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THESIS

CASUALTY PROFILE OF THE UNITED STATES ARMY IN AFGHANISTAN AND IRAQ

by

Sezgin Ozcan

June 2012

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Second Reader: Chad W. Seagren

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13. ABSTRACT (maximum 200 words)

The purpose of this study is to create a profile of U.S. Army troops killed or injured due to hostile incidents in Afghanistan and Iraq between 2003 and 2011.

The file used in this study was obtained from the Defense Manpower Data Center (DMDC). It was built from active-duty personnel extract files, covering the period from 2003 to 2011.

Our study shows that pay grades E1 through E3 are more likely to be involved in hostile incidents than other pay-grade groups, and that probability of injury or death decreases as pay grade increases. The findings for gender are not parallel to popular ideas. Male servicemen are less likely to get killed or injured than women after adjusting for other casualties. In terms of the effects of marital status, our study shows that married servicemen are more likely to be involved in hostile incidents. In our model, we found that regular forces have a lower risk of engaging in hostile incidents than guard and reserve forces, which is contrary to general expectation. The results for MOS were as expected. Combat troops are more likely to be killed or injured than other troops.

As a conclusion for our multivariate model, a serviceman who is female, married, serving in the reserve forces, serving in a combat troop, between pay grades E1–E3, serving in Iraq, serving the first deployment is the serviceman with most potential to get injured or killed in the U.S. Army.

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CASUALTY PROFILE OF THE UNITED STATES ARMY IN AFGHANISTAN AND IRAQ

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Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

The purpose of this study is to create a profile of U.S. Army troops killed or injured due to hostile incidents in Afghanistan and Iraq between 2003 and 2011.

The file used in this study was obtained from the Defense Manpower Data Center (DMDC). It was built from active-duty personnel extract files, covering the period from 2003 to 2011.

Our study shows that pay grades E1 through E3 are more likely to be involved in hostile incidents than other pay-grade groups, and that probability of injury or death decreases as pay grade increases. The findings for gender are not parallel to popular ideas. Male servicemen are less likely to get killed or injured than women after adjusting for other casualties. In terms of the effects of marital status, our study shows that married servicemen are more likely to be involved in hostile incidents. In our model, we found that regular forces have a lower risk of engaging in hostile incidents than guard and reserve forces, which is contrary to general expectation. The results for MOS (Military Occupational Specialty) were as expected. Combat troops are more likely to be killed or injured than other troops.

As a conclusion for our multivariate model, an actual-duty person who is female, married, serving in the reserve forces, serving in a combat troop, between pay grades E1–E3, serving in Iraq, serving the first deployment is the serviceman with most potential to get injured or killed in the U.S. Army.

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LIST OF ACRONYMS AND ABBREVIATIONS

AIC	Akaike Information Criterion
AF	Afghanistan
AFQT	Armed Forces Qualification Test
C	Combat Troops
CS	Combat Service Troops
CSS	Combat Service Support Troops
DoD	Department of Defense
DMDC	Defense Manpower Data Center
IED	Improvised Explosive Device
IZ	Iraq
MOS	Military Occupational Specialty
SSN	Social Security Number
WMD	Weapon of Mass Destruction

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EXECUTIVE SUMMARY

U.S. troops have been involved in two major wars since 2001 and over 35,000 servicemen of the Army have been either injured or killed due to hostile incidents in Iraq and Afghanistan. The purpose of this study is to create a profile of U.S. troops killed or injured due to hostile incidents in Afghanistan and Iraq.

The file used in this study was obtained from the Defense Manpower Data Center (DMDC). It was built from active-duty personnel extract files, covering the period from 2003 to 2011. To avoid the official limitations of using SSNs (social-security numbers), we received a file arranged according to identification numbers for each individual, rather than by SSN.

The data set contained information on death or injury date, injury status, death or injury country and city, service, military occupation specialties (MOS), gender, education, race and ethnicity, age, marital status, number of deployments, armed-forces time in service and pay grade, Armed Forces Qualification Test (AFQT), religion, race, death state, death country, home city, home country, service-branch classification code, ethnic affinity, and U.S. citizenship. In our study, we did not include death state, death country, home city, and home country because all were U.S.A. We did not include AFQT because officers do not take this test, nor are religion, race and U.S. citizenship accounted in our study. The file contained 48,312 records, representing all servicemen either injured or killed, and a sample consisting of 98,812 records of servicemen who served in the 2003–2011 period without injury. In our data, we used only servicemen killed or injured in hostile action, of whom there were 35,698.

The results suggest that pay grades E1 through E3 are more likely to be involved in hostile incidents than other pay-grade groups, and this exposure to danger decreases as pay grade increases. The findings for gender are not parallel to popular ideas. It is expected that males will be more exposed to hostile incidents than females. But even though the difference is not large, our results show that males are less likely to get killed or injured. In terms of the effects of marital status, our study shows that married

servicemen are more likely to be involved in hostile incidents. In our model, we found that regular forces have a lower risk of engaging in hostile incidents than guard and reserve forces, which is contrary to general expectation. The results for MOS were as expected. Combat troops are more likely to be killed or injured than other troops.

As a conclusion for our multivariate model, an actual-duty person who is female, married, serving in the reserve forces, serving in a combat role, between pay grades E1–E3, and serving the first deployment in Iraq, is the soldier most likely to get injured or killed in the U.S. Army.

ACKNOWLEDGMENTS

Foremost, I would like to thank to my beloved country for providing an opportunity to me to acquire such a quality education and degree. I express my sincere appreciation to my thesis advisors Professor Samuel Buttrey and Professor Chad Seagren for their patience and valuable guidance. I could not have written this thesis without their priceless contributions. I am grateful to all our instructors who made the time we spent in the Naval Postgraduate School a worthwhile experience. Lastly, but most importantly, I want to thank my wife Pinar (for her contributions to Java codes) and my little son Metin for their invaluable support and patience during this study.

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I. INTRODUCTION

A. BACKGROUND

The environment faced by today's servicemen is characterized by continual deployments to combat zones, where troops are exposed to the risks of the battlefield. Casualty, whether to combatants or noncombatants, is an unavoidable reality of war. Although the primary goal of combat is to defeat the enemy, keeping casualties down is important as well. Low numbers of injured or killed soldiers not only maintain the ranks of service members, but also have an incredible effect on morale.

U.S. troops have been involved in two major wars since 2001, and over 35,000 soldiers have been either injured or killed due to hostile incidents in Iraq and Afghanistan.

The deaths and injuries of U.S. troops in Iraq and Afghanistan are well publicized, but casualty totals alone do not indicate the risk for a given serviceman. A study by Buzzel and Preston reveals that the risk of death in Iraq shows considerable variability. It is highest in the Marine Corps, lowest in the Air Force, higher among enlisted troops than officers, much higher for men than women, and declines sharply with age. Hispanics have a higher death rate than non-Hispanics, and blacks have unusually low mortality in Iraq. (Buzzel and Preston, 2007)

To assess the risk to a serviceman who is exposed to a hostile incident, a multivariate analysis of factors causing these casualties will produce a better understanding of this least desired outcome of war.

B. THE PURPOSE OF THE STUDY AND RESEARCH QUESTIONS

The purpose of this study is to create a profile of U.S. troops killed or injured due to hostile incidents in Afghanistan and Iraq, by answering the following research questions.

- Does the number of deployments of servicemen have an effect on casualty status?

- Does experience (time in service) have an effect on casualty status?
- Is there a significant difference in casualty rates among the combat, combat service, and combat-service support branches in the Army?
- Is there a significant difference in casualty rates among the regular, guard, and reserve forces in the Army?
- Is there a significant difference in casualty rates among the ranks in the Army?
- Do demographics like age, gender, and marital status have any effect on casualty status?

C. ORGANIZATION OF THE STUDY

Chapter II provides a background of the wars considered and a review of previous studies. Chapter III provides descriptive statistics of the data. Chapter IV covers the methodology used, which includes a brief overview of logistic regression, a description of the variables and model, and results of the analysis. The final chapter presents a summary and recommendations.

II. LITERATURE REVIEW

A. THE IRAQ WAR

The Iraq War was a conflict that occurred in Iraq from March 2003 to December 2011. Before the war, United States asserted that Iraq's possession of weapons of mass destruction (WMD) was a threat to its security and allies. In 2002, the United Nations Security Council passed Resolution 1441, which called for Iraq to completely cooperate with UN inspectors to verify that Iraq was not in possession of WMDs. (Shakir, 2006)

The invasion of Iraq led to an occupation and the capture of President Saddam Hussein, who was tried in an Iraqi court and executed by the new Iraqi government. Violence against Coalition forces and among various sectarian groups led to an Iraqi insurgency and discord between Sunni and Shia Iraqi groups.

As public opinion favoring troop withdrawals increased and Iraqi forces began to take responsibility for security, member nations of the Coalition withdrew their forces. The United States and Iraqi governments had several agreements aimed at ensuring cooperation in constitutional rights, threat deterrence, education, energy development, and other areas. (Karadsheh, 2008)

In February 2009, U.S. President Barack Obama publicized a withdrawal plan for U.S. forces, with approximately 50,000 troops to remain in the country in non-combat operations. (Londoño, 2010)

On October 2011, President Obama announced that all U.S. troops would leave Iraq by the end of the year, bringing the U.S. mission in Iraq to an end. On December 15, 2011, U.S. Defense Secretary Leon Panetta officially declared the end of the Iraq War in Baghdad. The last U.S. troops left Iraqi on December 18, 2011. (Brook, 2011)

War began on 19 March 2003 with 173,000 troops, 150,000 of whom were Americans
670,000 Iraqi security forces were on duty as of March 2011
4,408 American troops have been killed
179 British troops have been killed
115,405 Iraqi civilians are estimated to have been killed
32,195 American troops have been wounded

Table 1. The War in Iraq in Numbers

Source: Brookings Iraq Index, U.S. Department of Defense

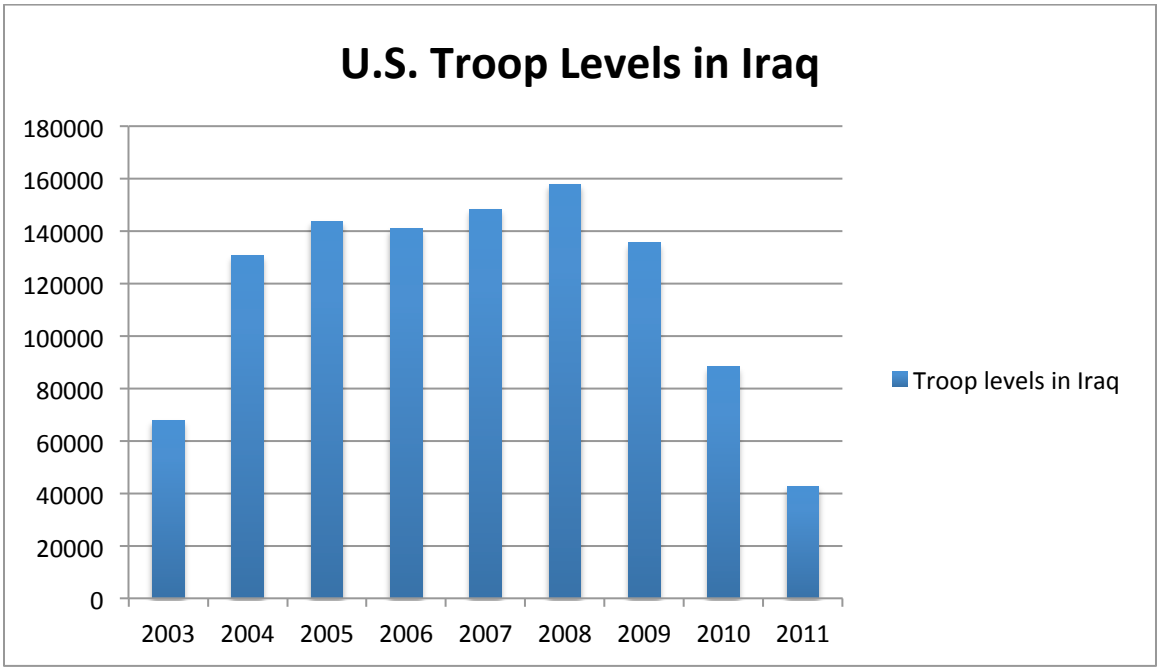

Figure 1. U.S. Troop Levels in Iraq

2003	2004	2005	2006	2007	2008	2009	2010	2011
67700	130600	143600	141100	148300	157800	135600	88300	42800

Table 2. Number of U.S. Troops in Iraq between 2003 and 2011

(Belasco, Troop Levels in the Afghan and Iraq Wars, FY2001-FY2012: Cost and Other Potential Issues, 2009)

OPERATION IRAQI FREEDOM (OIF) U.S. CASUALTY STATUS FATALITIES AS OF: MARCH 30, 2012			
	KIA	WIA	TOTAL
OIF U. S. Military Casualties	3,479	31,923	35,402

Table 3. The Number of Hostile Casualties in OIF between 2003 and 2011

Source: http://www.defense.gov/news/casualty.pdf

B. THE AFGANISTAN WAR

United States, the United Kingdom, and the Commonwealth of Australia invaded Afghanistan on October 7, 2001, launching Operation Enduring Freedom. The primary reason for the invasion was the September 11 attacks on the United States, and OEF had the stated goal of demolishing the al-Qaeda terrorist organization and ending its use of Afghanistan as a base. The United States also said that it would remove the Taliban regime from power and creates a democratic state (Wintour, 2001). The United States forced the Taliban from power in Afghanistan, and compelled it to cease its support for terrorist organizations. By removing the Taliban, the United States denied the terrorists the sanctuary they had enjoyed in Afghanistan and the support they had received from the Taliban. In addition, the United States was successful in killing or capturing many Taliban leaders and fighters. However, many important Taliban leaders remain at large and continue to support al-Qaeda. After ten years of war, the United States continues to battle a widespread Taliban insurgency (Herring, 2003).

OPERATION ENDURING FREEDOM (OEF) U.S. CASUALTY STATUS FATALITIES AS OF: MARCH 30, 2012			
	KIA	WIA	TOTAL
OEF U. S. Military Casualties	1,503	15,516	17,019

Table 4. The Number of Hostile Casualties in OEF between 2003 and 2011

Source: http://www.defense.gov/news/casualty.pdf

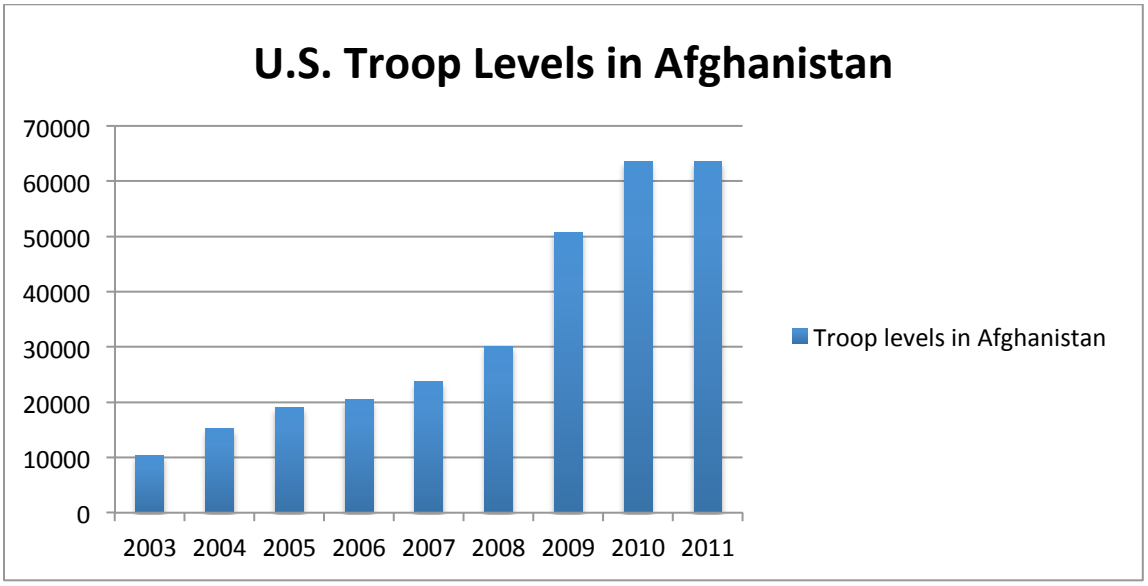

Figure 2. U.S. Troop Levels in Iraq between 2003 and 2011

2003	2004	2005	2006	2007	2008	2009	2010	2011
10400	15200	19100	20400	23700	30100	50700	63500	63500

Table 5. Number of U.S. Troops in Iraq between 2003 and 2011

(Belasco, 2009)

C. PREVIOUS STUDIES

1. Study by Buzzel and Preston (2007)

In their 2007 study, Buzzel and Preston examine how death risks vary according to certain personal characteristics and aspects of members of the armed forces. They

asserted that these risks vary from person to person, depending on such factors as branch of service, rank, age, sex, race, and ethnicity.

They constructed death rates for members of the United States military deployed to Iraq between March 2003 and September 2006. Data on the number and characteristics of troops deployed to Iraq were taken from Department of Defense website and Defense Manpower Data Center. The authors examined 2,706 deaths of U.S. troops in Iraq. They did not differentiate as to cause of death; this number includes deaths from all causes, whether hostile or not, as well as incidents that were directly related to in–theater operations in Iraq, even if they had occurred in another country.

The authors first analyzed differences in death rates according to branch of service and concluded that there was a huge difference among the services with respect to exposure to combat. Their study states that the rate death of Marines was more than double that of any other branch of service.

	Death rate per 1,000	Ratio of death rate to total death rate
Army	4.07	1.012
Marine Corps	8.59	2.140
Navy	0.92	0.229
Air Force	0.37	0.093
Total	4.02	1.000

Table 6. Number of Deaths and Relative Mortality Levels Per Deployment by Military Branch and Service Component, Iraq War, 2003-2006

Second, the authors analyzed death rates according to component of service. Their study showed that the active-Army risk of death was three times greater than that of Army reservists deployed to Iraq. They consider this difference to be a reflection of the fact that most members of the active Army were in C (combat) forces, while reservists were mostly in CS (combat support) and CSS (combat service support). In their analysis of Marines, they could not find a significant difference between active and reserve forces.

In their third analysis, the authors examined death rates according to rank. What they found is parallel to the one of the oldest observations in the social sciences, that low-ranking soldiers experience a greater risk of death than higher-ranked individuals. In the Army, those in the rank of private first class had a death risk three times greater than the combined categories of major, colonel, and general. The enlisted men had 38% higher mortality than officers. The same ratio was applicable to Marines as well. Lance corporals had a death risk 4.18 times greater than that of majors, colonels, and generals, and the single highest mortality group in any service consisted of lance corporals, whose death risk was 3.1 times that of all troops in Iraq.

The authors' fourth analysis was death rates according to age and sex. Their finding was that the male risk was 5.8 times that of females. They explained the difference by noting that women deployed to Iraq are not permitted to hold combat positions. Their analysis of age demonstrated a large mortality difference by age. In comparison to the civilian population, mortality rates declined precipitously with age. Troops aged 17–19 had a risk 4.4 times greater than that of troops aged 50 and older. This slope is explained by the distribution of rank and service affiliation by age. Another factor making the death rates higher among young troops was their inexperience within rank and branch of service.

As a conclusion, the authors state that the death rate of U.S. military personnel in Iraq was three times higher than the death rate of young Americans, but it was five times lower than the death rate of American troops serving in Vietnam. The Marines had a higher death risk than any other service. The death risk was higher for males than females and went down sharply with age.

In their study, the authors did not include wounded servicemen because they lacked the information needed to create a like profile. Another limitation of the study was that they did not differentiate between hostile and non-hostile incidents.

2. Study by Curtis and Payne (2010)

In their 2010 study, the authors investigate the disproportionate impact on rural communities of United States troop mortality in Iraq. Their study showed that troops

from non-metropolitan areas had higher mortality after accounting for the disproportionate enlistment of non-metropolitan youth, and that the non-metropolitan disadvantage generally persisted across military branch and rank. Moreover, most of the differential was due to higher risks of mortality for non-metropolitan, African-American and Hispanic military personnel, compared to metropolitan enlistees of the same race or ethnicity.

The authors start their analysis by addressing whether rural communities were more significantly affected by mortality in the Iraq War than urban communities. They disaggregated mortality data by the non-metropolitan status of the reported home counties of the dead and estimated whether troops from rural communities have a greater risk of death. Their analysis covered all U.S. military deaths since the invasion of Iraq, March 2003, through December 31, 2007, as reported by iCasualities and the Department of Defense (DoD). They used census definitions of metropolitan and non-metropolitan counties to analyze enlistment and death rates for all military personnel, disaggregated by non-metropolitan status, in addition to several risk factors associated with higher death rates, namely, military branch, rank within branch, and race or ethnicity. Their approach enables us to examine the extent to which the human costs of the Iraq War differentially affect rural communities.

In their study of rank, the authors examined whether a greater portion of non-metropolitan deaths were concentrated among the enlisted and lower ranks. They disaggregated the number of deaths and calculated the proportion of deaths, by rank, for non-metropolitan and metropolitan troops. They observed a similar pattern of mortality by rank for non-metropolitan and metropolitan troops. Compared to metropolitan troops, a greater concentration of deaths was found for non-metropolitan troops in the Army, especially among enlisted troops in the Army and, more specifically, Army sergeants; 37% of all non-metropolitan deaths were concentrated among Army sergeants, compared with 30% of all metropolitan deaths. There was a negligible difference between the proportions of total deaths among lower-ranked enlisted Army personnel. Likewise, there was little observed difference between non-metropolitan and metropolitan Army officers

or among Marines, whether enlisted or officers. The differences between non-metropolitan and metropolitan mortality appeared to be concentrated among Army sergeants.

The authors further examined mortality by calculating the relative risk of death for non-metropolitan troops by deployment and found evidence of a non-metropolitan/metropolitan inconsistency within rank. Results showed that the relative risk of mortality was generally higher for non-metropolitan enlisted troops and lower for non-metropolitan officers. Differences were especially evident in the Army; non-metropolitan enlistees have a 31% greater risk of mortality relative to their metropolitan counterparts. Among Army sergeants, those with the highest proportion of total deaths had a 48% greater risk of dying than metropolitan soldiers, and among officers, non-metropolitan officers had a 15% lower risk of death than metropolitan officers. The non-metropolitan disadvantage decreased with rank.

The authors found that African-Americans had a lower risk of death than whites across the metropolitan dimension. Non-metropolitan white troops had a 52% higher risk of mortality than non-metropolitan African-American personnel, while metropolitan white personnel were 2.7 times as likely to die as metropolitan African-Americans. Casualties among African-American personnel accounted for 7% of all non-metropolitan deaths and 10% of metropolitan deaths. Curtis and Payne explain this by citing the career intentions of African-Americans and their associated combat exposure.

As a conclusion, the authors' analysis of mortality among U.S. military troops indicates that non-metropolitan areas were experiencing a higher cost of the Iraq War. Troops from non-metropolitan counties had higher rates of death regardless of cause or military branch. Death rates inherently adjusted for differential enlistment suggested that non-metropolitan troops were at a greater risk of death after accounting for higher enlistment. But they did not answer the question why non-metropolitan troops experienced higher death rates and why rural communities bear a disproportionate burden of war.

D. CHAPTER SUMMARY

There are few publicized studies concerning the hostility casualties of U.S. troops in the two major wars the U.S. has been involved in since 2003. Both studies above include only deaths that occurred between 2003 and 2007 and do not differentiate causes of death. These deaths include both combat and non-combat related and cover only the incident that happened the Iraq War, whereas, in our study, we focus on combat-related casualties only, including death and injury, and cover incidents that happened in either Iraq or Afghanistan between 2003 and 2011. Both studies cover the Marine Corps, Air Force, Army, and Navy. In our study, we focus on the combat-related casualties of Army servicemen.

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III. DATA AND DESCRIPTIVE STATISTICS

A. INTRODUCTION

This chapter describes the data and sample used in our statistical analyses, provides descriptions of the dependent and explanatory variables used in the models, and presents basic descriptive statistics.

B. DATA SOURCE

The file used in this study was obtained from the DMDC. It was built from active-duty personnel extract files, covering the period from 2003 to 2011. To avoid the official limitations of using SSNs, we received a file arranged according to an identification number for each individual rather than by SSN.

The data set contained information on death or injury date, injury status, death or injury country and city, service, MOS, gender, education, race and ethnicity, age, marital status, number of deployments, armed force time in service and pay grade, AFQT, religion, race, death state, death country, home city, home country, service branch classification code, ethnic affinity and U.S. citizenship. In our study, we did not include death state, death country, home city, and home country because all were U.S.A. We did not include AFQT because officers do not take this test and religion, race and U.S. citizenship are not accounted in our study as well. The file contained 48,312 records of servicemen either injured or killed and 98,812 records of servicemen who served in the 2003–2011 period without injury. In our data, we used only army servicemen killed or injured in hostile action, of whom there were 35,698.

1. Dependent and Explanatory Variables

The dependent variable is binary and indicates whether the Army servicemen were injured or killed in a hostile action. The explanatory variables include demographic and military characteristics. Demographic characteristics include age, gender, number of dependents, and marital status. The military characteristics include branch, organization

code, pay grade, incident country, time in service, and number of deployments. Table 7 presents casualty numbers over the years for all variables used in the study.

VARIABLES		2003	2004	2005	2006	2007	2008	2009	2010	2011
NUMBER OF CASUALTIES		2411	5079	4790	4863	6324	2631	2356	3555	3689
INCIDENT COUNTRY	IZ	2279	4886	4529	4419	5488	1964	644	376	248
	AF	96	189	259	431	762	653	1698	3158	3612
MOS	COMBAT	986	2301	2470	2546	3492	1510	1502	2589	2756
	COMBAT SUPPORT	332	495	403	461	680	292	224	270	327
	COMBAT SERVICE SUPPORT	509	1115	800	674	899	363	338	548	761
ORAGNIZATION CODE	REGULAR	1831	3430	2692	4044	5361	2208	1847	2942	3338
	GUARD	286	1051	1677	612	699	342	450	468	392
	RESERVE	294	598	421	207	264	81	59	145	139
GENDER	MALE	2310	4915	4696	4767	6207	2592	2322	3488	3759
	FEMALE	100	164	91	92	112	37	34	67	107
AVERAGE YEARS IN ARMY		7.94	9.81	4.85	5.78	5.89	5.85	5.22	5.13	4.58
MARITAL STATUS	MARRIED	1237	2618	2483	2444	2924	1396	1237	1892	2052
	NEVER MARRIED	940	2301	2063	2200	2806	1048	940	1369	1592
	DIVORCED	87	136	203	168	205	86	87	115	113

Table 7. Dependent and Explanatory Variables (continue to next page)

VARIABLES		2003	2004	2005	2006	2007	2008	2009	2010	2011
AVERAGE NUMBER OF DEPLOYMENTS		1.95	1.81	1.85	1.97	1.98	2.04	1.93	1.89	1.78
NUMBER OF DEPENDENTS		1.14	1.18	1.12	1.22	1.28	1.36	1.31	1.33	1.29
AGE		26.00	27.31	27.39	26.21	25.90	26.60	26.07	24.42	22.65
PAY GRADE	OFFICER	174	351	287	299	401	189	134	231	235
	E13	521	909	778	976	1463	532	535	996	988
	E45	1272	2906	2847	2668	3386	1402	1266	2092	2082
	E69	444	913	878	920	1074	509	422	580	564

Table 7. Dependent and Explanatory Variables (cont.)

2. Data Description by Number of Casualties

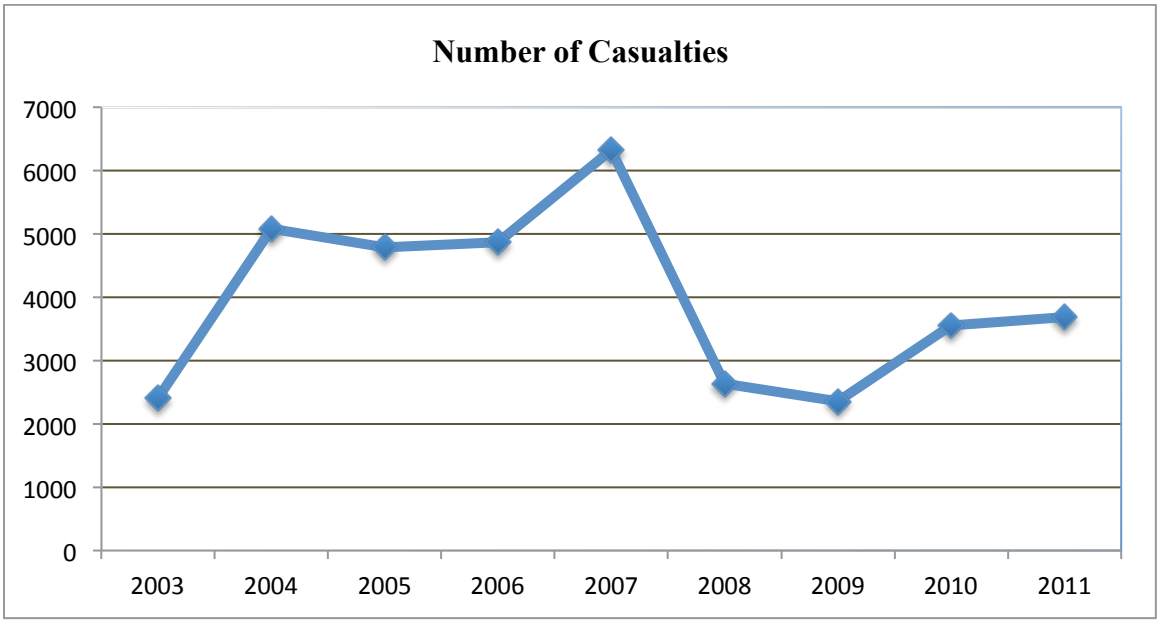

Figure 3. Number of Casualties

Figure 3 shows the total number of hostile casualties that occurred between 2003 and 2011 in Iraq and Afghanistan. The number of hostile casualties among U.S. troops more than doubled from 2003 to 2004. In 2003, the number was 2,411 and by 2004, this

number reached 5,079. In the following three years, the number of casualties did not change considerably. In 2007, the number of casualties increased by 1,461, reaching 6,324. This increase can be partly explained by the increased number of troops deployed to Afghanistan and Iraq, and is the highest number of casualties in 2003–2011. The number of casualties dropped significantly in 2008 to 2,631 and the following year reached its lowest value, 2,356. From 2009, the casualty number went up to around 3,500 for the following two years. This change can be explained by the change in focus of U.S. troops, from Iraq to Afghanistan.

3. Data Description by Incident Country

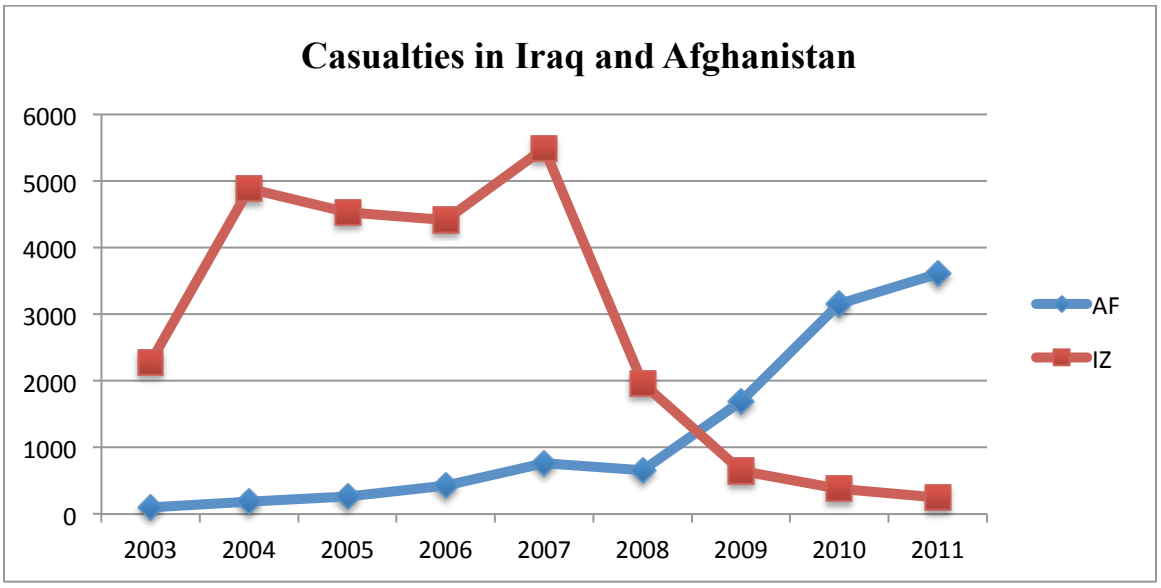

Figure 4. Casualties in Iraq and Afghanistan

Figure 4 shows the number of casualties in Iraq and Afghanistan. In 2003, the number of incidents in Afghanistan was lower than in Iraq. The number of troops deployed to Iraq was six times greater than the number deployed to Afghanistan, and the number of casualties that occurred in Iraq was twenty-three times greater. In 2004, the U.S. forces operating in Iraq doubled, reaching 130,600, and the number of hostile casualties doubled as well, increasing to 4,886. On the other hand, U.S. forces operating in Afghanistan increased by 50%, reaching 15,200; but the number of hostile casualties increased more than 100%. In the following two years, the U.S. troops deployed to Iraq

incremented by more than 10,000, but the incidents in those two years decreased by 7.4% in the first year and 9.6% in the second. In Afghanistan, troop size continued to grow by 50% for the year 2005, reaching 20,000, and the casualty percentage increased by 27% in the first year and 54% the following year. In 2007, the troop size extended to 148,300 and the number of hostile incidents increased to 5,488. This was the highest number of hostile casualties occurring in one year since 2003. In the same year, the troops in Afghanistan increased by 14%, but the casualty numbers increased by 43%. Although the number of troops deployed to Iraq reached its peak by year 2008, there was a sharp 65% drop in the number of casualties. In the following three years, until 2011, casualties decreased steadily. Meanwhile, the number of casualties in Afghanistan increased as the number of troops grew. Between 2009 and 2011, troop size increased by 40% for the first year and 17% for the second year, but the casualty number increased by 62% for the first year and 46.3 % for the second year.

In conclusion, there was a significant change in casualty numbers in Iraq in 2008, with a 65% drop in hostile casualties. The number decreased until 2011 when the U.S. left Iraq officially. The picture in Afghanistan is a little different. As the number of troops incremented, the number of casualties increased as well, specifically, after 2008.

4. Data Description by Pay Grade

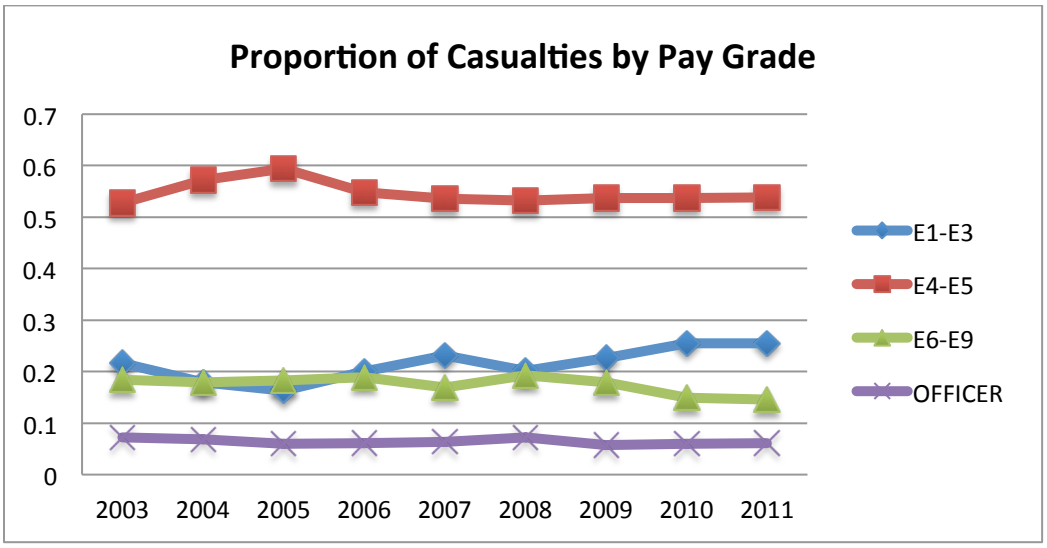

Figure 5. Proportion of Casualties by Pay Grade

Figure 5 shows casualty rates by pay grade in the U.S. Army between 2003 and 2011. Of all casualties, pay grades E1, E2, and E3 (shown by E13, make up 21%, E4 and E5 (shown by E45) made up 55%, E6, E7, E8 and E9 (shown by E69) made up 18%, and all officers makes up 6%. For the officers shown by O, the casualty ratio changed between 6% and 7% between 2003 and 2011. It reached its highest number in 2007, in which 401 officers were killed or injured. But the ratio among other pay grades did not change, because U.S. troops suffered the highest number of hostile events in that year. For the E69, the casualty ratio fluctuated between 14.5% and 19.3%. The highest number occurred in 2007, with 1,074 events, but the highest ratio happened the next year. Although there was a declining trend in the casualty ratio with respect to other pay grades, dropping to 14.5% after 2008, the casualty numbers of E69 went from 500 to 560. E45 is the pay-grade range that suffered more than half of all hostile incidents. The casualty ratio for E45 moved between 52.7% and 59.3%. The highest number of casualties was in 2007, with 3,386 killed or injured U.S. servicemen. After 2005, the casualty ratio as compared to other pay grades was steady at around 53%. For the E13, the casualty ratio fluctuated between 16.2% and 25.5%. This is the pay grade with the highest difference in casualty rates. After 2008, there was a steady increase in both the number and ratio of casualties.

5. Data Description by Number of C, CS, and CSS Troop Casualties

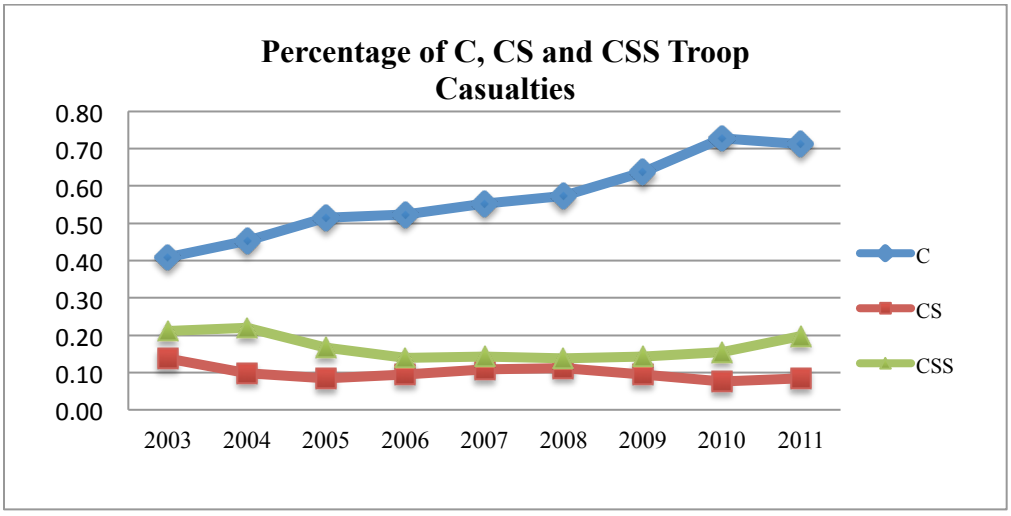

Figure 6. Percentage of C, CS and CSS Troop Casualties

Figure 6 presents the casualty numbers of C, CS, and CSS troops serving in Iraq and Afghanistan between 2003 and 2011. For the CSS troops, the casualty percentage changed between 21% and 14%. It reached its highest value in 2004, with 1,115 troops killed or injured. Until 2008, there was a steady decrease in the number of hostile casualties, dropping to 363 troops; but after that year, the number went up with increasing slope, incrementing to 761 troops in 2011. This can be partly explained by the increased number of troops in Afghanistan. For CS troops, the casualty percentage ranged between 8% and 14%. It reached its highest value in 2007, with 680 casualties. For the C troops, the casualty percentage changed between 41% and 71%. Its highest value was in 2007, with 3,492 casualties. Though there was a decrease in C-troop hostile casualties after 2007, the percentage of C troops killed or injured increased. There was a constant rise in the percentage of C-troop casualties between 2003 and 2010.

6. Data Description by Average Years in the Army

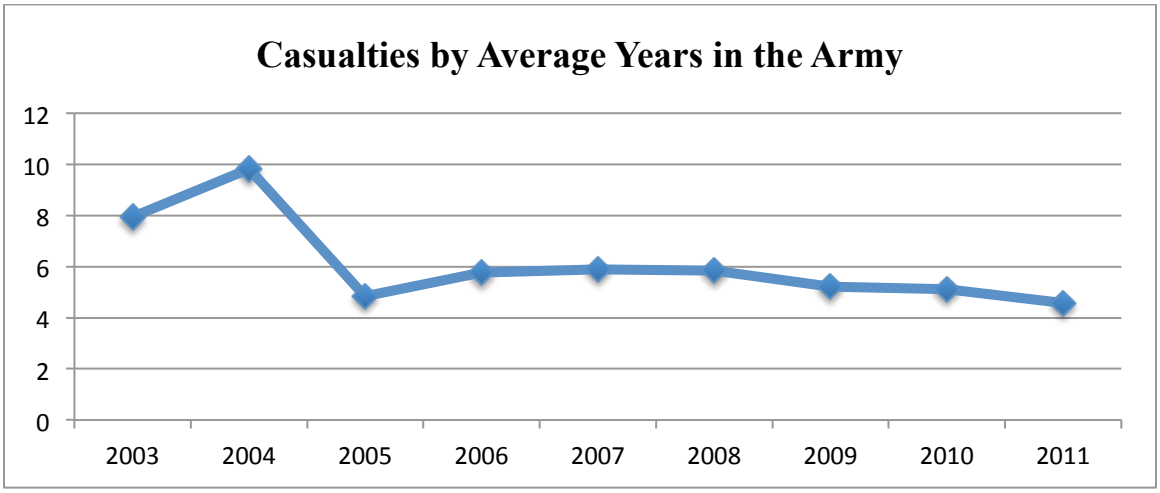

Figure 7. Casualties by Average Years in the Army

Figure 7 presents the time in Army service before members were killed or injured. In the first years of the wars, years spent in the Army were above eight, but in 2005, the number dropped to 4.85 years. Between 2005 and 2008, the time in service before injury increased slightly to 5.85 years, but after that year, the number declined steadily and reached its lowest value, 4.57 years, in 2011.

7. Data Description by Organization Component Code

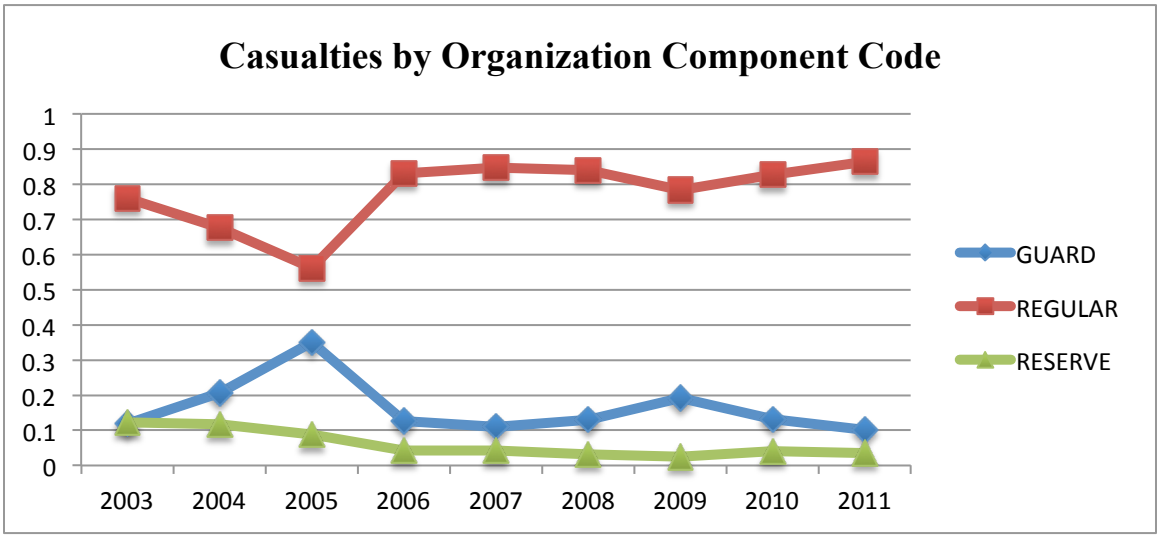

Figure 8. Casualties by Organization Component Code

Figure 8 presents hostile casualty numbers and percentages of regular, reserve, and guard forces that served in Iraq and Afghanistan between 2003 and 2011. In 2003, 76% of casualties were regular forces and the ratio of guard forces and reserve forces was about the same. The casualty ratio of reserve forces decreased steadily up to 3.5% in 2011. For the guard forces, there was a big jump in casualties between 2003 and 2005, from 11.8% to 35%. In 2006, there was a significant drop in the casualty ratio of guard forces, declining to 12.5%. After 2006, the casualty ratio of guard forces fluctuated between 10% and 12%. The average casualty ratio of regular forces was 77.6% between 2003 and 2011. There had been a sharp decline until 2005, dropping to 56%, but in the same period there was a sharp increase in casualties among guard forces. In 2006, the ratio of regular forces jumped again, to 83%. After 2006 and until 2011, the ratio fluctuated between 78% and 86%. A close look at the regular and guard forces reveals a symmetrical pattern. Whenever there is a change in the ratio of one force, there is an equal and opposite change in the other force.

8. Data Description by Average Number of Deployments

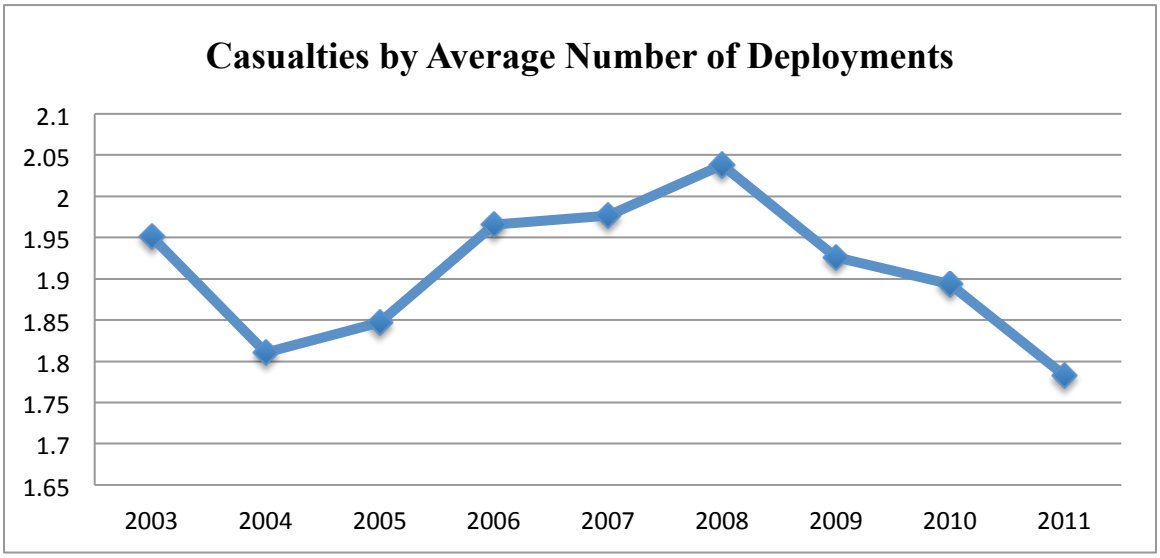

Figure 9. Casualties by Average Numbers of Deployments

Figure 9 shows the average number of deployments of U.S. troops before servicemen were injured or killed. The overall average number was 1.91 and fluctuated between 1.78 and 2.03 from 2003 to 2011. In 2004, the number dropped to 1.81 and after that year climbed constantly until 2008, reaching its highest value, 2.03 deployments. Following that year, the number of deployments decreased steadily until 2011, reaching its lowest value, 1.78 deployments. The declining trend after 2008 can be partly explained by an overall change in the U.S. Army. Figure 7 shows that the average years in the Army before getting killed or injured decreased, and in that figure we saw that time in service decreased steadily. Figure 10 shows that the age of casualties went down and Figure 5 shows that the ratio of hostile incidents after 2008 increased for service members between the E1 and E3 pay grades. We may infer that the average age of U.S. troops killed or injured in hostile actions got smaller.

9. Data Description by Average Age

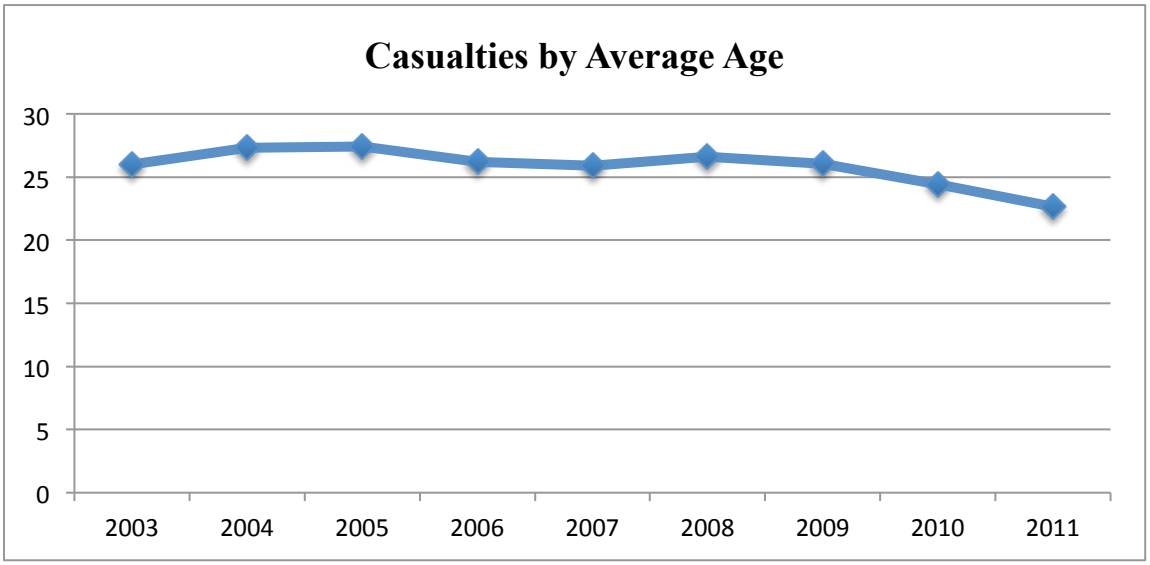

Figure 10. Casualties by Average Age

Figure 10 presents the average age of U.S. troops injured or killed in Iraq or Afghanistan. The average age was 25.83 years between 2003 and 2011. We observe no significant change until 2010, when the average casualty age fluctuated between 26 and 27, but in 2010, the average casualty age dropped to 24.4. In the following year, the average age decreased to 22.6 years. In this figure, we see a pattern similar to that observed in deployment numbers and years spent in the Army. All three variables decreased after 2008.

10. Data Description by Gender

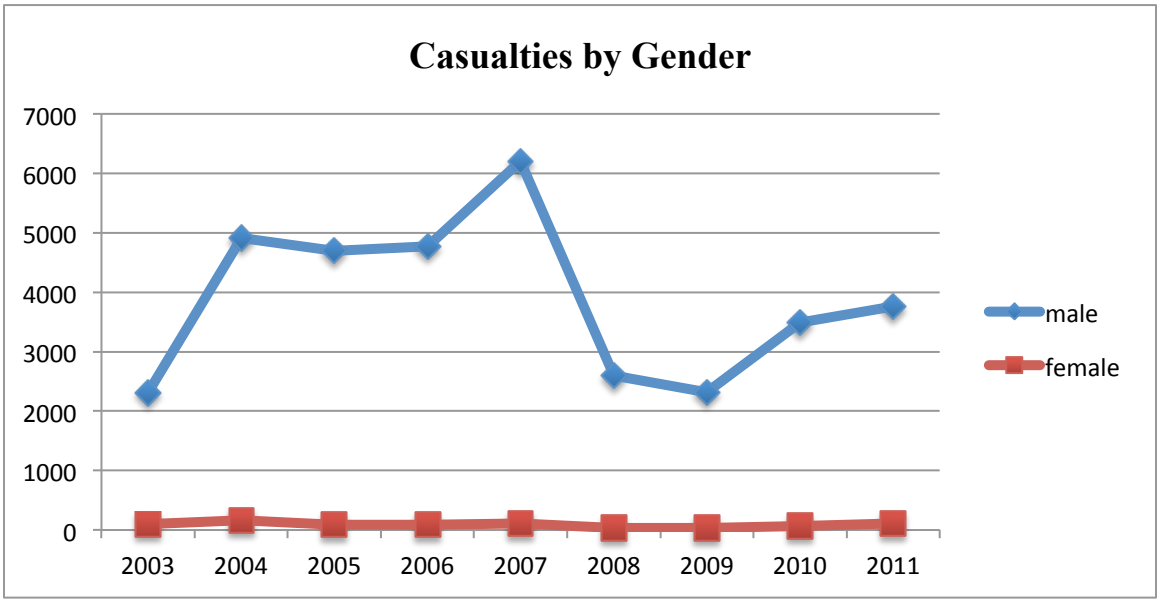

Figure 11. Casualties by Gender

Figure 11 presents the gender of U.S. troops injured or killed in Iraq or Afghanistan between 2003 and 2011. Ninety-eight percent of the casualties were male and 2% were female. This discrepancy may be explained by the fact that female service members were not allowed to serve as combat troops, which kept them away from exposure to hostile attacks.

11. Data Description by Marital Status

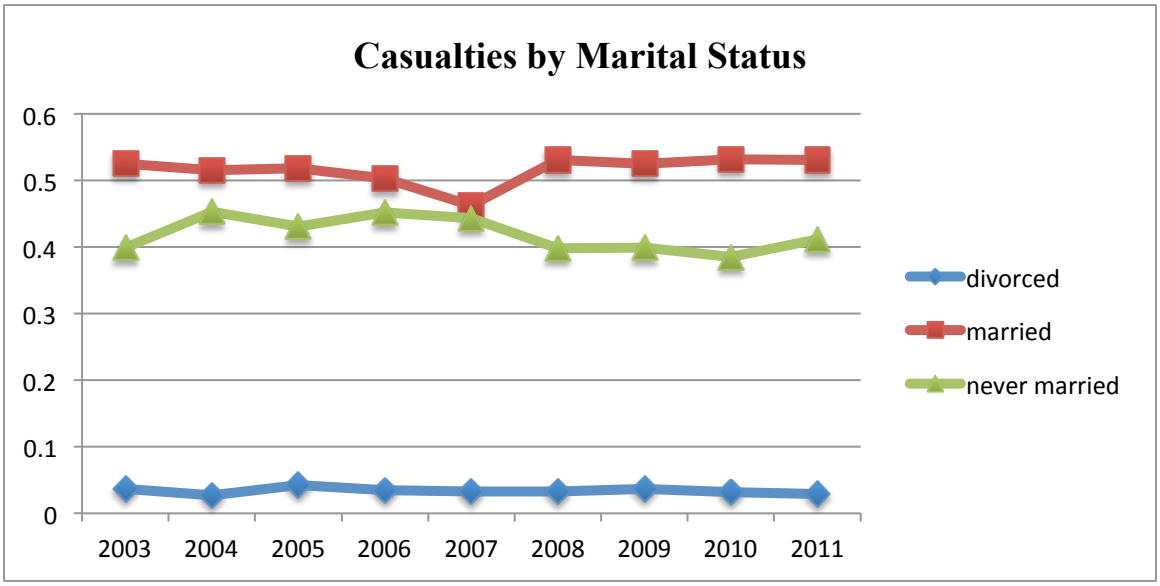

Figure 12. Casualties by Marital Status

Figure 12 presents the marital status of U.S. troops injured or killed in Iraq and Afghanistan between 2003 and 2011. There was not a significant observation in the ratio of divorced service members. The ratio of casualty changed between 3% and 4%. Married service members made the highest proportion with a ratio of over 50%. But this can be related with the proportion of married service members within the army. The casualty rate moved between 46% and 53.2%. In 2007, it reached its lowest value, while there was an increase in the casualty ratio of never-married service members. After 2007, the ratio went above 50% until 2011.

C. CHAPTER SUMMARY

This chapter describes the data and sample used in the statistical analysis, provides descriptions of the dependent and explanatory variables used in the models, and presents basic descriptive statistics.

Preliminary analysis shows that after 2008, there was a considerable decrease in hostile casualties in Iraq and an increase in casualties in Afghanistan. Figure 7 shows that the average number of years in the Army before getting killed or injured decreased, and

that time in service decreased steadily. Figure 10 shows the age of casualties going down and Figure 5 reveals that the ratio of hostile incidents after 2008 increases for service members in pay grades E1 to E3. We may infer that U.S. troops suffering casualties in hostile actions became younger in average age.

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IV. ANALYSIS

A. ANALYTICAL METHOD

This chapter contains the results of multivariate analysis of the casualty status of servicemen of the U.S. Army. First, a brief description of logistic regression is presented, and then evaluation and interpretation of analysis for the model is provided. The chapter concludes with a summary and comparison of the results found in the logistic regression model.

Regression methods are an integral part of any data analysis concerned with describing the relationships between a response variable and explanatory variables. Logistic regression is a well-known statistical technique for modeling data with binary outcomes.

We wish to analyze the reasons of causality status (killed/injured or not). Therefore, logistic regression is preferred, because the outcome of casualty is binary. The dependent variable for every observation (i) is defined as Yi, which is coded 1 if the servicemen is injured or killed, and 0 otherwise.

The theoretical model is:

$$\log (p_i / (1- p_i)) = \beta_0 + \beta_1 X_1 + ... + \beta_n X_n$$

where,

$\log (p_i / (1- p_i)$ = Log of odds ratio for individual *i*

p_i = Probability injured or killed

β_0 = Intercept

β = Estimated coefficient (change in log odds for a unit change in X_s)

X = Values of explanatory variables

The coefficients in the model represent the change in the log odds for a unit change in an *X* covariate. The *X* s capture the various demographic characteristics for the individuals, such as marital status, age, occupation component code, time in service, and rate of deployment. In logistic regression, the log-odds are generally assumed to be a linear function of various covariates.

The odds are defined as the probability that an individual with a particular set of characteristics was injured or killed in a hostile action, divided by the probability that he was not. The odds can be any number between zero and infinity. Odds of one mean that a serviceman with a set of characteristics is equally likely to get injured or killed. Odds greater than one mean that such a serviceman is more likely to get injured or killed, while odds less than one mean the serviceman is less likely to get killed or injured. (Fricker and Buttrey, 2008)

In our study, we analyzed two different models. In the first model, which we took as a base model, we have the variables without interactions, and in the second model, which is the alternative model; we have the interactions derived from the stepAIC function in R, which performs stepwise model selection by Akaike Information Criterion (AIC). (Venables and Ripley, 2002). In order to choose the best model, we performed pseudo-R^2 and Hosmer-Lomeshow tests.

Pseudo-R^2 test basically measures the percent of the variation in the dependent variable depending on changes in explanatory variables. The pseudo-R^2 is the logistic regression analog to the R^2 in linear regressions. It measures the proportion of deviance accounted for by the regression (Nagelkerke, 1991). Hosmer-Lomeshow test is a statistical test for goodness of fit for logistic regression models. The test assesses whether or not the observed event rates match expected event rates in subgroups of the model population. Hosmer and Lemeshow recommend partitioning the observations into 10 equal sized groups according to their predicted probabilities. Then,

$$G^2_{HL} = \sum_{j=1}^{10} \frac{\left(O_j - E_j\right)^2}{E_j\left(1 - E_j / n_j\right)} \sim \chi^2_8$$

where,

$E_j = \sum_i y_{ij}$ = Expected number of cases in the j^{th} group

n_j = Number of observartion in the j^{th} group

$O_j = \sum_i y_{ij}$ = Observed number of cases in the j^{th} group

(Hosmer, 2000)

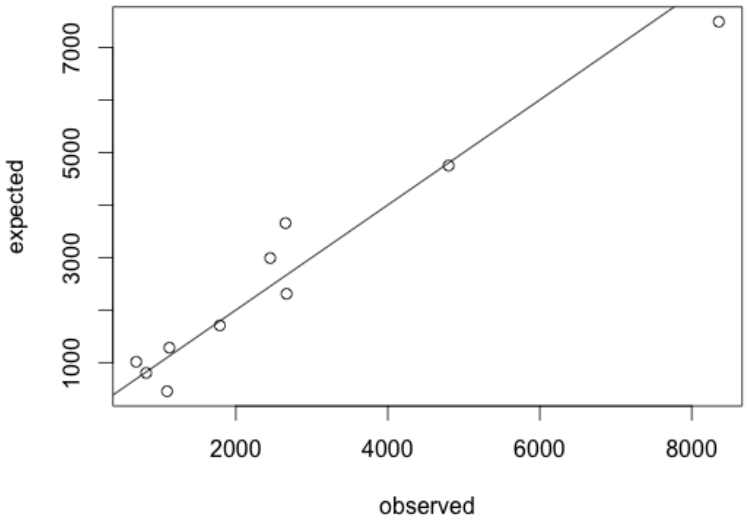

Figure 13. Hosmer-Lomeshow test result for the base model

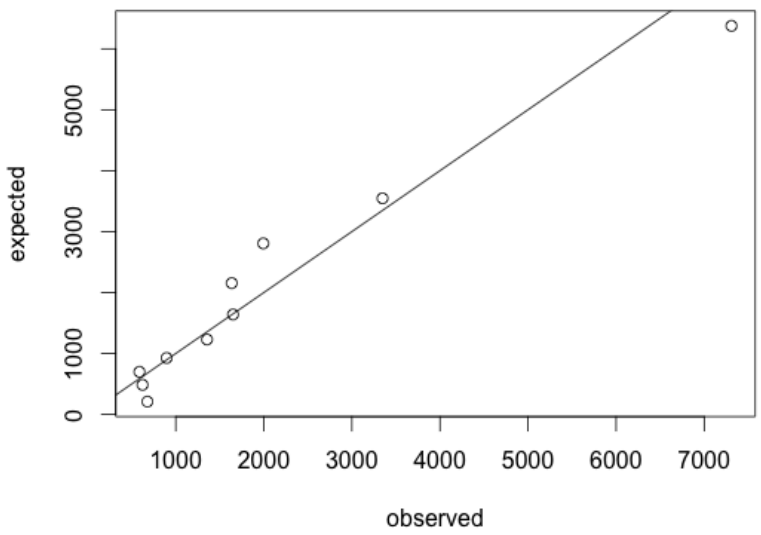

Figure 14. Hosmer-Lomeshow test result for the alternative model

The pseudo-R^2 value for the base model is 0.17 and is 0.22 for the alternative model. Evaluating the two models, we see that pseudo-R^2 value is higher for the alternative model. The results of Hosmer-Lomeshow tests are presented in Figure 13 for the base model and Figure 14 for the alternative model and we see that there is no significant difference between two figures. The p values for the both models are zero and chi-square values are 1941.7 for the base model and 2702.9 for the alternative one. Since a large p-value shows a good fit, neither of our models fit very well by this measure. Even though the pseudo-R^2 square value is higher for the model with interactions is better, we preferred to analyze the base model because the results of the base model are easier to interpret. The alternative model suggested by stepwise logistic regression is included in the appendix.

In symbols, the base model says,

$$\ln\left(p_i/(1-p_i)\right) = \beta_0 + \beta_1 \text{INJURY\_COUNTRY\_AF} +$$
$$\beta_2 \text{INJURY\_COUNTRY\_IRAQ} + \beta_3 \text{MARITAL\_STATUS\_M} +$$
$$\beta_4 \text{MARITAL\_STATUS\_F} + \beta_5 \text{AGE} + \beta_6 \text{GENDER\_M} +$$
$$\beta_7 \text{GENDER\_F} + \beta_8 \text{PAY\_GRADE\_E13} + \beta_9 \text{PAY\_GRADE\_E45} +$$
$$\beta_{10} \text{PAY\_GRADE\_E69} + \beta_{11} \text{ORG\_COMP\_CODE\_R} +$$
$$\beta_{12} \text{ORG\_COMP\_CODE\_G} + \beta_{13} \text{ORG\_COMP\_CODE\_V} +$$
$$\beta_{14} \text{DEPENDENT\_QUANTITY} + \beta_{15} \text{TIME\_IN\_SERVICE} +$$
$$\beta_{16} \text{MOS\_C} + \beta_{17} \text{MOS\_CS} + \beta_{18} \text{MOS\_CSS} +$$
$$\beta_{19} \text{DEPLOYMENT\_COUNT\_1} + \beta_{20} \text{DEPLOYMENT\_COUNT\_2} +$$
$$\beta_{21} \text{DEPLOYMENT\_COUNT\_3} + \beta_{22} \text{DEPLOYMENT\_COUNT\_4} +$$
$$\beta_{23} \text{DEPLOYMENT\_COUNT\_5}$$

where,

INJURY_COUNTRY_AF = killed or injured in Afghanistan

INJURY_COUNTRY_IRAQ = killed or injured in Iraq

MARITAL_STATUS_M = married

MARITAL_STATUS_N = never married

MARITAL_STATUS_D = divorced

AGE = age of the serviceman

GENDER_M = male serviceman

GENDER_F = female serviceman

PAY_GRADE_E13 = serviceman serving pay grades E1 through E3

PAY_GRADE_E45 = serviceman serving pay grades E4 through E5

PAY_GRADE_E69 = serviceman serving pay grades E6 through E9

PAY_GRADE_OF = officers

ORG_COMP_CODE _R = serviceman of regular forces

ORG_COMP_CODE _G = serviceman of guard forces

ORG_COMP_CODE _V = serviceman of reserve forces

DEPENDENT_QUANTITY = number of dependents of the serviceman

TIME_IN_SERVICE = number of years the serviceman served

MOS_C = serviceman of combat forces

MOS_CS = serviceman of combat support forces

MOS_CSS = serviceman of combat service support forces

DEPLOYMENT_COUNT_1 = serviceman deployed one time

DEPLOYMENT_COUNT_2 = serviceman deployed two times

DEPLOYMENT_COUNT_3 = serviceman deployed three times

DEPLOYMENT_COUNT_4 = serviceman deployed four times

DEPLOYMENT_COUNT_5 = serviceman deployed five or more times

B. VARIABLE DEFINITION

1. Dependent Variable

A binary variable was used to define a serviceman who was injured or killed. If the serviceman was killed or injured in a hostile action, this variable was given the value of 1 and the serviceman was classified as "killed or injured." If the serviceman was not killed or injured, the variable was given the value of 0. In this study, no distinction was made between killed and injured. Both these cases were classified in the same category.

2. Explanatory Variables

a. Pay Grade

Pay grades E1, E2, and E3 are taken as a group and presented by E13. Pay grades E4 and E5 are taken as a group and indicated by E45. Pay grades E6, E7, E8 and E9 are taken as a group and shown by E69, and all officers are taken as a group and indicated by Officer. The E45 pay-grade group casualty status makes the 55% of all casualties, followed by the E13 pay-grade group with 21%. With those statistics, servicemen serving in these two pay grades are more likely to get injured or killed. Pay grades E69 are expected to be less involved in hostile actions than other pay-grade groups because they are more likely assigned to staff or headquarter positions. So fewer casualties for servicemen of pay grades E69 are expected.

b. Gender

This variable presents the sex of the serviceman. Male servicemen constitute the majority of the army and they are expected to be more involved in hostile actions. Females are not allowed to serve in combat troops, which decreases exposure to hostile attacks. This makes males more exposed to hostile incidents.

c. Age

This variable gives the age of the serviceman at the time of the incident. The general expectation is that a junior serviceman is more likely to get killed or injured than the senior serviceman, because juniors are assigned to posts involving more danger than are seniors.

d. Marital Status

This variable gives the marital status of the serviceman at the time of the incident. Marital status was categorized into the levels of married, never married, and divorced.

e. Injury Country

This variable explains where the incident happened. In this study, only hostile incidents in Iraq and Afghanistan were taken into account.

f. Organization Component Code

The U.S. Army consists of regular, reserve and guard forces; the organization component code was categorized into these three variables. Regular forces make up the majority of the army, and it is expected that regular forces are more likely to be killed or injured. Analyzing the univariate statistics in Figure 8, we see that 27% of regular forces, 25.9% of guard forces, and 23.2% of reserve forces were injured during the two wars, which is consistent with our anticipation.

g. Time in Service

This variable explains the total years served before a serviceman was injured or killed. Time in service was calculated with the difference between the death or injury date and enlistment date. It is expected that as serviceman gains more experience and training, he is better prepared for hostile actions and less likely to get killed or injured. But a contrary assumption would be that in the early years of service, a serviceman is assigned to posts involving more danger.

h. Military Occupation Specialties (MOS)

This variable explains the military occupation specialties of the servicemen. To simplify, infantry, armor, field artillery, combat-engineer and air-defense artillery were grouped as combat troops. The chemical corps, general engineering, military-intelligence corps, military-police corps, signal corps and Army aviation were grouped as combat-support troops. The remaining military occupation specialties were grouped as combat-service support troops. The general anticipation is that those serving as combat troops are more exposed to danger and more likely to get killed or injured.

i. Deployment Count

This variable explains the number of deployment a serviceman had at time of incident. The Deployment Count variable was categorized in five groups. The servicemen were categorized to group 1 through group 4 with respect to number of deployments and group 5 includes the servicemen with 5 or more deployments. The common-sense expectation is that as the deployment numbers go up, the serviceman gains more experience and orientation to the battle environment and is less likely to get killed or injured.

C. ANALYSIS RESULTS

The effect of each independent variable was determined by trying all one-term deletions from the base model using the dropterm function. (Venables, 2002). Based on the results of this function, we decide whether a variable is statistically significant to analyze or not.

	Df	Deviance	AIC	LRT	Pr(Chi)
none		105485	105523		
Gender	1	105499	105535	13.3	0.000272 ***
Injury_Country	1	105551	105587	66.2	4.132e-16 ***
Marital_Status	2	105610	105644	124.8	< 2.2e-16 ***
Deployment_Count	4	105809	105839	323.6	< 2.2e-16 ***
Pay_Grade	3	106874	106906	1389.1	< 2.2e-16 ***
Dependent_Quantity	1	106944	106980	1458.9	< 2.2e-16 ***
Age	1	107746	107782	2260.9	< 2.2e-16 ***
Org_Comp_Code	2	108256	108290	2770.2	< 2.2e-16 ***
MOS	2	114532	114566	9046.5	< 2.2e-16 ***
Time_In_Service	1	115306	115342	9820.6	< 2.2e-16 ***

Table 8. Dropterm function results for the base model

Table 8 shows the results of the dropterm function our model. The effects of the variables are presented in ascending order. We see that the Gender was the least effective while Time_In_Service was the most effective among all variables included in the model.

Table 9 shows the results of summary function for the base model. This model demonstrates the effects of injury country, marital status, gender, pay grade, organization component code, dependent-quantity code, time in service, number of deployments, and MOS.

Term	Estimate	Std. Error	z value	Pr(>|z|)
Intercept	2.0586	0.08824	23.327	< 2e-16 ***
Marital_Status_Code_M	0.2005	0.04172	4.807	1.53e-06 ***
Marital_Status_Code_N	0.0087	0.04367	0.201	0.8406
Age	-0.0897	0.00200	-44.744	< 2e-16 ***
Gender_ M	-0.1820	0.04918	-3.701	0.000215 ***
Pay_Grade_E45	-0.1275	0.02160	-5.903	3.58e-09 ***
Pay_Grade_E69	-1.1026	0.03481	-31.669	< 2e-16 ***
Pay_Grade_Officers	-0.4880	0.04100	-11.903	< 2e-16 ***
Org_Comp_Code_R	-1.1560	0.02529	-45.704	< 2e-16 ***
Org_Comp_Code_V	0.2075	0.03792	5.473	4.43e-08 ***
Dependent_Quantity_Code	0.0203	0.00052	38.803	< 2e-16 ***
Time_Inservice	0.2305	0.00256	90.022	< 2e-16 ***
Deployment_Count_2	-0.1590	0.01879	-8.460	< 2e-16 ***
Deployment_Count_3	-0.4157	0.02473	-16.810	< 2e-16 ***
Deployment_Count_4	-0.3791	0.03828	-9.905	< 2e-16 ***
Deployment_Count_5	-0.1038	0.05489	-1.892	0.058432
MOS_CS	-1.4797	0.01952	-65.091	< 2e-16 ***
MOS_CSS	-1.5419	0.02273	-78.993	< 2e-16 ***
Injury_Country_Iraq	-0.1363	0.01671	-8.156	3.46e-16 ***

* significant at 10 %; ** significant at 5 %; *** significant at 1 %

Table 9. Summary function results for the base model

1. Pay Grade

In our model, the base case for pay grade is E1–E3. In Figure 5, we see that the majority of casualties occurred in the E4–E5 pay grades, with 55% followed by the E13 pay-grade group with 21%. Our initial descriptive study is not very consistent with one of the oldest observations in the social sciences, that lower-ranking servicemen are exposed to a greater risk of death than higher-ranking individuals (Buzzel and Preston, 2007). The study by Buzzel and Preston also shows that in the Army, privates first class have a death

risk three times greater than the combined categories of major, colonel, and general; and enlisted men have a 38% higher mortality than officers. In the Marine Corps, lance corporals have a death risk 4.18 times greater than that of majors, colonels, and generals, and the single highest mortality group in any service consist of lance corporals, whose death risk is 3.1 times that of all troops in Iraq.

The base case for pay grade is E1–E3. After adjusting to other casualties, in our multivariate model we see that all other pay grades have lower odds ratio. The odds ratio values are 0.88 for E4–E5, 0.66 for Officers and 0.33 for E6–E9 pay grades. With our new results, we may infer that all the pay grades have lower odds ratios of getting killed or injured than pay grades E1–E3. But that difference is not as large as has been mentioned in previous studies.

2. Marital Status

The base case for marital status in our model is divorced servicemen. In descriptive statistics, we see that 27.7% of married, 28.7% of never married, and 22% of divorced servicemen were either injured or killed. Our model results show that a married serviceman is more likely to get injured or killed than both divorced and never married serviceman. The odds ratios for divorced and never married servicemen are very close that we can say that there is no significant difference between those two. In our model, we may conclude married servicemen are more likely to get injured or killed.

3. Gender

The base case for gender in the model is female. In Figure 11, we see that 98% of casualties were males. In both wars, 29.2% of male and 18.6% of female servicemen were injured or killed. With these statistics, the casualty of a male serviceman is more likely to occur, but in our model we perceive what is contrary to general expectation. A male serviceman has a lower odds ratio than an otherwise female serviceman. We may interpret that a male serviceman is less likely to get killed or injured due to hostile incident. The reasons for this result might be the physical capacity, better training and higher orientation to the conditions of the battlefield.

4. Injury Country

In our model, the base case for country of injury is Afghanistan. The number of casualties in Iraq was more than twice the number that occurred in Afghanistan. Dividing the casualty numbers by the total number of troops served, we get the ratio of 29.4% casualty percentage for troops who served in Iraq and 27.1% for troops who served in Afghanistan. In multivariate analysis, a serviceman serving in Iraq has an odds ratio of 0.87, which is very close to 1. We may infer that there is not much difference in the casualty status between the two countries.

5. Organization Component Code

The base case for organization component code in our model is guard forces. In the descriptive-statistics part, we see that 29.2% of regular forces, 28.3% of guard forces and 25.5% of reserve forces were either injured or killed. These ratios looks logical because regular forces are expected to be more exposed to hostile attacks than the other two groups. In our model, we see that regular forces are less likely to get killed or injured than other forces. The reserve forces have the highest odds ratio, which means they are predicted by the model more susceptible to death or injury. The level of training the forces get might explain this contradiction. Regular forces have more experience in the field and are more accustomed to the conditions of the battlefield, while the other two forces might have less experience.

6. Military Occupation Specialties (MOS)

The base case for MOS in our model is combat troops, which make the majority in the sample data. In our model, we see that the odds ratios for combat support and combat-service support troops indicate that they are less likely to get injured or killed than combat troops. This result looks convincing, because CS and CSS troops do not engage the enemy as C troops do.

7. Deployment Count

The base case for Deployment Count in our model is the first deployment. Interpreting the coefficients in Table 9, we see that servicemen in their first deployment

are more likely to get killed or injured. Servicemen with two deployments have odds ratio of 0.85 and servicemen with three and four deployments got nearly the same odds ratios, which are about 0.66. Even though the odds ratio for five or more deployments is 0.90, the *p* value is 0.06, which is statistically insignificant. We may interpret that as the number of deployments increases, the servicemen are less likely to killed or injured. The reason for this result might be that as the number of deployment increases, the serviceman gains more experience and is better oriented to the battlefield. Another factor is the fact that the pay grade of the servicemen increases as the number of deployments increases. Our pay grade analysis suggests that servicemen with higher pay grades are less likely to involve in hostile incidents.

8. Age

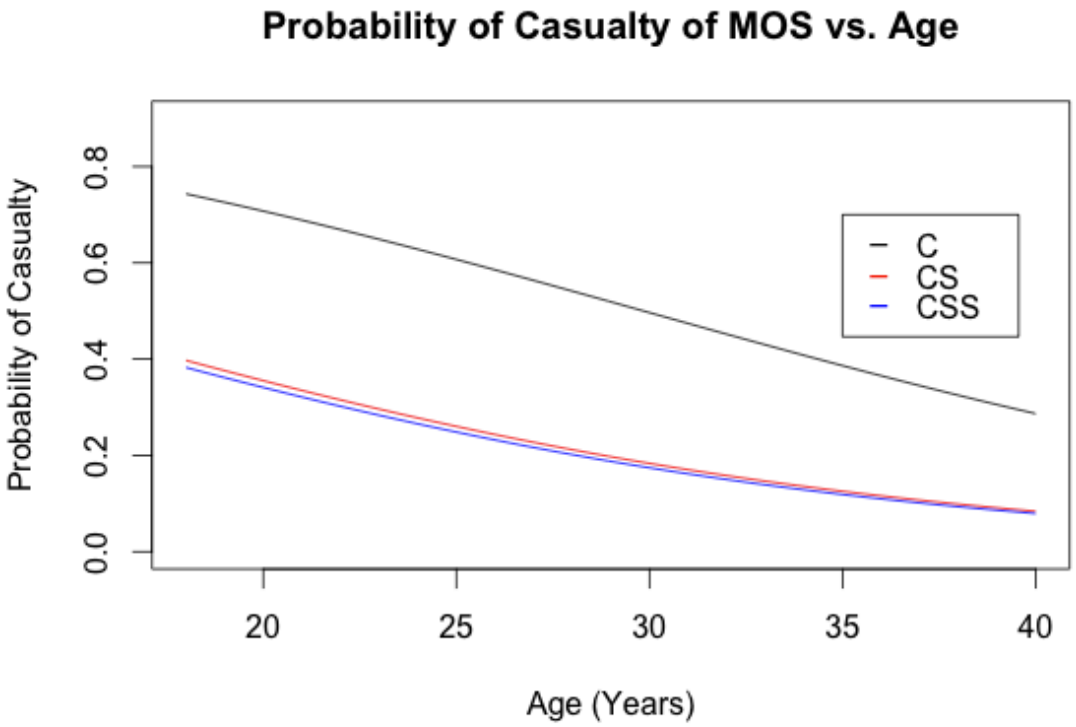

Figure 15. Probability of Casualty of MOS vs. Age

Figure 15 shows the probability of casualty of MOS with respect to age. We got Figure 15 with the help of the predict function in R. Predict is a generic function for

predictions from the results of various model fitting functions. The function invokes particular methods, which depend on the class of the first argument. (Chambers and Hastie, 1992) The first argument in our study was a male never married serviceman who was 28 years old and serving in Afghanistan. His pay grade was E45, and was serving as regular force in CSS troops. He had been serving in the Army for eight years and was on his second deployment. This particular serviceman was replicated for a number of times and was fitted in our model to see the effect of time in service on MOS. Figure 15 shows the probability of casualty of MOS with respect to the time they served. We see that the probability of casualty decreases for all troops as the age of the servicemen grows. C troops have the highest probability of casualty in all ages. CS and CSS troops have about the same probability of being killed or injured. As the age grows, we see that the gap between C and other two troops decreases. This might be explained by the fact that as the age grows C troops serviceman might be assigned to posts which are less susceptible to hostile incidents.

D. CHAPTER SUMMARY

This chapter contains the results of multivariate analysis of the casualty status of servicemen in the U.S. Army. The chapter started by describing the variables used in the model, then multivariate analysis was presented separately for each variable.

The results suggest that pay grades E1 through E3 are more likely to be involved in hostile incidents than other pay-grade groups, and this exposure to danger decreases as the pay grades increase. The findings for gender are not parallel to popular ideas. It is expected that males will be more exposed to hostile incidents than females. But even though the difference is not large, our results show that males are less likely to get killed or injured. In terms of the effects of marital status, our study shows that married servicemen are more likely to be involved in hostile incidents. In our model, we found that regular forces have a lower risk of engaging in hostile incidents than guard and reserve forces, which is contrary to general expectation. The results for MOS were as expected. Combat troops are more likely to be killed or injured than other troops.

As a conclusion for our multivariate model, a serviceman who is female, married, serving in the reserve forces, serving in a combat troop, between pay grades E1–E3, serving in Iraq, serving the first deployment is the serviceman with most potential to get injured or killed in the U.S. Army.

The data set contained information on death or injury date, injury status, death or injury country and city, service, MOS, gender, education, race and ethnicity, age, marital status, number of deployments, armed-force time in service, and pay grade.

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V. SUMMARY, RECOMMENDATIONS AND FUTURE RESEARCH

A. SUMMARY

The purpose of this study is to create a profile of the U.S. Troops who have been killed or injured due to hostile incident in Iraq or Afghanistan.

The second chapter of the thesis provided a background of the wars and review of previous studies. U.S. troops have been involved in two major wars since 2001 and over 35,000 Army servicemen have been either injured or killed due to hostile incidents in Iraq or Afghanistan.

There are few published studies concerning the hostility casualties of U.S. troops in the two major wars. Previous studies include only deaths that occurred between 2003 and 2007 and do not differentiate the causes of death. These deaths include both combat and non-combat related and the studies cover only those incidents that happened in Iraq, whereas in our study, we have focused on combat-related casualties, including both deaths and injuries, and we covered incidents in Iraq and Afghanistan between 2003 and 2011. Earlier studies covered the Marine Corps, Air Force, Army and Navy. Our study focused on combat-related casualties of Army servicemen only.

The third chapter provided descriptive statistics of the data. The file used in this study was obtained from the DMDC. It was built from active-duty personnel extract files, covering 2003 to 2011. The file contained 48,312 records of servicemen either injured or killed and 98,812 records of servicemen who served in the 2003–2011 period with no injury. In our data, we used only servicemen killed or injured in hostile action, of which there were 35,698.

Preliminary analysis shows that after 2008, there is a significant decrease in hostile casualties in Iraq and a significant increase in casualties in Afghanistan. Our results shows that the time in service before getting killed or injured decreases, the average age of the servicemen who was injured or killed decreases, and the number of

casualties of servicemen between pay grade E1 and E3 increases. We may infer that both the average age of the U.S. troops involved in hostile actions and the average age of the Army is getting younger.

The fourth chapter covered the methodology utilized, which includes a brief overview of logistic regression, a description of the variables and model and the analytical results. Also in this chapter are the results of multivariate analysis of the casualty status of servicemen in the U.S. Army.

The results suggest that pay grades through E1 and E3 are more likely to be involved in hostile incidents than other pay-grade groups and that exposure to danger decreases as pay grade increases.

The findings for gender are not consistent with popular notions. It is expected that males will be more exposed to hostile incidents than females. Even though the difference is not large, our results show that males are less likely to get killed or injured.

In terms of the effects of marital status, after adjusting to the other variables, our study shows that married servicemen are more likely to be involved in hostile incidents.

In our model, we found that regular forces have a lower risk of engaging in hostile incidents than guard and reserve forces, which is contrary to general expectation. The type of training the forces go through and their battlefield experience might affect this result. It is known that regular forces get more training and have more war experience.

The results for MOS were as expected. Combat troops are more likely to be killed or injured than other troops.

As a conclusion for our multivariate model, an actual-duty person who is female, married, serving in guard forces in a combat troop, between pay grades E1-E3, and serving in Iraq is the most likely actual-duty person to be injured or killed in U.S. Army.

B. RECOMMENDATIONS AND FUTURE RESEARCH

In this study, the types of hostile casualties have not been investigated. The reason for the hostile incident, integrated in multivariate models, may reveal noteworthy results. The incident could involve an improvised, explosive device (IED), direct attack, suicide

bombers, mortar or artillery fire, or a traffic accident. Research on casualties with respect to type of incident may give decision planners valuable insights about the casualty status of troops serving in the battlefield.

In our study, we did not differentiate between killed and injured; we treated all events as hostile casualties. Studies examining killed and injured events separately may produce stronger results. For pay grade, we classified the ranks as four groups: E1–E3, E4–E5, E6–E9 and officers. A study focused on one particular rank may create clearer results about that rank.

Due to data restrictions, we studied only servicemen of the Army. Studies including all the forces may explain the differences among casualty types.

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APPENDIX. LOGISTIC REGRESSION RESULTS FOR ALTERNATIVE MODEL WITH INTERACTIONS

The alternative model in symbol is:

$$\ln\left(pi / (1- pi)\right) = \beta_0 + \beta_1 \text{INJURY\_COUNTRY\_AF} + \beta_2 \text{INJURY\_COUNTRY\_IRAQ} + \beta_3 \text{MARITAL\_STATUS\_M} + \beta_4 \text{MARITAL\_STATUS\_F} + \beta_5 \text{AGE} + \beta_6 \text{GENDER\_M} + \beta_7 \text{GENDER\_F} + \beta_8 \text{PAY\_GRADE\_E13} + \beta_9 \text{PAY\_GRADE\_E45} + \beta_{10} \text{PAY\_GRADE\_E69} + \beta_{11} \text{ORG\_COMP\_CODE\_R} + \beta_{12} \text{ORG\_COMP\_CODE\_G} + \beta_{13} \text{ORG\_COMP\_CODE\_V} + \beta_{14} \text{DEPENDENT\_QUANTITY} + \beta_{15} \text{TIME\_IN\_SERVICE} + \beta_{16} \text{MOS\_C} + \beta_{17} \text{MOS\_CS} + \beta_{18} \text{MOS\_CSS} + \beta_{19} \text{DEPLOYMENT\_COUNT\_1} + \beta_{20} \text{DEPLOYMENT\_COUNT\_2} + \beta_{21} \text{DEPLOYMENT\_COUNT\_3} + \beta_{22} \text{DEPLOYMENT\_COUNT\_4} + \beta_{23} \text{DEPLOYMENT\_COUNT\_5} + \beta_{24} \text{ORG\_COMP\_CODE:AGE} + \beta_{25} \text{PAY\_GRADE\_E13:AGE} + \beta_{26} \text{ORG\_COMP\_CODE:MOS} + \beta_{27} \text{DEPENDENT\_QUANTITY:TIME\_IN\_SERVICE} + \beta_{28} \text{ORG\_COMP\_CODE:DEPLOYMENT\_COUNT} + \beta_{29} \text{DEPLOYMENT\_COUNT:AGE} + \beta_{30} \text{DEPLOYMENT\_COUNT: PAY\_GRADE} + \beta_{31} \text{INJURY\_COUNTRY:MOS}$$

	Df	Deviance	AIC	LRT	Pr(Chi)
none		105029	105155		
Gender	1	105042	105166	12.4	0.0004242
Marital_Status	2	105151	105273	121.2	< 2.2e-16 ***
MOS:Injury_Country	2	105159	105281	129.5	< 2.2e-16 ***
Dep_Count:Pay_Grade	12	105273	105375	243.2	< 2.2e-16 ***
Dep_Count:Org_Code	8	105267	105377	237.6	< 2.2e-16 ***
Dep_Count:Age	4	105329	105447	300.1	< 2.2e-16 ***
Org_Code:MOS	4	105331	105449	300.5	< 2.2e-16 ***
Dep_Qty:Time_InService	1	105417	105541	387.9	< 2.2e-16 ***
Age:Pay_Grade	3	105865	105985	835.8	< 2.2e-16 ***
Org_Code:Pay_Grade	6	106308	106422	1279.0	< 2.2e-16 ***
Age:Org_Code	2	107596	107718	2566.6	< 2.2e-16 ***
Org_Code:Time_InService	2	119056	119178	14026.5	< 2.2e-16 ***

Table 10. Dropterm function results for the alternative model

Term	Estimate	Std. Error	z value	Pr(>|z|)
Intercept	– 1.4337	0.13678	– 10.482	< 2e-16 ***
Marital_Status_Code_M	0.2145	0.04147	5.179	< 2e-16 ***
Marital_Status_Code_N	0.0259	0.04324	0.6	5.03e-05 ***
Age	0.0419	0.00464	9.029	< 2e-16 ***
Gender_ M	– 0.1730	0.04826	– 3.586	0.000335 ***
Pay_Grade_E45	0.4986	0.12126	4.112	3.92e-05 ***
Pay_Grade_E69	2.8100	0.18492	15.201	< 2e-16 ***
Pay_Grade_Officers	4.0209	0.23332	17.233	< 2e-16 ***
Org_Comp_Code_R	3.1919	0.10068	31.703	< 2e-16 ***
Org_Comp_Code_V	0.0870	0.17090	0.509	0.610467
Dependent_Quantity_Code	0.0295	0.00066	44.368	< 2e-16 ***
Time_Inservice	0.0071	0.00051	13.999	< 2e-16 ***
Deployment_Count_2	0.4315	0.10830	3.984	6.77e-05 ***
Deployment_Count_3	1.6497	0.16548	9.969	< 2e-16 ***
Deployment_Count_4	2.8205	0.32114	8.783	< 2e-16 ***
Deployment_Count_5	3.6501	0.58283	6.263	< 2e-16 ***
MOS_CS	– 1.5184	0.06166	– 24.623	< 2e-16 ***
MOS_CSS	– 0.9457	0.04977	– 19	< 2e-16 ***
Injury_Country_Iraq	– 0.3135	0.02138	– 14.66	< 2e-16 ***
Org_Code_R:Time_Inservice	0.3776	0.00375	100.709	< 2e-16 ***
Org_Code_V:Time_Inservice	0.0026	0.00110	2.338	0.0119375
Org_Code_R:Age	– 0.1718	0.00375	– 45.827	< 2e-16 ***
Org_Code_V:Age	0.0077	0.00487	1.599	0.109804
Pay_Grade_E45:Age	– 0.0248	0.00447	– 5.546	2.93e-08 ***
Pay_Grade_E69:Age	– 0.1013	0.00555	– 18.256	< 2e-16 ***
Pay_Grade_OF:Age	– 0.1564	0.00742	– 21.057	< 2e-16 ***
Pay_Grade_E45:Org_Code_R	– 0.3073	0.06182	– 4.971	6.66e-07 ***
Pay_Grade_E69:Org_Code_R	– 2.3021	0.08932	– 25.773	< 2e-16 ***
Pay_Grade_OF:Org_Code_R	– 0.3240	0.10650	– 3.043	0.002343 **
Pay_Grade_E45:Org_Code_V	0.5255	0.12308	4.27	1.95e-05 ***
Pay_Grade_E69:Org_Code_V	0.6909	0.15215	4.541	5.59e-06 ***
Pay_Grade_OF:Org_Code_V	1.4806	0.16333	9.066	< 2e-16 ***
Org_Code_R:MOS_CS	– 0.0019	0.00011	– 17.857	< 2e-16 ***
Org_Code_V:MOS_CS	– 0.3954	0.05562	– 7.11	1.16e-12 ***
Org_Code_R:MOS_CSS	– 0.7931	0.09989	– 7.94	2.02e-15 ***
Org_Code_V:MOS_CSS	– 0.7531	0.04602	– 16.36	< 2e-16 ***

Table 11. Summary function results for the alternative model

Term	Estimate	Std. Error	z value	Pr(>|z|)
Org_Code_R:Dep.Count_2	– 0.8382	0.08345	10.044	< 2e-16 ***
Org_Code_V:Dep.Count_2	– 0.4738	0.04700	– 10.044	< 2e-16 ***
Org_Code_R:Dep.Count_3	– 0.4678	0.07899	– 5.923	3.17e-09 ***
Org_Code_V:Dep.Count_3	– 0.8269	0.07313	– 11.307	< 2e-16 ***
Org_Code_R:Dep.Count_3	– 0.3100	0.12189	– 2.544	0.010970 *
Org_Code_V:Dep.Count_3	– 0.9834	0.14903	– 6.599	4.13e-11 ***
Org_Code_R:Dep.Count_4	– 0.4825	0.24592	– 1.962	0.049732 *
Org_Code_V:Dep.Count_4	– 0.4825	0.25378	– 4.499	6.82e-06 ***
Org_Code_R:Dep.Count_5	– 1.1418	0.41711	– 0.415	0.67804
Org_Code_V:Dep.Count_5	– 0.1731	0.00351	– 6.417	1.39e-10 ***
Age:Dep.Count_2	– 0.0225	0.00504	– 12.504	< 2e-16 ***
Age:Dep.Count_3	– 0.0630	0.00836	– 11.882	< 2e-16 ***
Age:Dep.Count_4	– 0.0993	0.01215	– 7.713	1.23e-14 ***
Age:Dep.Count_5	– 0.0937	0.05088	4.818	1.45e-06 ***
Pay_Grade_E45:Dep.Count_2	0.2451	0.07808	8.801	< 2e-16 ***
Pay_Grade_E69:Dep.Count_2	0.6872	0.09352	2.953	0.003151 **
Pay_Grade_Officers:Dep.Count_2	0.2761454	0.08702	-0.154	0.877534
Pay_Grade_E45:Dep.Count_3	– 0.0134101	0.10932	8.084	6.28e-16 ***
Pay_Grade_E69:Dep.Count_3	0.8837333	0.13325	0.258	0.796426
Pay_Grade_Officers:Dep.Count_3	0.0343752	0.19515	-0.05	0.960489
Pay_Grade_E45:Dep.Count_4	– 0.0096677	0.20934	4.744	2.09e-06 ***
Pay_Grade_E69:Dep.Count_4	0.9931975	0.24232	2.983	0.002852 **
Pay_Grade_Officers:Dep.Count_4	0.7229051	0.42807	– 1.211	0.225978
Pay_Grade_E45:Dep.Count_5	– 0.5183075	0.43646	0.95	0.341976
Pay_Grade_E69:Dep.Count_5	0.4147561	0.46617	– 0.288	0.773079
Pay_Grade_Officers:Dep.Count_5	– 0.1344222	0.04988	11.164	< 2e-16 ***
Injury_Country_Iraq:MOS_CS	0.5568558	0.03974	1.872	0.061260
Injury_Country_Iraq:MOS_CSS	0.0743897	0.03974	0.466178	< 2e-16 ***

Table 11. Summary function results for the alternative model (cont.)

Where,

INJURY_COUNTRY_AF = killed or injured in Afghanistan

INJURY_COUNTRY_IRAQ = killed or injured in Iraq

MARITAL_STATUS_M = married

MARITAL_STATUS_N = never married

MARITAL_STATUS_D = divorced

AGE = age of the serviceman

GENDER_M = male serviceman

GENDER_F = female serviceman

PAY_GRADE_E13 = serviceman serving pay grades E1 through E3

PAY_GRADE_E45 = serviceman serving pay grades E4 through E5

PAY_GRADE_E69 = serviceman serving pay grades E6 through E9

PAY_GRADE_OF = officers

ORG_COMP_CODE _R = serviceman of regular forces

ORG_COMP_CODE _G = serviceman of guard forces

ORG_COMP_CODE _V = serviceman of reserve forces

DEPENDENT_QUANTITY = number of dependents of the serviceman

TIME_IN_SERVICE = number of years the serviceman served

MOS_C = serviceman of combat forces

MOS_CS = serviceman of combat support forces

MOS_CSS = serviceman of combat service support forces

DEPLOYMENT_COUNT_1 = serviceman deployed one time

DEPLOYMENT_COUNT_2 = serviceman deployed two times

DEPLOYMENT_COUNT_3 = serviceman deployed three times

DEPLOYMENT_COUNT_4 = serviceman deployed four times

DEPLOYMENT_COUNT_5 = serviceman deployed five or more times

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