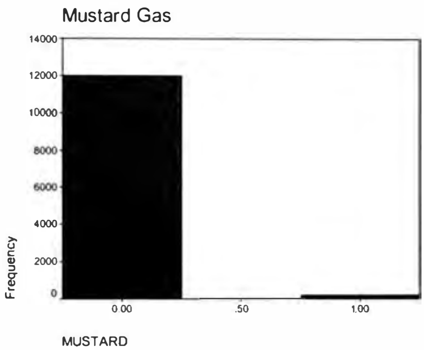
8) Other Petrochemicals
N = 12,205
# Exposed = 5869 (48.1%)
# Not Exposed = 6336 (51.9%)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .48



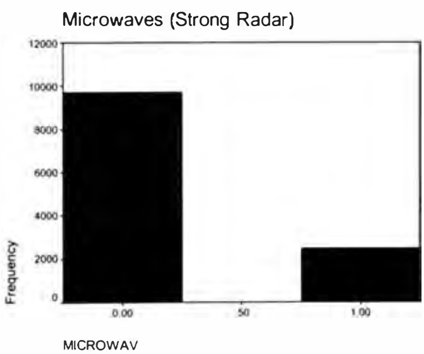
9) Depleted Uranium
N = 12,205
# Exposed = 1,909 (15.6 %)
# Not Exposed = 10,296 (84.4 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .16



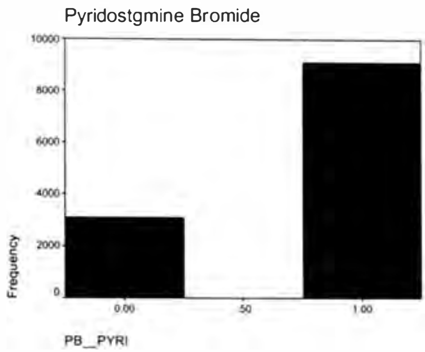
10) Nerve Gas
N = 12,205
# Exposed = 806 (6.6 %)
# Not Exposed = 11,399 (93.4 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .07



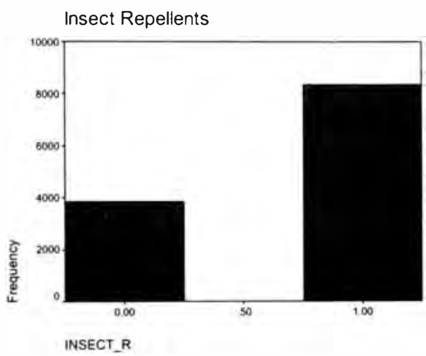
11) Mustard Gas
N = 12,205
# Exposed = 206 (1.7%)
# Not Exposed = 11,999 (98.3)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .02



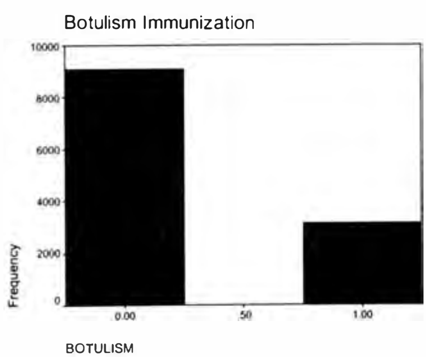
12 Microwaves (Strong Radar)
N = 12,205
# Exposed = 2,489 (20.4 %)
# Not Exposed = 9,716 (79.6 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .20



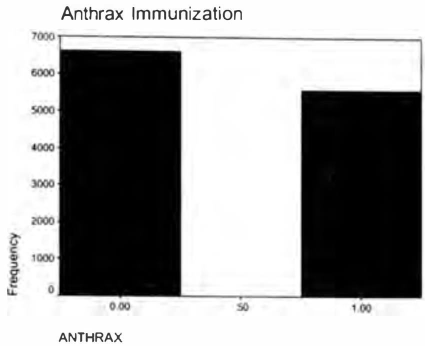
<u>13) PB Pills</u>
N = 12,205
# Exposed = 9,133 (74.8 %)
# Not Exposed = 3,072 (25.2 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .75



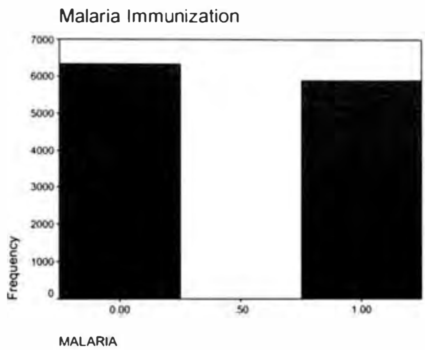
<u>14) Insect Repellents</u>
N = 12,205
# Exposed = 8,363 (68.5 %)
# Not Exposed = 3,842 (31.5 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .69



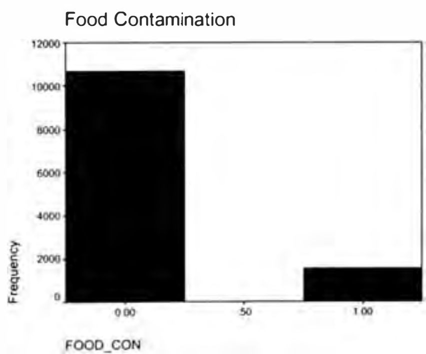
<u>15) Botulism Immunization</u>
N = 12,205
# Exposed = 3,114 (25.5 %)
# Not Exposed = 9,091 (74.5 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .26



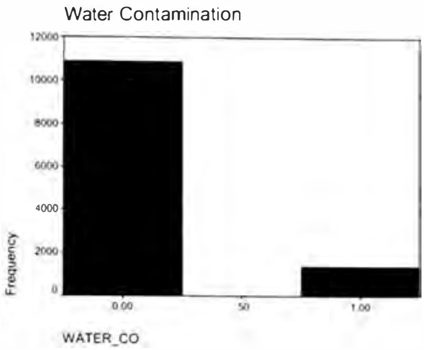
16) Anthrax Immunization
N = 12,205
# Exposed = 5,594 (45.8 %)
# Not Exposed = 6,611 (54.2 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .46



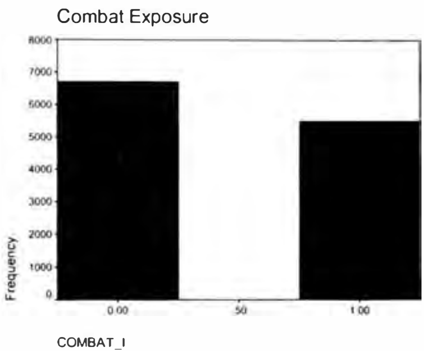
17) Malaria Prevention
N = 12,205
# Exposed = 5,882 (48.2 %)
# Not Exposed = 6,323 (51.8 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .48



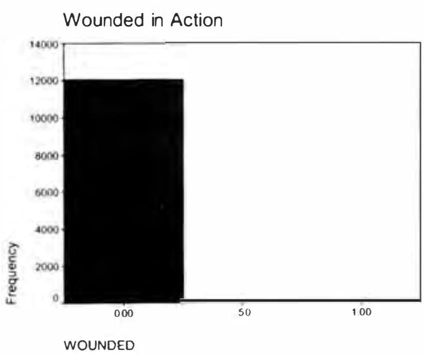
18) Food Contamination
N = 12,205
# Exposed = 1,547 (12.7 %)
# Not Exposed = 10,658 (87.3 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .13



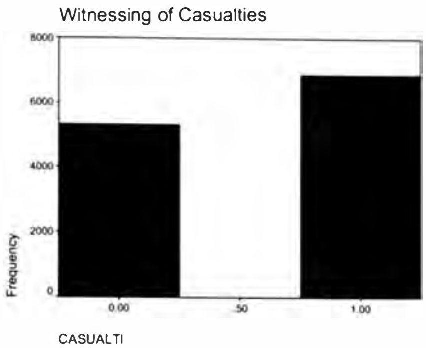
19) Water Contamination
N = 12,205
# Exposed = 1,358 (11.1 %)
# Not Exposed = 10,847 (88.9%)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .11



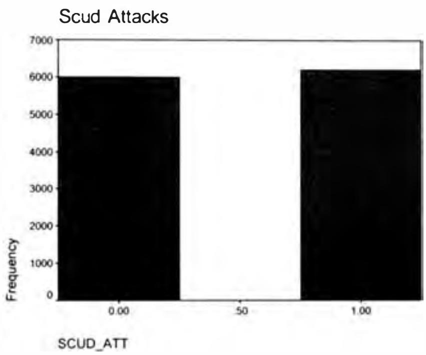
20) Combat Exposure
N = 12,205
# Exposed = 5,513 (45.2 %)
# Not Exposed = 6,692 (54.8 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .45



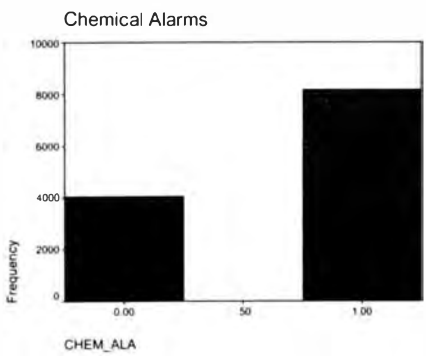
21) Wounded in Action
N = 12,205
# Exposed = 158 (1.3 %)
# Not Exposed = 12,047 (98.7%)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .01



22) Witnessing of Casualties
N = 12,205
# Exposed = 6892 (56.5%)
# Not Exposed = 5313 (43.5 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .56

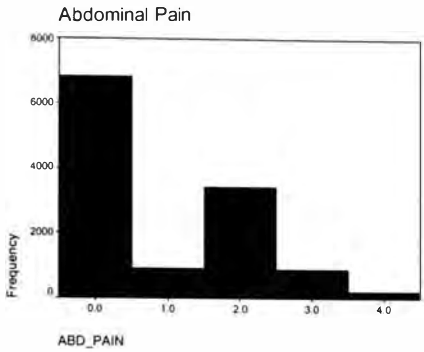


23) Scud Attacks
N = 12,205
# Exposed = 6,208 (50.9 %)
# Not Exposed = 5,997 (49.1 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .51

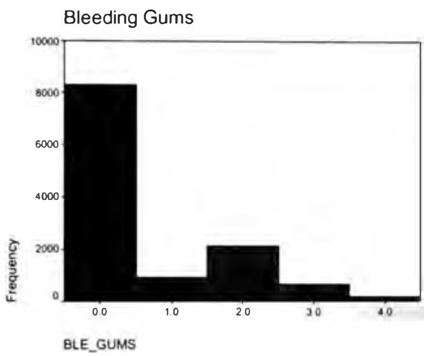


24) Chemical Alarms
N = 12,205
# Exposed = 8,169 (66.9 %)
# Not Exposed = 4,036 (33.1 %)
Max (exposed) = 1
Min (not exposed) = 0
Mean = .67

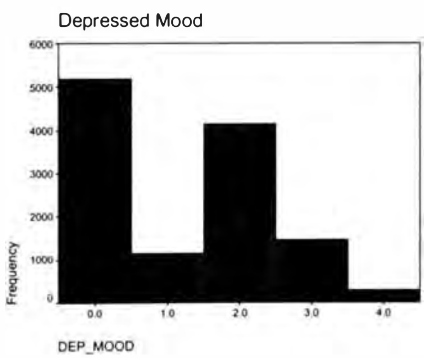
Table 24: Descriptive Statistics on Health Outcome Data



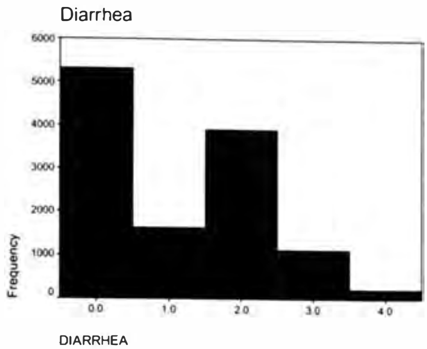
1) Abdominal Pain
N = 12,205
Min 0: 6,809 (55.8 %)
1: 920 (7.5 %)
2: 3,407 (27.9 %)
3: 876 (7.2 %)
Max 4: 193 (1.6 %)
Mean: .91
Standard Deviation: 1.12



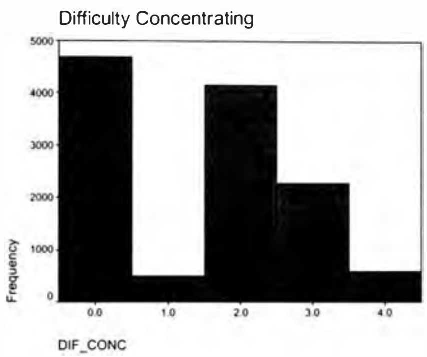
2) Bleeding Gums
N = 12,205
Min 0: 8,297 (68.0 %)
1: 929 (7.6 %)
2: 2,145 (17.6 %)
3: 644 (5.3 %)
Max 4: 190 (1.6 %)
Mean: .65
Standard Deviation: 1.04



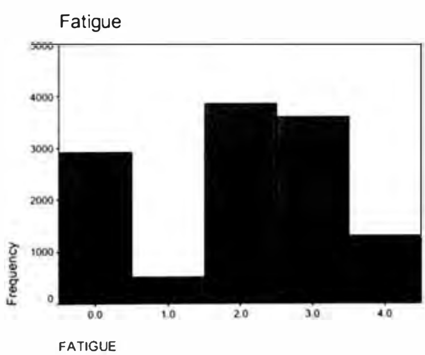
3) Depressed Mood
N = 12,205
Min 0: 5,188 (42.5 %)
1: 1,147 (9.4 %)
2: 4,141 (33.9 %)
3: 1,450 (11.9 %)
Max 4: 279 (2.3 %)
Mean: 1.22
Standard Deviation: 1.18



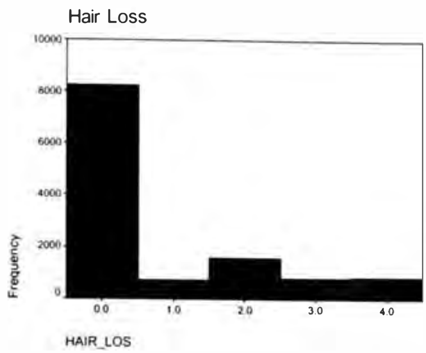
4) Diarrhea
N = 12,205
Min 0: 5,322 (43.6 %)
1: 1,635 (13.4 %)
2: 3,895 (31.9 %)
3: 1,135 (9.3 %)
Max 4: 218 (1.8 %)
Mean: 1.12
Standard Deviation: 1.13



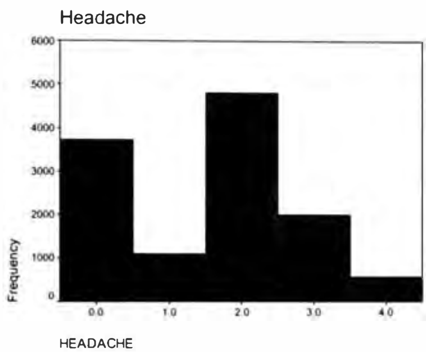
5) Difficulty Concentrating
N = 12,205
Min 0: 4,688 (38.4 %)
1: 502 (4.1 %)
2: 4,160 (34.1 %)
3: 2,274 (18.6 %)
Max 4: 501 (4.8 %)
Mean: 1.47
Standard Deviation: 1.29



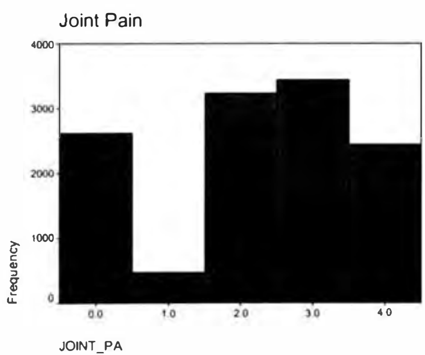
6) Fatigue
N = 12,205
Min 0: 2,917 (23.9 %)
1: 522 (4.3 %)
2: 3,854 (31.6 %)
3: 3,607 (29.6 %)
Max 4: 1,305 (10.7 %)
Mean: 1.99
Standard Deviation: 1.31



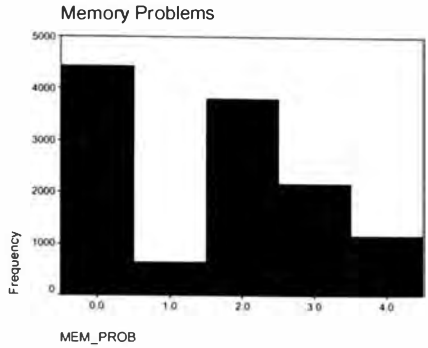
7) Hair Loss
N = 12,205
Min 0: 8,235 (67.5 %)
1: 721 (5.9 %)
2: 1,588 (13.0 %)
3: 827 (6.8 %)
Max 4: 834 (6.8 %)
Mean: .8
Standard Deviation: 1.28



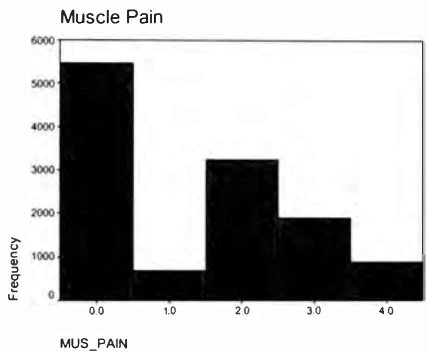
8) Headache
N = 12,205
Min 0: 3,723 (30.5 %)
1: 1,109 (9.1 %)
2: 4,802 (39.3 %)
3: 1,997 (16.4 %)
Max 4: 574 (4.7 %)
Mean: 1.56
Standard Deviation: 1.21



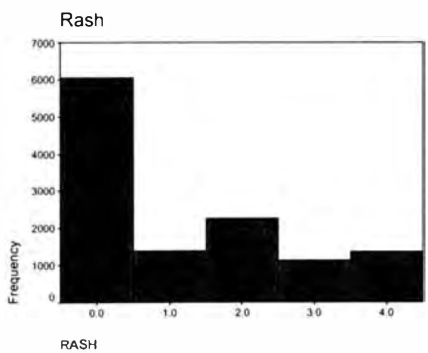
9) Joint Pain
N = 12,205
Min 0: 2,615 (21.4 %)
1: 471 (3.9 %)
2: 3,235 (26.5 %)
3: 3,438 (28.2 %)
Max 4: 2,446 (20.0 %)
Mean: 2.22
Standard Deviation: 1.39



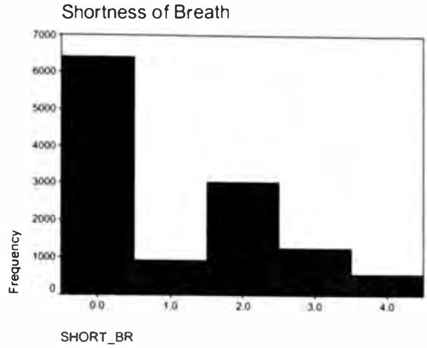
10) Memory Problems
N = 12,205
Min 0: 4,421 (36.2 %)
1: 641 (5.3 %)
2: 3,812 (31.2 %)
3: 2,167 (17.8 %)
Max 4: 1,164 (9.5 %)
Mean: 1.59
Standard Deviation: 1.38



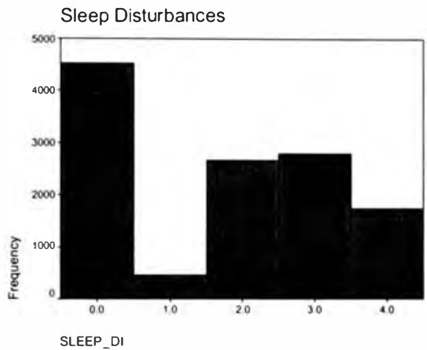
11) Muscle Pain
N = 12,205
Min 0: 5,468 (44.8 %)
1: 694 (5.7 %)
2: 3,248 (26.6 %)
3: 1,903 (15.6 %)
Max 4: 892 (7.3 %)
Mean: 1.35
Standard Deviation: 1.37



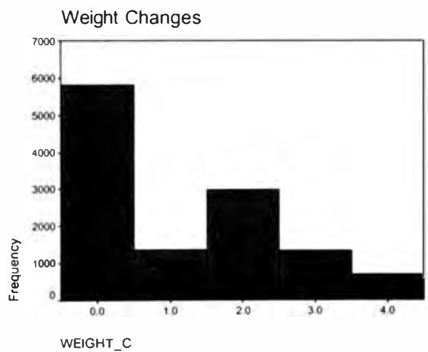
12) Rash
N = 12,205
Min 0: 6,038 (49.5 %)
1: 1,392 (11.4 %)
2: 2,277 (18.7 %)
3: 1,138 (9.3 %)
Max 4: 1,360 (11.1 %)
Mean: 1.21
Standard Deviation: 1.42



13 Shortness of Breath
N = 12,205
Min 0: 6,419 (52.6 %)
1: 937 (7.7 %)
2: 3,028 (24.8 %)
3: 1,258 (10.3 %)
Max4: 563 (4.6 %)
Mean: 1.07
Standard Deviation: 1.26



14) Sleep Disturbances
N = 12,205
Min 0: 4,517 (37.0 %)
1: 464 (3.8 %)
2: 2,671 (21.9 %)
3: 2,802 (23.0 %)
Max4: 1,751 (14.0 %)
Mean: 1.74
Standard Deviation: 1.50



15) Weight Change
N = 12,205
Min 0: 5,810 (47.6 %)
1: 1,375 (11.3 %)
2: 2,995 (24.5 %)
3: 1,336 (10.9 %)
Max4: 689 (5.6 %)
Mean: 1.16
Standard Deviation: 5.6

Appendix XXV: Outcome Variable Correlations and Factor Analysis

Abdominal Pain Correlations

		AB_ONSET	AB_DURAT	AB_FREQU	AB_IMPAI
AB_ONSET	Pearson Correlation	1.000	.763**	.849**	.815**
	Sig. (2-tailed)	.	.000	.000	.000
	N	12205	12205	12205	12205
AB_DURAT	Pearson Correlation	.763**	1.000	.835**	.760**
	Sig. (2-tailed)	.000	.	.000	.000
	N	12205	12205	12205	12205
AB_FREQ	Pearson Correlation	.849**	.835**	1.000	.853**
	Sig. (2-tailed)	.000	.000	.	.000
	N	12205	12205	12205	12205
AB_IMPAI	Pearson Correlation	.815**	.760**	.853**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	12205	12205	12205	12205

**. Correlation is significant at the 0.01 level (2-tailed)

Abdominal Pain Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
AB_ONSET	1.87	2.22	12205
AB_DURAT	1.47	1.99	12205
AB_FREQ	1.91	1.12	12205
AB_IMPAI	.56	.71	12205

Communalities

	Initial	Extraction
AB_ONSET	1.000	.854
AB_DURAT	1.000	.818
AB_FREQ	1.000	.912
AB_IMPAI	1.000	.855

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.439	85.970	85.970	3.439	85.970	85.970
2	.256	6.407	92.376			
3	.185	4.622	96.998			
4	.120	3.002	100.000			

Extraction Method: Principal Components Analysis.

Component Matrix

	Component
	1
AB_ONSET	.924
AB_DURAT	.904
AB_FREQU	.955
AB_IMPAI	.925

Extraction Method: Principal Components Analysis

Component Score Coefficient Matrix

	Component
	1
AB_ONSET	.269
AB_DURAT	.263
AB_FREQU	.278
AB_IMPAI	.269

Extraction Method: Principal Components Analysis

Component Score Covariance Matrix

Component	1
1	1.000

Extraction Method: Principal Components Analysis

Bleeding Gums Correlations

		BG_ONSET	BG_DURAT	BG_FREQU	BG_IMPAI
BG_ONSET	Pearson Correlation	1.000	.765**	.824**	.889**
	Sig. (2-tailed)	.	.000	.000	.000
	N	12205	12205	12205	12205
BG_DURAT	Pearson Correlation	.765**	1.000	.857**	.829**
	Sig. (2-tailed)	.000	.	.000	.000
	N	12205	12205	12205	12205
BG_FREQ	Pearson Correlation	.824**	.857**	1.000	.888**
	Sig. (2-tailed)	.000	.000	.	.000
	N	12205	12205	12205	12205
BG_IMPAI	Pearson Correlation	.889**	.829**	.888**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	12205	12205	12205	12205

**. Correlation is significant at the 0.01 level (2-tailed)

Bleeding Gums Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
BG_ONSET	1.28	2.02	12205
BG_DURAT	1.05	1.80	12205
BG_FREQ	.65	1.04	12205
BG_IMPAI	.33	.49	12205

Communalities

	Initial	Extraction
BG_ONSET	1.000	.858
BG_DURAT	1.000	.842
BG_FREQ	1.000	.904
BG_IMPAI	1.000	.923

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.527	88.180	88.180	3.527	88.180	88.180
2	.251	6.265	94.445			
3	.133	3.314	97.759			
4	8.963E-02	2.241	100.000			

Extraction Method: Principal Components Analysis.

Component Matrix

	Component 1
BG_ONSET	.926
BG_DURAT	.918
BG_FREQU	.951
BG_IMPAI	.961

Extraction Method: Principal Components Analysis

Component Score Coefficient Matrix

	Component 1
BG_ONSET	.263
BG_DURAT	.260
BG_FREQU	.270
BG_IMPAI	.272

Extraction Method: Principal Components Analysis

Component Score Covariance Matrix

Component	1
1	1.000

Extraction Method: Principal Components Analysis

Diarrhea Correlations

		DIA_ONSE	DIA_DURA	DIA_FREQ	DIA_IMPA
DIA_ONSE	Pearson Correlation	1.000	.667**	.799**	.787**
	Sig. (2-tailed)	.	.000	.000	.000
	N	12205	12205	12205	12205
DIA_DURA	Pearson Correlation	.667**	1.000	.781**	.693**
	Sig. (2-tailed)	.000	.	.000	.000
	N	12205	12205	12205	12205
DIA_FREQ	Pearson Correlation	.779**	.781**	1.000	.827**
	Sig. (2-tailed)	.000	.000	.	.000
	N	12205	12205	12205	12205
DIA_IMPAI	Pearson Correlation	.787**	.693**	.827**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	12205	12205	12205	12205

**. Correlation is significant at the 0.01 level (2-tailed)

Diarrhea Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
DIA_ONSE	2.18	2.10	12205
DIA_DURA	1.57	1.91	12205
DIA_FREQ	1.12	1.13	12205
DIA_IMPA	.67	.68	12205

Communalities

	Initial	Extraction
DIA_ONSE	1.000	.808
DIA_DURA	1.000	.746
DIA_FREQ	1.000	.889
DIA_IMPA	1.000	.837

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.280	82.001	82.001	3.280	82.001	82.001
2	.357	8.923	90.923			
3	.213	5.319	96.242			
4	.150	3.758	100.000			

Extraction Method: Principal Components Analysis.

Component Matrix

	Component
	1
DIA_ONSE	.889
DIA_DURA	.864
DIA_FREQ	.943
DIA_IMPA	.915

Extraction Method: Principal Components Analysis

Component Score Coefficient Matrix

	Component
	1
DIA_ONSE	.274
DIA_DURA	.263
DIA_FREQ	.287
DIA_IMPA	.279

Extraction Method: Principal Components Analysis

Component Score Covariance Matrix

Component	1
1	1.000

Extraction Method: Principal Components Analysis

Fatigue Correlations

		F_ONSET	F_DURAT	F_FREQU	F_IMPAI
F_ONSET	Pearson Correlation	1.000	.713**	.762**	.691**
	Sig. (2-tailed)	.	.000	.000	.000
	N	12205	12205	12205	12205
F_DURATI	Pearson Correlation	.713**	1.000	.805**	.702**
	Sig. (2-tailed)	.000	.	.000	.000
	N	12205	12205	12205	12205
F_FREQUE	Pearson Correlation	.762**	.803**	1.000	.806**
	Sig. (2-tailed)	.000	.000	.	.000
	N	12205	12205	12205	12205
F_IMPAIR	Pearson Correlation	.691**	.702**	.806**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	12205	12205	12205	12205

**. Correlation is significant at the 0.01 level (2-tailed)

Fatigue Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
F_ONSET	3.30	2.01	12205
F_DURATI	2.94	2.10	12205
F_FREQUE	1.99	1.31	12205
F_IMPAIR	1.08	.78	12205

Communalities

	Initial	Extraction
F_ONSET	1.000	.771
F_DURATI	1.000	.799
F_FREQUE	1.000	.881
F_IMPAIR	1.000	.789

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.240	81.010	81.010	3.240	81.010	81.010
2	.315	7.879	88.889			
3	.287	7.183	96.072			
4	.157	3.928	100.000			

Extraction Method: Principal Components Analysis.

Component Matrix

	Component
	1
F_ONSET	.878
F_DURATI	.894
F_FREQUE	.939
F_IMPAIR	.888

Extraction Method: Principal Components Analysis

Component Score Coefficient Matrix

	Component
	1
F_ONSET	.271
F_DURATI	.276
F_FREQUE	.290
F_IMPAIR	.274

Extraction Method: Principal Components Analysis

Component Score Covariance Matrix

Component	1
1	1.000

Extraction Method: Principal Components Analysis

Hair Loss Correlations

		AB_ONSET	AB_DURAT	AB_FREQU	AB_IMPAI
HL_ONSET	Pearson Correlation	1.000	.850**	.798**	.894**
	Sig. (2-tailed)	.	.000	.000	.000
	N	12205	12205	12205	12205
HL_DURAT	Pearson Correlation	.850**	1.000	.887**	.916**
	Sig. (2-tailed)	.000	.	.000	.000
	N	12205	12205	12205	12205
HL_FREQU	Pearson Correlation	.798**	.887**	1.000	.871**
	Sig. (2-tailed)	.000	.000	.	.000
	N	12205	12205	12205	12205
HL_IMPAI	Pearson Correlation	.894**	.916**	.871**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	12205	12205	12205	12205

**. Correlation is significant at the 0.01 level (2-tailed)

Hair Loss Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
HL_ONSET	1.30	2.02	12205
HL_DURAT	1.38	2.10	12205
HL_FREQ	.80	1.28	12205
HL_IMPAI	.33	.49	12205

Communalities

	Initial	Extraction
HL_ONSET	1.000	.868
HL_DURAT	1.000	.925
HL_FREQ	1.000	.876
HL_IMPAI	1.000	.940

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.609	90.223	90.223	3.609	90.223	90.223
2	.209	5.228	95.451			
3	.107	2.678	98.129			
4	7.484E-02	1.871	100.000			

Extraction Method: Principal Components Analysis.

Component Matrix

	Component 1
HL_ONSET	.932
HL_DURAT	.962
HL_FREQU	.936
HL_IMPAI	.969

Extraction Method: Principal Components Analysis

Component Score Coefficient Matrix

	Component 1
HL_ONSET	.258
HL_DURAT	.267
HL_FREQU	.259
HL_IMPAI	.269

Extraction Method: Principal Components Analysis

Component Score Covariance Matrix

Component	1
1	1.000

Extraction Method: Principal Components Analysis

Headache Correlations

		HA_ONSET	HA_DURAT	HA_FREQU	HA_IMPAI
HA_ONSET	Pearson Correlation	1.000	.659**	.752**	.685**
	Sig. (2-tailed)	.	.000	.000	.000
	N	12205	12205	12205	12205
HA_DURAT	Pearson Correlation	.659**	1.000	.754**	.683**
	Sig. (2-tailed)	.000	.	.000	.000
	N	12205	12205	12205	12205
HA_FREQU	Pearson Correlation	.752**	.754**	1.000	.807**
	Sig. (2-tailed)	.000	.000	.	.000
	N	12205	12205	12205	12205
HA_IMPAI	Pearson Correlation	.685**	.683**	.807**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	12205	12205	12205	12205

**. Correlation is significant at the 0.01 level (2-tailed)

Headache Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
HA_ONSET	2.81	2.11	12205
HA_DURAT	2.42	2.15	12205
HA_FREQU	1.56	1.21	12205
HA_IMPAI	.95	.80	12205

Communalities

	Initial	Extraction
HA_ONSET	1.000	.752
HA_DURAT	1.000	.753
HA_FREQU	1.000	.871
HA_IMPAI	1.000	.797

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.173	79.324	79.324	3.173	79.324	79.324
2	.341	8.514	87.838			
3	.315	7.879	95.718			
4	.171	4.282	100.000			

Extraction Method: Principal Components Analysis.

Component Matrix

	Component
	1
HA_ONSET	.867
HA_DURAT	.868
HA_FREQU	.933
HA_IMPAI	.893

Extraction Method: Principal Components Analysis

Component Score Coefficient Matrix

	Component
	1
HA_ONSET	.273
HA_DURAT	.273
HA_FREQU	.294
HA_IMPAI	.281

Extraction Method: Principal Components Analysis

Component Score Covariance Matrix

Component	1
1	1.000

Extraction Method: Principal Components Analysis

Joint Pain Correlations

		JP_ONSET	JP_DURAT	JP_FREQU	JP_IMPAI
JP_ONSET	Pearson Correlation	1.000	.691**	.712**	.643**
	Sig. (2-tailed)	.	.000	.000	.000
	N	12205	12205	12205	12205
JP_DURAT	Pearson Correlation	.691**	1.000	.797**	.692**
	Sig. (2-tailed)	.000	.	.000	.000
	N	12205	12205	12205	12205
JP_FREQ	Pearson Correlation	.712**	.797**	1.000	.795**
	Sig. (2-tailed)	.000	.000	.	.000
	N	12205	12205	12205	12205
JP_IMPAI	Pearson Correlation	.643**	.692**	.795**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	12205	12205	12205	12205

**. Correlation is significant at the 0.01 level (2-tailed)

Joint Pain Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
JP_ONSET	3.37	2.00	12205
JP_DURAT	3.22	2.07	12205
JP_FREQU	2.22	1.39	12205
JP_IMPAI	1.20	.83	12205

Communalities

	Initial	Extraction
JP_ONSET	1.000	.726
JP_DURAT	1.000	.801
JP_FREQU	1.000	.868
JP_IMPAI	1.000	.774

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.169	79.218	79.218	3.169	79.218	79.218
2	.370	9.249	88.467			
3	.294	7.353	95.821			
4	.167	4.179	100.000			

Extraction Method: Principal Components Analysis.

Component Matrix

	Component 1
JP_ONSET	.852
JP_DURAT	.895
JP_FREQU	.932
JP_IMPAI	.880

Extraction Method: Principal Components Analysis

Component Score Coefficient Matrix

	Component 1
JP_ONSET	.269
JP_DURAT	.282
JP_FREQU	.294
JP_IMPAI	.278

Extraction Method: Principal Components Analysis

Component Score Covariance Matrix

Component	1
1	1.000

Extraction Method: Principal Components Analysis

Muscle Pain Correlations

		MU_ONSET	MU_DURAT	MU_FREQU	MU_IMPAI
MU_ONSET	Pearson Correlation	1.000	.809**	.829**	.791**
	Sig. (2-tailed)	.	.000	.000	.000
	N	12205	12205	12205	12205
MU_DURAT	Pearson Correlation	.809**	1.000	.854**	.794**
	Sig. (2-tailed)	.000	.	.000	.000
	N	12205	12205	12205	12205
MU_FREQU	Pearson Correlation	.829**	.854**	1.000	.880**
	Sig. (2-tailed)	.000	.000	.	.000
	N	12205	12205	12205	12205
MU_IMPAI	Pearson Correlation	.791**	.794**	.880**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	12205	12205	12205	12205

**. Correlation is significant at the 0.01 level (2-tailed)

Muscle Pain Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
MU_ONSET	2.38	2.28	12205
MU_DURAT	2.13	2.21	12205
MU_FREQU	1.35	1.37	12205
MU_IMPAI	.79	.83	12205

Communalities

	Initial	Extraction
MU_ONSET	1.000	.843
MU_DURAT	1.000	.858
MU_FREQU	1.000	.914
MU_IMPAI	1.000	.863

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.479	86.975	86.975	3.479	86.975	86.975
2	.223	5.578	92.553			
3	.193	4.815	97.368			
4	.105	2.632	100.000			

Extraction Method: Principal Components Analysis.

Component Matrix

	Component
	1
MU_ONSET	.918
MU_DURAT	.926
MU_FREQU	.956
MU_IMPAI	.929

Extraction Method: Principal Components Analysis

Component Score Coefficient Matrix

	Component
	1
MU_ONSET	.264
MU_DURAT	.266
MU_FREQU	.275
MU_IMPAI	.267

Extraction Method: Principal Components Analysis

Component Score Covariance Matrix

Component	1
1	1.000

Extraction Method: Principal Components Analysis

Rash Correlations

		RASH_ONS	RASH_DUR	RASH_FRE	RASH_IMP
RASH_ONS	Pearson Correlation	1.000	.773**	.782**	.854**
	Sig. (2-tailed)	.	.000	.000	.000
	N	12205	12205	12205	12205
RASH_DUR	Pearson Correlation	.773**	1.000	.861**	.783**
	Sig. (2-tailed)	.000	.	.000	.000
	N	12205	12205	12205	12205
RASH_FRE	Pearson Correlation	.782**	.861**	1.000	.806**
	Sig. (2-tailed)	.000	.000	.	.000
	N	12205	12205	12205	12205
RASH_IMP	Pearson Correlation	.854**	.783**	.806**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	12205	12205	12205	12205

**. Correlation is significant at the 0.01 level (2-tailed)

Rash Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
RASH_ONS	2.08	2.19	12205
RASH_DUR	1.79	2.12	12205
RASH_FRE	1.21	1.42	12205
RASH_IMP	.55	.60	12205

Communalities

	Initial	Extraction
RASH_ONS	1.000	.846
RASH_DUR	1.000	.851
RASH_FRE	1.000	.868
RASH_IMPI	1.000	.865

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.429	85.735	85.735	3.429	85.735	85.735
2	.287	7.170	92.905			
3	.151	3.770	96.675			
4	.133	3.325	100.000			

Extraction Method: Principal Components Analysis.

Component Matrix

	Component 1
RASH_ONS	.920
RASH_DUR	.923
RASH_FRE	.931
RASH_IMP	.930

Extraction Method: Principal Components Analysis

Component Score Coefficient Matrix

	Component 1
RASH_ONS	.268
RASH_DUR	.269
RASH_FRE	.272
RASH_IMP	.271

Extraction Method: Principal Components Analysis

Component Score Covariance Matrix

Component	1
1	1.000

Extraction Method: Principal Components Analysis

Shortness of Breath Correlations

		SOB_ONSE	SOB_DURA	SOB_FREQ	SOB_IMPA
SOB_ONSE	Pearson Correlation	1.000	.818**	.837**	.817**
	Sig. (2-tailed)	.	.000	.000	.000
	N	12205	12205	12205	12205
SOB_DURA	Pearson Correlation	.818**	1.000	.865**	.815**
	Sig. (2-tailed)	.000	.	.000	.000
	N	12205	12205	12205	12205
SOB_FREQ	Pearson Correlation	.837**	.865**	1.000	.878**
	Sig. (2-tailed)	.000	.000	.	.000
	N	12205	12205	12205	12205
SOB_IMPA	Pearson Correlation	.817**	.815**	.878**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	12205	12205	12205	12205

**. Correlation is significant at the 0.01 level (2-tailed)

Shortness of Breath Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
SOB_ONSE	2.04	2.26	12205
SOB_DURA	1.80	2.17	12205
SOB_FREQ	1.07	1.26	12205
SOB_IMPA	.64	.78	12205

Communalities

	Initial	Extraction
SOB_ONSE	1.000	.856
SOB_DURA	1.000	.870
SOB_FREQ	1.000	.913
SOB_IMPA	1.000	.876

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.516	87.888	87.888	3.516	87.888	87.888
2	.192	4.800	92.688			
3	.184	4.595	97.283			
4	.109	2.717	100.000			

Extraction Method: Principal Components Analysis.

Component Matrix

	Component 1
SOB_ONSE	.925
SOB_DURA	.933
SOB_FREQ	.955
SOB_IMPA	.936

Extraction Method: Principal Components Analysis

Component Score Coefficient Matrix

	Component 1
SOB_ONSE	.263
SOB_DURA	.265
SOB_FREQ	.272
SOB_IMPA	.266

Extraction Method: Principal Components Analysis

Component Score Covariance Matrix

Component	1
1	1.000

Extraction Method: Principal Components Analysis

Weight Change Correlations

		WC_ONSET	WC_DURAT	WC_FREQU	WC_IMPAI
WC_ONSET	Pearson Correlation	1.000	.867**	.804**	.846**
	Sig. (2-tailed)	.	.000	.000	.000
	N	12205	12205	12205	12205
WC_DURAT	Pearson Correlation	.867**	1.000	.854**	.839**
	Sig. (2-tailed)	.000	.	.000	.000
	N	12205	12205	12205	12205
WC_FREQU	Pearson Correlation	.804**	.854**	1.000	.827**
	Sig. (2-tailed)	.000	.000	.	.000
	N	12205	12205	12205	12205
WC_IMPAI	Pearson Correlation	.846**	.839**	.827**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	12205	12205	12205	12205

**. Correlation is significant at the 0.01 level (2-tailed)

Weight Change Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
WC_ONSET	2.33	2.32	12205
WC_DURAT	2.07	2.16	12205
WC_FREQU	1.16	1.28	12205
WC_IMPAI	.59	.63	12205

Communalities

	Initial	Extraction
WC_ONSET	1.000	.879
WC_DURAT	1.000	.901
WC_FREQU	1.000	.862
WC_IMPAI	1.000	.876

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.518	87.961	87.961	3.518	87.961	87.961
2	.198	4.961	92.922			
3	.167	4.164	97.086			
4	.117	2.914	100.000			

Extraction Method: Principal Components Analysis.

Component Matrix

	Component 1
WC_ONSET	.938
WC_DURAT	.949
WC_FREQU	.928
WC_IMPAI	.936

Extraction Method: Principal Components Analysis

Component Score Coefficient Matrix

	Component 1
WC_ONSET	.267
WC_DURAT	.270
WC_FREQU	.264
WC_IMPAI	.266

Extraction Method: Principal Components Analysis

Component Score Covariance Matrix

Component	1
1	1.000

Extraction Method: Principal Components Analysis

Depressed Mood Correlations

		DM_ONSET	DM_DURAT	DM_FREQU	DM_IMPAI
DM_ONSET	Pearson Correlation	1.000	.712**	.816**	.789**
	Sig. (2-tailed)	.	.000	.000	.000
	N	12205	12205	12205	12205
DM_DURAT	Pearson Correlation	.712**	1.000	.817**	.757**
	Sig. (2-tailed)	.000	.	.000	.000
	N	12205	12205	12205	12205
DM_FREQU	Pearson Correlation	.816**	.817**	1.000	.862**
	Sig. (2-tailed)	.000	.000	.	.000
	N	12205	12205	12205	12205
DM_IMPAI	Pearson Correlation	.789**	.757**	.862**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	12205	12205	12205	12205

**. Correlation is significant at the 0.01 level (2-tailed)

Depressed Mood Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
DM_ONSET	2.43	2.23	12205
DM_DURAT	1.82	2.01	12205
DM_FREQU	1.22	1.18	12205
DM_IMPAI	.75	.75	12205

Communalities

	Initial	Extraction
DM_ONSET	1.000	.813
DM_DURAT	1.000	.796
DM_FREQ	1.000	.907
DM_IMPAI	1.000	.862

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.378	84.452	84.452	3.378	84.452	84.452
2	.292	7.302	91.754			
3	.206	5.159	96.913			
4	.123	3.087	100.000			

Extraction Method: Principal Components Analysis.

Component Matrix

	Component 1
DM_ONSET	.902
DM_DURAT	.892
DM_FREQU	.952
DM_IMPAI	.928

Extraction Method: Principal Components Analysis

Component Score Coefficient Matrix

	Component 1
DM_ONSET	.267
DM_DURAT	.264
DM_FREQU	.282
DM_IMPAI	.275

Extraction Method: Principal Components Analysis

Component Score Covariance Matrix

Component	1
1	1.000

Extraction Method: Principal Components Analysis

Difficulty Concentrating Correlations

		DC_ONSET	DC_DURAT	DC_FREQU	DC_IMPAI
DC_ONSET	Pearson Correlation	1.000	.795**	.840**	.788**
	Sig. (2-tailed)	.	.000	.000	.000
	N	12205	12205	12205	12205
DC_DURAT	Pearson Correlation	.795**	1.000	.845**	.777**
	Sig. (2-tailed)	.000	.	.000	.000
	N	12205	12205	12205	12205
DC_FREQU	Pearson Correlation	.840**	.845**	1.000	.869**
	Sig. (2-tailed)	.000	.000	.	.000
	N	12205	12205	12205	12205
DC_IMPAI	Pearson Correlation	.788**	.777**	.869**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	12205	12205	12205	12205

**. Correlation is significant at the 0.01 level (2-tailed)

Difficulty Concentrating Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
DC_ONSET	2.71	2.25	12205
DC_DURAT	2.37	2.22	12205
DC_FREQU	1.47	1.29	12205
DC_IMPAI	.87	.81	12205

Communalities

	Initial	Extraction
DC_ONSET	1.000	.846
DC_DURAT	1.000	.843
DC_FREQU	1.000	.915
DC_IMPAI	1.000	.853

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.458	86.443	86.443	3.458	86.443	86.443
2	.227	5.684	92.127			
3	.204	5.110	97.236			
4	.111	2.764	100.000			

Extraction Method: Principal Components Analysis.

Component Matrix

	Component 1
DC_ONSET	.920
DC_DURAT	.918
DC_FREQU	.957
DC_IMPAI	.924

Extraction Method: Principal Components Analysis

Component Score Coefficient Matrix

	Component 1
DC_ONSET	.266
DC_DURAT	.266
DC_FREQU	.277
DC_IMPAI	.267

Extraction Method: Principal Components Analysis

Component Score Covariance Matrix

Component	1
1	1.000

Extraction Method: Principal Components Analysis

Memory Problems Correlations

		MP_ONSET	MP_DURAT	MP_FREQU	MP_IMPAI
MP_ONSET	Pearson Correlation	1.000	.828**	.820**	.782**
	Sig. (2-tailed)	.	.000	.000	.000
	N	12205	12205	12205	12205
MP_DURAT	Pearson Correlation	.828**	1.000	.840**	.780**
	Sig. (2-tailed)	.000	.	.000	.000
	N	12205	12205	12205	12205
MP_FREQU	Pearson Correlation	.820**	.840**	1.000	.860**
	Sig. (2-tailed)	.000	.000	.	.000
	N	12205	12205	12205	12205
MP_IMPAI	Pearson Correlation	.782**	.780**	.860**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	12205	12205	12205	12205

**. Correlation is significant at the 0.01 level (2-tailed)

Memory Problems Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
MP_ONSET	2.86	2.25	12205
MP_DURAT	2.61	2.26	12205
MP_FREQU	1.59	1.38	12205
MP_IMPAI	.90	.81	12205

Communalities

	Initial	Extraction
MP_ONSET	1.000	.850
MP_DURAT	1.000	.860
MP_FREQU	1.000	.898
MP_IMPAI	1.000	.847

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.455	86.385	86.385	3.455	86.385	86.385
2	.244	6.109	92.494			
3	.175	4.387	96.881			
4	.125	3.119	100.000			

Extraction Method: Principal Components Analysis.

Component Matrix

	Component 1
MP_ONSET	.922
MP_DURAT	.928
MP_FREQU	.948
MP_IMPAI	.920

Extraction Method: Principal Components Analysis

Component Score Coefficient Matrix

	Component 1
MP_ONSET	.267
MP_DURAT	.268
MP_FREQU	.274
MP_IMPAI	.266

Extraction Method: Principal Components Analysis

Component Score Covariance Matrix

Component	1
1	1.000

Extraction Method: Principal Components Analysis

Sleep Disturbances Correlations

		SD_ONSET	SD_DURAT	SD_FREQU	SD_IMPAI
SD_ONSET	Pearson Correlation	1.000	.820**	.809**	.765**
	Sig. (2-tailed)	.	.000	.000	.000
	N	12205	12205	12205	12205
SD_DURAT	Pearson Correlation	.820**	1.000	.876**	.784**
	Sig. (2-tailed)	.000	.	.000	.000
	N	12205	12205	12205	12205
SD_FREQU	Pearson Correlation	.809**	.876**	1.000	.831**
	Sig. (2-tailed)	.000	.000	.	.000
	N	12205	12205	12205	12205
SD_IMPAI	Pearson Correlation	.765**	.784**	.831**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	12205	12205	12205	12205

**. Correlation is significant at the 0.01 level (2-tailed)

Sleep Disturbances Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
SD_ONSET	2.63	2.17	12205
SD_DURAT	2.66	2.28	12205
SD_FREQU	1.74	1.50	12205
SD_IMPAI	.83	.76	12205

Communalities

	Initial	Extraction
SD_ONSET	1.000	.835
SD_DURAT	1.000	.881
SD_FREQU	1.000	.900
SD_IMPAI	1.000	.828

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.444	86.100	86.100	3.444	86.100	86.100
2	.243	6.087	92.187			
3	.197	4.935	97.122			
4	.115	2.878	100.000			

Extraction Method: Principal Components Analysis.

Component Matrix

	Component 1
SD_ONSET	.914
SD_DURAT	.939
SD_FREQU	.949
SD_IMPAI	.910

Extraction Method: Principal Components Analysis

Component Score Coefficient Matrix

	Component 1
SD_ONSET	.265
SD_DURAT	.273
SD_FREQU	.275
SD_IMPAI	.264

Extraction Method: Principal Components Analysis

Component Score Covariance Matrix

Component	1
1	1.000

Extraction Method: Principal Components Analysis

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