

OBESITY AND ARMY READINESS

A thesis presented to the Faculty of the U.S. Army
Command and General Staff College in partial
fulfillment of the requirements for the
degree

MASTER OF MILITARY ART AND SCIENCE
General Studies

by

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2019

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REPORT DOCUMENTATION PAGE				<i>Form Approved</i> <i>OMB No. 0704-0188</i>	
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1. REPORT DATE (DD-MM-YYYY) 14-06-2019		2. REPORT TYPE Master's Thesis		3. DATES COVERED (From - To) AUG 2018 – JUN 2019	
4. TITLE AND SUBTITLE Obesity and Army Readiness				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) MAJ Evan T. Trivette				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Command and General Staff College ATTN: ATZL-SWD-GD Fort Leavenworth, KS 66027-2301				8. PERFORMING ORG REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for Public Release; Distribution is Unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT In the context of the dramatic increase in overweight and obesity prevalence in the United States as well as the global population, the United States Army has likewise noted an increase in the prevalence of obesity among active duty ranks. Using a centrally stored data repository, the Medical Readiness Assessment Tool (MRAT), the researcher obtained health and physical profile data on 15 active duty brigades with a result of 52,435 soldiers, and analyzed the relationship between the variables of rank, body mass index, and medical (limiting) permanent profile data. The assessed population demonstrated a statistically significant relationship between obesity and permanent profiles, both those indicating limitations and significant physical limitations. The assessed population also demonstrated a statistically significant increase in both obesity and permanent profiles with increasing rank. This thesis recommends that the Army adjust the standards and regulations with respect to body weight, body composition, and medical profiling.					
15. SUBJECT TERMS Obesity, Body Composition, Military Readiness, Army Fitness, Medical Profiling					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT (U)	18. NUMBER OF PAGES 115	19a. NAME OF RESPONSIBLE PERSON
a. REPORT (U)	b. ABSTRACT (U)	c. THIS PAGE (U)			19b. PHONE NUMBER (include area code)

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

MASTER OF MILITARY ART AND SCIENCE

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

OBESITY AND ARMY READINESS, by Evan T. Trivette, 115 pages.

In the context of the dramatic increase in overweight and obesity prevalence in the United States as well as the global population, the United States Army has likewise noted an increase in the prevalence of obesity among active duty ranks. Using a centrally stored data repository, the Medical Readiness Assessment Tool (MRAT), the researcher obtained health and physical profile data on 15 active duty brigades with a result of 52,435 soldiers, and analyzed the relationship between the variables of rank, body mass index, and medical (limiting) permanent profile data. The assessed population demonstrated a statistically significant relationship between obesity and permanent profiles, both those indicating limitations and significant physical limitations. The assessed population also demonstrated a statistically significant increase in both obesity and permanent profiles with increasing rank. This thesis recommends that the Army adjust the standards and regulations with respect to body weight, body composition, and medical profiling.

ACKNOWLEDGMENTS

First and most importantly I must state that my wife is amazing and I owe her everything for what is good in my life. I appreciate her tolerance of my distraction in pursuit of knowledge and achievement. I would like to thank my parents for raising me to be well adjusted and successful, and to thank my children for being the source of my happiness and sense of meaning. I would like to thank all past, present, and future soldiers, sailors, marines, airmen, and other service members for their service. I am very grateful for the selfless work they have done, are doing and will do for the defense of the nation. I would like to thank Dr. Bitters and Dr. Shanda Lauer for the countless hours of their time they invested with me in analyzing this project data. Finally, I would like to thank my committee members for their guidance and direction and for being very patient with me in pursuing this research.

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ACRONYMS

ANOVA	Analysis of Variance
AR	Army Regulation
ABCP	Army Body Composition Program
AWCP	Army Weight Control Program
BMI	Body Mass Index, measured in kilograms of total body weight per the height in meters squared (kg/m^2)
IAW	In Accordance With
MEB	Medical Evaluation Board
MRAT	Medical Readiness Assessment Tool
PHI	Protected Health Information
PULHES	Physical, Upper, Lower, Hearing, Eyes, Psychiatric (medical profile categories for physical limitations per Army Regulation 40-501. <i>Standards of Medical Fitness</i>)
USARIEM	U.S. Army Institute of Environmental Medicine
VO ₂ max	maximal oxygen uptake, which is measured in milliliters of oxygen used in one minute per kilogram of body weight
WHO	World Health Organization
WHtR	Waist to Height Ratio

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CHAPTER 1

INTRODUCTION

The free man owns himself. He can damage himself with either eating or drinking; he can ruin himself with gambling. If he does he is certainly a damn fool, and he might possibly be a damned soul; but if he may not, he is not a free man any more than a dog

—Gilbert Keith Chesterton, Broadcast talk 6-11-1935

As society has changed over the past 30 to 50 years, it is an inescapable fact that the prevalence of obesity is rising sharply, both in the United States and globally.¹ The most recent available data from 2015-2016, from the Center for Disease Control (CDC), indicate that nearly two out of every five adults (39.8%) and one out of every five adolescents (18.5%) in America is considered obese. These facts have significant implications for the Army because physical fitness is a fundamentally important characteristic of soldiers, and obesity is now the #1 reason for medical disqualification of recruits for service.² Additional to the question of future recruitment is the topic of active soldiers relative to body weight and composition. Although regulations mandate that soldiers maintain a healthy body weight, intending to preclude obesity in the ranks, there has been a significant measured increase in obesity prevalence affecting U.S. Army

¹ Craig M. Hales, Margaret D. Carroll, Cheryl D. Fryar, and Cynthia L. Ogden, *Prevalence of Obesity Among Adults and Youth: United States, 2015–2016*, NCHS Data Brief no. 288 (Hyattsville, MD: National Center for Health Statistics, 2017), accessed 2 October 2018, <https://www.cdc.gov/nchs/data/databriefs/db288.pdf>.

² Marian Tanofsky-Kraff, Tracy Sbrocco, Kelly R. Theim, L. Adelyn Cohen, Eleanor R. Mackey, Eric Stice, Jennifer L. Henderson, Sarah J. McCreight, Edny J. Bryant, and Mark B. Stephens, “Obesity and the U.S. Military Family,” *Obesity* 21, no. 11 (November 2013): 2205-2220, doi:10.1002/oby.20566.

soldiers over the past 17 years.³ The most current data from the Army Public Health Center indicates that in 2018, 17 percent of soldiers were obese.⁴ This sharp rise causes concern for the effect that obesity has on the physical abilities of soldiers.

Obesity, defined as the state of excess adipose tissue mass, is medically diagnosed in adults when one is found to have an obese body mass index (BMI) ≥ 30 , which is determined by weight in kilograms divided by height squared in meters squared. This consensus definition has been adopted by the National Institutes of Health and the World Health Organization among many other organizations.⁵ Some sources further suggest various ethnic specific cutoffs in diagnosing obesity. The condition may also be

³ Andrew Tilghman, “The U.S. Military has a Huge Problem with Obesity and it’s Only Getting Worse,” *The Military Times*, 11 September 2016, accessed 3 November 2018, <https://www.militarytimes.com/news/your-military/2016/09/11/the-u-s-military-has-a-huge-problem-with-obesity-and-it-s-only-getting-worse/>; Andrew Tilghman, “And the Fattest Military Service is...” *The Military Times*, 9 October 2016, accessed 28 February 2019, <https://www.militarytimes.com/news/your-military/2016/10/09/and-the-fattest-u-s-military-service-is/>; Deydre S. Teyhen, *Professional Soldier Athlete: The Cornerstone of Strategic Landpower’s Human Dimension*, The Land Warfare Papers No. 104 (Arlington, VA: The Institute of Land Warfare, Association of the United States Army, October 2014), accessed 9 October 2018, <https://www.ausa.org/publications/professional-soldier-athlete-cornerstone-strategic-landpower’s-human-dimension>; Office of the Surgeon General, *2015 Health of the Force Report: Create a Healthier Force For Tomorrow* (Aberdeen Proving Ground, MD: U.S. Army Public Health Center, November 2015); Office of the Surgeon General, *2017 Health of the Force Report: Create a Healthier Force For Tomorrow* (Aberdeen Proving Ground, MD: U.S. Army Public Health Center, November 2017).

⁴ Office of the Surgeon General, *2018 Health of the Force Report: Create a Healthier Force for Tomorrow* (Aberdeen Proving Ground, MD: U.S. Army Public Health Center, November 2018).

⁵ George A. Bray, William E. Heisel, Ashkan Afshin, Michael D. Jensen, William H. Dietz, Michael Long, Robert F Kushner, Stephen R. Daniels, Thomas A. Wadden, Adam G. Tsai, Frank B. Hu, John M. Jakicic, Donna H Ryan, Bruce M Wolfe, and Thomas H. Inge, “The Science of Obesity Management: An Endocrine Society Scientific Statement,” *Endocrine Reviews* 39, no. 2 (2018): 79-132, doi:10.1210/er.2017-00253.

diagnosed by having either an overweight BMI ≥ 25 kg/m² or an excess waist circumference of 88 centimeters in females or 102 centimeters in males if either or both are found in the presence of comorbid conditions, such as hypertension, metabolic syndrome, dyslipidemia, diabetes or prediabetes, etc. The condition of obesity is important because of the risk of additional health problems and mortality.⁶

Although active duty military personnel have lower rates of obesity than the general population, after leaving military service the risk of obesity increases to that of the general population.⁷ Given the perceived burden of obesity in American society, one concerned about national defense naturally questions what is the impact of obesity on the Army? Implicit in this question is the concept of readiness, with the working definition of readiness being the ability of individuals and units to deploy and accomplish their assigned mission. Some secondary questions include: In the Army of today, what proportion of soldiers in the deployable active force are obese? Does a relationship exist

⁶ National Heart, Lung, and Blood Institute, *Managing Overweight and Obesity: Systematic Evidence Review from the Obesity Expert Panel, 2013* (Bethesda, MD: National Heart, Lung, and Blood Institute, National Institutes of Health, U.S. Dept of Health and Human Services; 2013), <http://www.nhlbi.nih.gov/guidelines>; Dennis L. Kasper, Anthony S. Fauci, Stephen L. Hauser, Dan L. Longo, J. Larry Jameson, Joseph Loscalzo, Cynthia Brown, and Brian Houston, *Harrison's Principles of Internal Medicine*, 19th ed. (New York: McGraw Hill Education, 2015), 2391-2398; National Institutes of Health, *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults—The Evidence Report* (Bethesda, MA: National Institutes of Health, Obesity Research, 1998).

⁷ Justin T. McDaniel, Kate H. Thomas, Caroline M. Angel, Michael S. Erwin, Louis P. Nemec, Brandon B Young, Nicholas J. Armstrong, Blayne P. Smith, and John M. Pinter, "Regional Differences in BMI, Obesity, and Exercise Frequency in a Large Veteran Service Organization: a Secondary Analysis of New Veteran Member Surveys from team red, White & Blue," *Preventive Medicine Reports* 12 (2018): 116-121, doi:10.1016/j.pmedr.2018.09.001.

between obesity and medical limitations, such as are delineated by army medical profiles? Is there a difference between those with some documented limitations as opposed to those with severe, presumably disqualifying limitations? Are there disparities in the impact on obesity in the deployable active force, such as what is the relationship between active duty rank and obesity? Further, given that army regulations are intended to preclude obesity in the ranks, how effective is the army at addressing obesity in soldiers?

In light of these questions, the purpose of this thesis is to explore the interrelationship between obesity, rank, and physical limitations as measured by medical restrictions in the army profile system. Limitations on this study include soldier health parameters outside those reported in the system of record, including any personally identifiable information (PII) or individual health information of any kind, to include those related to medical profile limitations and duty disposition.

Delimitations of this thesis include the causes of obesity in soldiers, the aggregate effect of obesity on retention, the direct attributable fiscal costs, the direct effect of age or gender on the incidence of obesity, the rates at which soldiers gain or lose weight or fat mass, and the explicitly defined effects of obesity on military readiness and deployability.

This thesis will analyze quantitative data about obesity in the U.S. Army and its impact on soldier readiness, association with rank, and physical limitations, which have an inverse relationship with readiness. Although other studies have reviewed the impact of obesity on accession, initial entry training and performance, the author is unaware of any prior research investigating the interrelationship of obesity, rank, and physical limitation. The goal is to determine the impact of obesity on the Army and make

recommendations to address the problem of obesity, improve army readiness and retention, and reduce the prevalence of medically limited soldiers.

CHAPTER 2

LITERATURE REVIEW

In a basic way, unhealthy diet and physical inactivity are well recognized causes of obesity, and physicians have recognized this relationship since the 19th century.⁸ In addition, there are numerous genetic, environmental, and psychosocial factors that affect individual predilections towards weight gain and the development of related health problems. Moreover, the field of nutrition and metabolism is admittedly complex. Ultimately, the stability of body weight for any person over the long-term rests in caloric intake being equal to calories used.

Before the Industrial Revolution and before commercial agriculture became prevalent, most humans throughout history lived near subsistence levels and struggled to consistently secure enough food, living in many cases with the episodic threat of starvation. Advances in technology, agriculture, commerce, and governance as well as in other fields brought about an abundant and consistent food supply, as well as increased the availability of high calorie foods. Human beings, in the absence of an impetus to move, have a defined tendency to conserve energy, and whereas in the past there was a threat of inadequate sustenance, now increasingly modern societies face the ramifications of individuals consuming more energy in food than they expend.⁹ Further, for most

⁸ Anne Berghöfer, Tobias Pischon, Thomas Reinhold, Caroline M. Apovian, Arya M. Sharma, and Stefan N. Willich, "Obesity Prevalence from a European Perspective: A Systematic Review," *BMC Public Health* 8, no. 200 (2008), doi:10.1186/1471-2458-8-200.

⁹ Jens Freese, Rainer Johannes Klement, Begoña Ruiz-Núñez, Sebastian Schwarz, and Helmut Lötzerich, "The Sedentary (R)evolution: Have We Lost Our Metabolic

individuals, loss of excess weight is very difficult. Fewer than 20% of individuals attempting to lose weight are successful in attaining a 10% reduction over a year.¹⁰

The researcher proposes that one should consider obesity as a form of chronic malnutrition. The more conventional medical paradigm is to consider malnutrition as being synonymous with deficiency, either in general intake or in a nutritional component. The authoritative medical textbook *Harrison's Principles of Internal Medicine, 19th edition* (named for Tinsley R. Harrison's, the famous physician and editor of the first five editions) defines primary malnutrition as a condition resulting "from inadequate or poor-quality food intake"¹¹ and secondary malnutrition as a condition arising from diseases that "alter food intake or nutrient requirements, metabolism, or absorption."¹² One pictures images of people emaciated by calorie malnutrition (marasmus) or children with swollen abdomens characteristic of protein malnutrition (kwashiorkor). Obesity however can be just as medically damaging in terms of health and function of human bodies, and the negative health effects of overnutrition and lack of physical activity are well established.

Flexibility?" *F1000Research* (2 October 2017), last updated 2 February 2018, doi:10.12688/f1000research.12724.2.

¹⁰ Paul S. Maclean, Audrey Bergouignan, Marc-Andre Cornier, and Matthew R. Jackman, "Biology's Response to Dieting: The Impetus for Weight Regain, *American Journal of Physiology. Regulatory, Integrative and Comparative Physiology* 301, no. 3 (2011): R581-600.

¹¹ Kasper et al., *Harrison's Principles of Internal Medicine*, 459-465.

¹² Ibid

Far from being simply a cosmetic issue, there are numerous and serious health problems attributable to or influenced by obesity. As early as the sixth century BC the Indian Physician Sushruta, who authored an ancient medical treatise more than a century before the more widely known Greek Physician Hippocrates, noted an interrelation between obesity, diabetes and heart disease.¹³ The medical complications of obesity include, among others, hypertension, type 2 diabetes, cardiovascular diseases, cerebrovascular diseases, sleep apnea, back pain, osteoarthritis, non-alcohol-related fatty liver infiltration, kidney diseases, malignancies, and psychosocial disturbances.¹⁴ Largely because of the increase in obesity the Centers for Disease Control (CDC) and Prevention now estimated that 9.4% of the U.S. population in 2015 had diabetes.¹⁵ Further, overweight and obesity, along with physical inactivity, have a known adverse impact on physical performance. The conditions of overweight and obesity have progressive effects related to their severity, and obesity limits strenuous activity notably before physical disease of comorbidities occur.¹⁶

¹³ Dimpymoni Saikia, Sultana Jesmin Ahmed, Hiranya Saikia, and Ratna Sarma, “Body Mass Index and Body Fat Percentage in Assessing Obesity: An Analytical Study Among the Adolescents of Dibrugarh, Assam,” *Indian Journal of Public Health* 62, no. 4 (2018): 277-228, doi: 10.4103/ijph.IJPH_24_18.

¹⁴ Hatim A. Omar and Donald E. Greydanus, eds., *Obesity and Adolescence- A Public Health Concern* (Nova Science Publishers, Incorporated, 2009), ProQuest Ebook Central, accessed 5 February 2019, <https://ebookcentral.proquest.com/lib/carl-ebooks/detail.action?docID=3020637>.

¹⁵ Centers for Disease Control and Prevention, *National Diabetes Statistics Report, 2017* (Atlanta, GA: Centers for Disease Control and Prevention, U.S. Department of Health and Human Services, 2017).

¹⁶ Teyhen, *Professional Soldier Athlete*.

The Army Regulation (AR) 600-9 Army Weight Control Program (AWCP) seeks to promote a healthy weight in soldiers by establishing policies and procedures for addressing weight, and establishes standards for body fat percentages. Its primary objective is to: “ensure that all personnel are able to meet the physical demands of their duties under combat conditions, and present a trim military appearance at all times.”¹⁷ The AWCP objectives are further listed as assisting in establishing and maintaining discipline, readiness, physical fitness, health, and effectiveness of army personnel through proper weight control.¹⁸

The Army Weight Control stipulates in chapter 2-13 that individuals:

Each Soldier (commissioned officer, warrant officer, and enlisted) is responsible for meeting the standards prescribed in this regulation. To assist Soldiers in meeting these responsibilities, screening tables will continue to be prescribed for use as is currently being done. A 5 percent zone below the screening table weight ceiling is suggested as a help to Soldiers in targeting their personal weight at a level that will minimize the probability of exceeding the screening table weight ceiling as a matter of habit. Soldiers will be coached to select their personal weight goals within or below the 5 percent zone and to strive to maintain that weight through adjustment of life style and fitness routines. A Soldier who consistently exceeds the personal weight goal will be encouraged to seek the assistance of designated unit fitness trainer or training NCO for advice in proper exercise and fitness and health care personnel for a proper dietary program. In other words, exceeding a properly selected goal will “trigger” the Soldier to use the substantial help available to alter the fitness and dietary behavior before confronting the finality of the screening table and initiation of official action if the body fat standards are exceeded.¹⁹

¹⁷ Headquarters, Department of the Army (HQDA), Army Regulation (AR) 600-9, *The Army Body Composition Program* (Washington, DC: Government Publishing Directorate, 28 June 2013), 1.

¹⁸ *Ibid.*, 2.

¹⁹ *Ibid.*

The regulation presumes that soldiers below threshold weight for height, known as table screening weight, meet standards for body composition. The table screening weights proscribed in AR 600-9 generally correspond to mid-overweight ranges of a soldier's body mass index (BMI). BMI is a widely used measure of body size and is used by the World Health Organization to classify overweight and obesity, as stated earlier, is obtained by taking a person's weight in kilograms divided by their height in meters squared.²⁰

Sub-classification of BMI is commonly performed using World Health Organization (WHO) standards for BMI, individuals who are considered underweight have a BMI<18.5, while normal weight individuals have a BMI between 18.5 and 25. For overweight individuals BMI will fall between 25 and 30. For obese individuals, Class I obesity occurs with BMI >30 but less than 35, while Class II or severe obesity will have BMI>35 less than 40, and individuals with Class III or morbid obesity will have BMI>40.²¹

AR 600-9 *The Army Body Composition Program*, table screening weights generally correspond to BMI levels between 26 and 27.5 kg/m² (See Table 1). In Table 1 Screening Table Weight, we see the specific weight for height cutoff prescribed by AR 600-9 as screening table weights. When a soldier exceeds his or her screening table

²⁰ Hales, et al., *Prevalence of Obesity Among Adults and Youth*.

²¹ Won Kyoung Cho, Kyungdo Han, Moon Bae Ahn, Yong-Moon Park, Min Ho Jung, Byung-Kyu Suh, and Yong-Gyu Park, "Metabolic Risk Factors in Korean Adolescents with Severe Obesity: Results from the Korea National Health and Nutrition Examination Surveys (K-NHANES) 2007-2014," *Diabetes Research and Clinical Practice* 138 (2018): 169-176, doi:10.1016/j.diabres.2018.01.030.

weight based on height, the regulation states that commanders assess these soldiers for body fat percentage using the tape test. In performing the tape test, waist, neck and height measurements are used in the estimation of body fat percent in men, and in women the waist, hips, neck and height measurements are used.²² In both males and females, neck circumference is subtracted from the other measurements to determine a “circumference value” that is used in a standardized table B5 for males and B6 for females in AR 600-9.

Soldiers of different ages and genders have different allowable body fat standards, within four age categories. The age ranges cover ages 17-20, 21-27, 28-39, and 40 years and over, with increases of 2% allowable percent body fat for each age category. Females in every age category are authorized 10% higher body fat than males, thus standards range from 20% body fat for 17-20-year-old males and 36% body fat for females age 40 years and older.²³ However, the regulation also states that regarding body composition all personnel are encouraged to achieve the more stringent Department of Defense goal, which is 18 percent body fat for males and 26 percent body fat for females.

²² HQDA, AR 600-9, 14-39.

²³ Ibid., 1.

Screening Table Weight

Table 3–1
Weight for height table (screening table weight)

Height (in inches)	Minimum weight (in pounds)*	Male weight in pounds, by age				Female weight in pounds, by age			
		17–20	21–27	28–39	40+	17–20	21–27	28–39	40+
58	91	—	—	—	—	119	121	122	124
59	94	—	—	—	—	124	125	126	128
60	97	132	136	139	141	128	129	131	133
61	100	136	140	144	146	132	134	135	137
62	104	141	144	148	150	136	138	140	142
63	107	145	149	153	155	141	143	144	146
64	110	150	154	158	160	145	147	149	151
65	114	155	159	163	165	150	152	154	156
66	117	160	163	168	170	155	156	158	161
67	121	165	169	174	176	159	161	163	166
68	125	170	174	179	181	164	166	168	171
69	128	175	179	184	186	169	171	173	176
70	132	180	185	189	192	174	176	178	181
71	136	185	189	194	197	179	181	183	186
72	140	190	195	200	203	184	186	188	191
73	144	195	200	205	208	189	191	194	197
74	148	201	206	211	214	194	197	199	202
75	152	206	212	217	220	200	202	204	208
76	156	212	217	223	226	205	207	210	213
77	160	218	223	229	232	210	213	215	219
78	164	223	229	235	238	216	218	221	225
79	168	229	235	241	244	221	224	227	230
80	173	234	240	247	250	227	230	233	236

Notes:

* Male and female Soldiers who fall below the minimum weights shown in table 3–1 will be referred for immediate medical evaluation.

¹ Height will be measured in stocking feet (without shoes), standing on a flat surface with the chin parallel to the floor. The body will be straight but not rigid, similar to the position of attention. The measurement will be rounded to the nearest inch with the following guidelines: If the height fraction is less than 1/2 inch, round down to the nearest whole number in inches; if the height fraction is 1/2 inch or greater, round up to the next highest whole number in inches.

² Weight will be measured and recorded to the nearest pound within the following guidelines: If the weight fraction is less than 1/2 pound, round down to the nearest pound; if the weight fraction is 1/2 pound or greater, round up to the next highest pound.

³ All measurements will be in a standard PT uniform (gym shorts and T-shirt, without shoes).

⁴ If the circumstances preclude weighing Soldiers during the APFT, they will be weighed within 30 days of the APFT.

⁵ Add 6 pounds per inch for males over 80 inches and 5 pounds for females for each inch over 80 inches.

Source: Headquarters, Department of the Army, Army Regulation 600-9, *The Army Body Composition Program* (Washington, DC: Government Publishing Directorate, 28 June 2013), 4.

Despite these stipulations, based on publications of senior noncommissioned officers, opinions among senior leaders regarding the Army Body Composition Program (previously Army Weight Control Program) and the topic of obesity seem mixed. A published after-action review of a senior noncommissioned officer selection board found, “significant trends where the NCO (sic) consistently struggled to maintain physical

fitness standards,”²⁴ particularly as they pertained to body weight and composition. Multiple sources noted that the provisions of the Army Regulation (AR) 600-9 Army Body Composition Program (ABCP) are neither consistently nor evenly enforced. One representative source who wrote while attending the Sergeants Major Academy noted, “We also have senior leaders in key positions who are not IAW (In accordance with) AR 600-9.”²⁵

The same source, Sergeant Major (SGM) Keith Carmickle, noted that leaders mandated the removal of flags from overweight soldiers so that they could deploy, a practice, which at the time, he infers was due to manpower shortages. This would contravene the prescriptions of AR 600-9 Chapter 3-2 subparagraph e: “Soldiers identified as exceeding the body fat standard will be flagged in accordance with AR 600-8-2 and enrolled in the ABCP. They must meet the body fat standard in this regulation in order to be released from the program.”²⁶ The Army Regulation 600-8-2 Suspension of Favorable Personnel Action states that the purpose of a Flag is to “Prevent or preclude the execution of favorable actions to a Soldier who may be in an unfavorable status (not in good standing)” as well as to administratively prevent movement or transfer of a

²⁴ Secretariat for Department of the Army Selection Boards, (2016), Memorandum, Subject: Field After Action Report - Fiscal Year 2016 (FY16) Regular Army (RA) and Army Reserve Active Guard Reserve (AGR) Sergeant First Class (SFC) Promotion Board, accessed 18 September 2018, <https://www.hrc.army.mil/>.

²⁵ Keith D. Carmickle, “The Ethical Dilemma of the Army Overweight Program,” (Paper, United States Army Sergeants Major Academy, Fort Bliss, TX, 3 January 2008).

²⁶ HQDA, AR 600-9, 1.

soldier.²⁷ Soldiers who fail to lose weight while enrolled in the Army Body Composition Program are subject to administrative separation under Chapter 18 Army Regulation 635-200 Active Duty Enlisted Administrative Separations,²⁸ and for national guard and reserve soldiers under Chapter 15 Army Regulation 135-178 Administrative Enlisted Separations.²⁹ A flag in other words is an unfavorable personnel action that, although not punitive in design or intent, is generally viewed by soldiers as punishment, and the complaint of CSM Carmickle was that leaders were inconsistent in the application of the regulation.

To understand these shortages, it is important to note that during the years of frequent combat deployments to Iraq and Afghanistan the Army struggled to meet manning requirements. From 2005 to 2008, recruiting shortfalls forced the Army to lower its entrance standards to meet force demands, specifically including a 16 percent drop in high school graduates as well as a 7 percent reduction in highly qualified recruits as determined by the Armed Forces Qualifying Test (AFQT).³⁰ The Armed Forces

²⁷ Headquarters, Department of the Army (HQDA), Army Regulation (AR) 600-8-2, *Suspension of Favorable Personnel Action* (Washington, DC: Government Publishing Directorate, 11 May 2016).

²⁸ Headquarters, Department of the Army (HQDA), Army Regulation (AR) 635-200, *Active Duty Administrative Enlisted Separations* (Washington, DC: Government Publishing Directorate, 19 December 2016).

²⁹ Headquarters, Department of the Army (HQDA), Army Regulation (AR) 135-178, *Administrative Enlisted Separations* (Washington, DC: Government Publishing Directorate, 7 November 2017).

³⁰ Colby K. Krug, "Sustaining the Quality of the All-Volunteer Force: A Cost-Effective Approach," (Monograph, School of Advanced Military Studies, U.S. Army Command and General Staff College, Fort Leavenworth, KS, 26 May 2016).

Qualification Test is used to assess the trainability of potential recruits in assessing Word Knowledge, Arithmetic Reasoning, Paragraph Comprehension and Mathematics Knowledge. Test Score Categories I to IIIA are those who score in the top half of test takers, and these are considered high quality recruits, whereas those scoring in the bottom 10-30% are Category IV and are less likely to successfully complete their term of service. Those scoring below 10 percent, the Category V, are considered disqualified based on low aptitude.

Parallel to the decrease in recruiting standards, one may note that the many, rapid and repeated mobilizations for the conflicts in Iraq and Afghanistan correlate with a rapid rise in obesity in the force. The *Military Times*, a publication with an intended audience of active duty service members, noted in a 2016 article that prior to the War on Terror, only 1.6% of soldiers were obese,³¹ while another source stated that for the same period 2.3% of soldiers were obese.³² Subsequently however, the prevalence of obesity in the ranks rose sharply. According to the *Health of the Force* 2015 report authored by the Office of the Surgeon General, 13% of the Army assessed as obese and obesity rates ranged from 9 to 18% across different installations.³³ Two years later, that number increased to 17.3% of active duty soldiers obese by height and weight data.³⁴ As the

³¹ Tilghman, “The U.S. Military has a Huge Problem with Obesity and it’s Only Getting Worse.”

³² Anthony L. Hunsaker, “Army Obesity is a Problem,” (Paper, United States Army Sergeants Major Academy, Fort Bliss, TX, 28 November 2016).

³³ Surgeon General, *2015 Health of the Force Report*, 49.

³⁴, Surgeon General, *2017 Health of the Force Report*, 27.

Army struggled to recruit and retain soldiers, one apparent explanation is that leaders became more permissive in the enforcement and maintenance of body composition standards.

From the perspective of SGM Carmickle, however, body composition became far less important than individual physical strength in terms of whom would be functional in combat. His point is relevant in that there is significant individual variance in the relationship between weight and physical fitness. The underlying argument of SGM Carmickle's paper is that if leaders determine a soldier fit enough to deploy and fight, it would be unfair and imprudent to separate the same soldier based on body weight. This is particularly so given that it is possible for individuals with low fitness and low musculoskeletal mass and proportionately high fat to in many cases meet weight standards that other fitter, larger soldiers fail. Supporting this contention is the Institute of Medicine Committee on Military Nutrition Research finding that among service members, "Within the range of body composition exhibited by current military personnel, there is no consistent relationship between body fat content and physical performance."³⁵

Although criteria vary, medical and fitness literature generally acknowledge multiple distinct domains which qualify and confer the condition of fitness. Proponents of CrossFit for example promote 10 fitness criteria that include cardiovascular or respiratory endurance, stamina, strength, flexibility, power, speed, coordination, agility, balance and

³⁵ Karl E. Friedl, "Body Composition and Military Performance: Origins of The Army Standards," in *Body Composition and Physical Performance: Applications For the Military Services*, ed. U.S. Institute of Medicine Committee on Military Nutrition Research, B. M. Marriott, and J. Grumstrup-Scott (Washington, DC: National Academies Press, 1990), accessed 25 April 2019, <https://www.ncbi.nlm.nih.gov/books/NBK235960/>.

accuracy.³⁶ These criteria have direct military applicability particularly as they pertain to the 10 physical movements that Training and Doctrine Command (TRADOC) has identified as critical for all soldiers: lifting from the ground, lifting overhead, pushing, pulling/climbing, rotation, jumping and landing, lunging, marching, running, and changing direction.³⁷ Both an understanding of fitness principles and an appreciation of the physical requirements of soldiering stress the need to maintain physical fitness in soldiers by a judicious army leadership.

That an individual can have both physical fitness and obesity is an important concept; this is known as the Fat-Fit Paradox.³⁸ SGM Carmickle's previously noted argument, while cogent, makes the assumption that body weight and physical fitness are independent variables. A significant body of evidence and medical literature, however, relates body composition, health, and physical fitness. These variables affect each other in a much more complex manner to where there is, in fact, a very significant interrelationship between body composition, health and fitness.

At least since World War II there has been concern about the physical fitness of the American soldier; it was no less than General of the Army Omar Bradley, First

³⁶ Darren P. Bemis, "The Air Force Fitness Program and the Challenge of Creating a More Fit Force," (Master's thesis, U.S. Army Command and General Staff College, Fort Leavenworth, KS, 8 June 2012).

³⁷ C. Thomas Lowman, "Does Current Army Physical Fitness Training Doctrine Adequately Prepare Soldiers for War?" (Master's thesis, U.S. Army Command and General Staff College, Fort Leavenworth, KS, 11 June 2010).

³⁸ Kathy Do, Ruth Brown, Sean Wharton, Chris I. Ardern, Jennifer L. Kuk, "Association Between Cardiorespiratory Fitness and Metabolic Risk Factors in a Population with Mild to Severe Obesity," *BMC Obesity* 5, no. 5 (2018), doi:10.1186/s40608-018-0183-7.

Chairman of the Joint Chiefs of Staff, who during the invasion of Normandy as the Commander of First Army observed and remarked upon a lack of overall fitness among army soldiers.³⁹ Furthermore, since the American Civil War, leaders have argued for improvements in soldier fitness. As one source noted: “Every war in which the U.S. has been involved since 1860 has revealed the physical deficiencies of our soldiers during the initial mobilization . . . casualties in initial engagements were attributed to the inability of our soldiers to physically withstand the rigors of combat.”⁴⁰ In parallel to this, we see more recent modern military thinkers expressing concern for soldier fitness. As a scholar of advanced military studies noted over 20 years ago, “The sedentary nature of the post-industrial age has created a society less physically fit.”⁴¹

From a historical perspective of the past half century, on 30 November 1976 the Army instituted the fourth revision of the Army Physical Fitness Program, which included the Army Weight Control Program.⁴² National leaders revisited the topic in 1980 when President Carter directed the commission of the Study of the Military Services Physical Fitness, which was completed in 1981. The result of these reports was

³⁹ Bemis, “The Air Force Fitness Program and the Challenge of Creating a More Fit Force,” 10-11.

⁴⁰ Teyhen, *Professional Soldier Athlete*.

⁴¹ Mark R., Forman, “Too Fat to Fight-Too Weak to Win, Soldier Fitness in the Future?” (Monograph, School of Advanced Military Studies, U.S. Army Command and General Staff College, Fort Leavenworth, KS, 22 January 1997).

⁴² Whitfield B. East, *A Historical Review and Analysis of Army Physical Readiness Training and Assessment* (Fort Leavenworth, KS: U.S. Army Combined Arms Center, Combat Studies Institute Press, 2013), accessed 2 October 2018, <http://www.dtic.mil/dtic/tr/fulltext/u2/a622014.pdf>.

the issuance of Department of Defense (DOD) directive 1308.1, *DoD Physical Fitness and Body Fat Program*, in 1981, which required that services assess for obesity using body fat as a metric.⁴³ Historically, the Army developed height and weight standards to prevent malnourished recruits or those with inadequate muscular and skeletal mass from admission. Concern for obesity has been a relatively new problem.

In 1982 and in the wake of these findings and directives, General Glenn K. Otis, Commander of Army Training and Doctrine Command (TRADOC), established the Army Physical Fitness Research Institute (APFRI) at the Army War College.⁴⁴ Additionally, in 1982 the Army published standards on body fat percentage, with sources attributing this to the interrelation between body composition and cardiorespiratory performance measured by maximal oxygen uptake (VO₂max), which is measured in milliliters of oxygen used in one minute per kilogram of body weight.⁴⁵ This measure is an assessment of individual aerobic fitness and is observed to decrease with increasing percent body fat, but does not correlate well to muscular fitness.⁴⁶

In studying army recruits, James A. Vogel, Director, Occupational Health and Performance, U.S. Army Institute of Environmental Medicine (USARIEM) found that the average VO₂max for new recruits was 51 ml/kg/min in males and 37 ml/kg/min in females, the difference between which appears to have been used to justify excluding

⁴³ Friedl, “Body Composition and Military Performance.”

⁴⁴ East, *A Historical Review and Analysis of Army Physical Readiness Training and Assessment*, 158.

⁴⁵ Forman, “Too Fat to Fight-Too Weak to Win, Soldier Fitness in the Future?”

⁴⁶ Ibid.

females from combat arms military occupational specialties (MOS).⁴⁷ In addition to gender differences in VO₂max, there have been found to be significant differences directly attributable to body mass. A study of twins who had diverging body mass index found that objectively measured VO₂max was significantly lower in the heavier twins, indicating a weight related reduction of aerobic capacity independent of other factors.⁴⁸ This evidence supports the perspective that although adequate lean mass is important in muscular strength, increasing body mass has an adverse effect on cardiovascular fitness.

In review of the literature, it is important to note that most sources rely on the World Health Organization definition of obesity, which is a body mass index (BMI) of $>30 \text{ kg/m}^2$. That this measure does not directly measure body composition has led to criticism of its applicability in the military population.⁴⁹ Other research in the International Journal of Obesity has noted that use of BMI to test for excess adiposity has good specificity, but poor sensitivity for obesity.⁵⁰ It goes on to note that “Studies assessing correlation between BMI and body fat have shown that people with

⁴⁷ Forman, “Too Fat to Fight-Too Weak to Win, Soldier Fitness in the Future?”

⁴⁸ Bram Berntzen, Sakari Jukarainen, M. Kataja, A. Hakkarainen, J. Lundbom, N. Lundbom, T. Tammelin, R. Simonen, P. Piirilä, A. Rissanen, J. Kaprio, E. J. Paavonen, and K. H. Pietiläinen, “Physical Activity, Cardiorespiratory Fitness, and Metabolic Outcomes in Monozygotic Twin Pairs Discordant for Body Mass Index,” *Scandinavian Journal of Medicine and Science in Sports* 28, no. 3 (March 2018): 1048-1055, doi:10.1111/sms.12975.

⁴⁹ Tilghman, “And the Fattest Military Service is....”

⁵⁰ D. O. Okorodudu, M. F. Jumeau, Victor Manuel Montori, A. Romero-Corral, Virend Somers, P. J. Erwin, and Francisco Lopez-Jimenez, “Diagnostic Performance of Body Mass Index to Identify Obesity as Defined by Body Adiposity: A Systematic Review and Meta-Analysis,” *International Journal of Obesity* 34, no. 5 (2 February 2010): 791-799, doi:10.1038/ijo.2010.5.

intermediate BMI values represent a heterogeneous group regarding body fat content, some with preserved lean mass . . . whereas others have high body fat and limited lean mass or so-called “normal weight obese.”⁵¹

Subsequently, although BMI is easily measured it does not distinguish between fat mass and non-fat mass in individuals, and it is generally recognized by the medical community that measures of adipose, or fat tissue, content estimating body fat percentage provide a better indication of medical risk.⁵² This is particularly true with central or abdominally distributed fat tissue, because visceral fat is recognized as being metabolically more dangerous than peripherally distributed fat.⁵³ There is no consensus definition as to what body fat percent makes someone obese, and different ethnicities have different suggested cutoffs or recommendations. One commonly used cutoff for obesity by body fat percentage is a body fat percentage >25% in males and >30% in females, which is also used by The Institute of Medicine (IOM) Committee on Military Nutrition Research.⁵⁴

Whereas BMI calculation is a relatively straightforward calculation based on height and weight, the estimation of body fat percentage varies by methodology and is

⁵¹ Okorodudu et al., “Diagnostic Performance of Body Mass Index to Identify Obesity as Defined by Body Adiposity,” 791-799.

⁵² Saikia et al., “Body Mass Index and Body Fat Percentage in Assessing Obesity,” 277-281.

⁵³ Kasper et al., *Harrison’s Principles of Internal Medicine*.

⁵⁴ William F. Barko and Mark A. Vaitkus, eds, *U.S. Army War College Guide to Executive Health and Fitness* (Carlisle, PA: U.S. Army Physical Fitness Research Institute, August 2000), accessed 9 October 2018 <https://www.cdc.gov/nccdphp/dnpa/usphs/pdfs/army.pdf>.

more complex. The assessment of excess body fat percent is important because, regardless of weight or BMI, excess body fat percentage has an association with metabolic dysregulation and the health risks previously discussed with obesity.⁵⁵

The Army conducts body fat estimation using the tape test discussed previously on page 11; however, for many years the adequacy of this method has been in question. Specifically, investigators at APFRI and the IOM Committee on Military Nutrition Research had concern that then current methods of estimation could fail to identify some soldiers physically unfit (Endomorphs) as out of standard and could also result in heavy, but fit/muscular soldiers identified as not meeting standard. In other words, light but weak soldiers would be favored over strong but heavy soldiers, which could perversely favor the less fit over the more fit individuals.

This concern did not go unnoticed by the principle investigators into military fitness. With lean body mass or non-fat mass being responsible for force generation, individuals of the same BMI but different body composition will have significantly different physical strength.⁵⁶ As the committee on military nutrition research noted: “current body fat standards draw a precise line, without confidence intervals, for acceptable fatness; these standards take into account neither the strength of the association between body fat and military performance nor the reliability of the method of estimation.”⁵⁷

⁵⁵ Okorodudu, et al, “Diagnostic Performance of Body Mass Index to Identify Obesity as Defined by Body Adiposity,” 792.

⁵⁶ Forman, “Too Fat to Fight-Too Weak to Win, Soldier Fitness in the Future?”

⁵⁷ Friedl, “Body Composition and Military Performance.”

That the tape test as administered seems to have a significant false negative rate appears well established in a review of the literature. Complicating the issue is that there is a lack of a consensus definition of what cutoff value for percent body fat qualifies an individual as obese.⁵⁸ Recent data support this, as although nearly half of army soldiers exceeded authorized screening table weight. Of those over authorized weight only 10% were flagged, or identified as overweight, by their leadership.⁵⁹ As the Institute of Medicine Committee on Military Nutrition Research suggested, “the reliability of the method of estimation” for the tape test is called into question. If record numbers of soldiers are obese by height and weight calculations, why are commanders not issuing flags for overweight when soldiers are assessed for excess body fat by the tape test? A possibility may be that although a soldier with excess body fat percentage may be overweight, and in some cases very overweight, by height and weight standards, that soldier may not be being marked as failing body composition on the tape test, i.e. a false negative measure.

Some in the military, such as Sergeants Major Academy student Master Sergeant (MSG) Steve Minyard, believe that the scope of this inconsistency is not accidental, but is “a pattern of deliberate variance...indicating manipulation to meet the standards of Army Regulation 600-9.”⁶⁰ MSG Minyard concluded in his paper that when

⁵⁸ Richard N. Baumgartner, Steven B. Heymsfield, Alex F. Roche, “Human Body Composition and the Epidemiology of Chronic Disease,” *Obesity Research* 3, no. 1 (1995): 73-95.

⁵⁹ Surgeon General, *2017 Health of the Force Report*.

⁶⁰ Steve Minyard, “Dishonest Evaluations: An Ethics-Based Approach,” (Paper, United States Army Sergeants Major Academy, Fort Bliss, TX, 7 February 2017).

inconsistencies such as soldiers having progressively taller heights recorded occurs, it indicates a widespread willingness to tell “white lies.”⁶¹ This willingness to break regulations and/or mislead is due to a phenomenon known as ethical fading. Ethical fading is the involuntary blinding of a person to the ethical components of a decision by focusing on other aspects of a choice, and MSG Minyard argues it negatively impacts the Army by hiding those who fail standards, proliferating the obesity problem, and allowing for an environment of hypocrisy. Hypocrisy is of concern both because the standard may not be equally implemented across ranks, as well as that the Army espouses and promulgates standards it fails to enforce.

Nor should the issue of standard application with respect to body mass be viewed as purely an Army problem either, as the U.S. Air Force has also noted problems with reporting standards in high weight-for-height service members. When the air force hired an independent fitness company, the Fitness Assessment Cell, to audit height and weight data for a sample population of airmen, the auditors found that airman who fellow airmen reported as marginal passing had an average of three inches larger waist circumference than had been reported.⁶²

In the medical community is generally beyond dispute that there are significant negative health consequences of both obesity and physical inactivity. Physical inactivity, or sedentary habits, have been shown to increase body fat percentage, body mass index,

⁶¹ Minyard, “Dishonest Evaluations.”

⁶² Bemis, “The Air Force Fitness Program and the Challenge of Creating a More Fit Force,” 10-11.

and reduced physical fitness when comparing those who exercise and those who do not.⁶³

Low physical fitness also increases the prevalence of post-traumatic stress symptoms, anxiety and depression.⁶⁴ Physical inactivity and low cardiorespiratory fitness confer significant risk of mortality⁶⁵ and today, the fourth leading global mortality risk factor is physical inactivity.⁶⁶ Closely related to obesity is the term cardiometabolic syndrome, or metabolic syndrome, and physical inactivity is a major factor in the increasing prevalence of obesity,⁶⁷ and in developing metabolic syndrome, which estimates claim to affect 20-30% of the world's population. Components of metabolic syndrome include atherogenic dyslipidemia (high blood cholesterol and lipids that predispose to blood vessel injury and plaque formation), high blood pressure, insulin resistance, high blood glucose, obesity,

⁶³ Korcz Agata and Makama a Monyeke, "Association Between Sport Participation, Body Composition, Physical Fitness, and Social Correlates Among Adolescents: The PAHL Study," *International Journal of Environmental Research and Public Health* 15, no. 12 (2018): 2793. doi:10.3390/ijerph15122793.

⁶⁴ Allen D. Leth, "The Relationship Between Post-Traumatic Stress and Physical Fitness and the Impact of Army Fitness Policy on Post-Traumatic Stress Prevention," (Master's thesis, U.S. Army Command and General Staff College, Fort Leavenworth, KS, 12 June 2009).

⁶⁵ Ming Wei, MD, Larry W. Gibbons, PhD, James B. Kampert, MD, Milton Z. Nichaman, MD and Steven Blair, PED, "Low Cardiorespiratory Fitness and Physical Inactivity as Predictors of Mortality in Men with Type 2 Diabetes," *Annals of Internal Medicine* 132, no. 8 (April 2000): 605-611, accessed 28 February 2019, <https://annals.org/aim/article-abstract/713389/low-cardiorespiratory-fitness-physical-inactivity-predictors-mortality-men-type-2>.

⁶⁶ Ismet Kazaz, Ender Angin, Seray Kabaran, Gozde Iyigun, Berkiye Kirmizigil, and Mehtap Malkoc, "Evaluation of the Physical Activity Level, Nutrition Quality, and Depression in Patients with Metabolic Syndrome," *Medicine* 19, no. 18 (2018), doi:10.1097/MD.00000000000010485.

⁶⁷ Omar and Greydanus, *Obesity and Adolescence- A Public Health Concern*.

and abdominal obesity.⁶⁸ Metabolic syndrome is a major risk factor for the development of diabetes and other medical problems.⁶⁹ Further, metabolic syndrome is significant because it confers two to five times the risk of cardiovascular disease and events compared to individuals without it.⁷⁰ This syndrome is observed mostly in individuals with unhealthy nutrition habits, insufficient physical activity and that are under stress. In a comparative study of metabolic syndrome and non-MetS patients in North Cyprus, the study found that 81% of metabolic syndrome patients were physically inactive whereas only 22% of non-MetS patients were physically inactive. The study concludes there is significant attributable risk of metabolic syndrome due to physical inactivity and that an active lifestyle can help protect against metabolic syndrome.

The rising prevalence of obesity in our nation can be expected to affect service members, as a family history of obesity strongly correlates with an individual becoming

⁶⁸ Ambrish K. Srivastava, "Challenges in the Treatment of Cardiometabolic Syndrome," *Indian Journal of Pharmacology* 44, no. 2 (March 2012): 155-156, doi:10.4103/0253-7613.93579.

⁶⁹ Katsutaro Morino, Kitt Falk Petersen, and Gerald I. Shulman, "Molecular Mechanisms of Insulin Resistance in Humans and Their Potential Links with Mitochondrial Dysfunction," *Diabetes* 55, no. 2 (2006): S9-S15; Abbas E. Kitabchi, Marinella Tempresa, William Knowler, Steven Kahn, Sarah Fowler, Steven Haffner, Reuben Andres, Christopher Staudek, Sharon Edelstein, Richard Arakaki, Mary Beth Murphy, and Harry Shamoon, "Role of Insulin Secretion and Sensitivity in the Evolution of Type 2 Diabetes in the Diabetes Prevention Program: Effects of Lifestyle Intervention and Metformin," *Diabetes* 54, no. 8 (2005): 2404-2414.

⁷⁰ Christian K. Roberts, Andrea L. Hevener, R. James Barnard, "Metabolic Syndrome and Insulin Resistance: Underlying Causes and Modification by Exercise Training," *Comprehensive Physiology* 3 no. 1 (January 2013): 1-58, doi:10.1002/cphy.c110062.

obese.⁷¹ Ongoing research supports rising obesity prevalence in the Army as a reflection of a more obese society. A recent RAND corporation study found 69.4% of currently serving soldiers were overweight or obese.⁷² These results were from survey data and not direct measurement. As such, these rates of overweight and obesity are based on BMI computation from height weight and not measured body fat percentage, as previously discussed. The RAND study noted that in terms of physical health 48.9% of soldiers reported a functional impairment in occupational, social, or family domains; however, the study did not detail if or how obesity and functional impairment were interrelated.⁷³

The topic of body composition and fitness was extensively studied in the 1980s and early 1990s by the Military Nutrition Division of the U.S. Army Institute of Environmental Medicine (USARIEM) in Natick, Massachusetts.⁷⁴ The 1992 National Academy of Sciences report had extensively and authoritatively reviewed the topic of body composition and found lean body mass a better predictor of strength and physical

⁷¹ Maria Elena Romero-Ibarguengoitia, Felipe Vadillo-Ortega, Augusto Enrique Caballero, Isabel Ibarra-Gonzalez, Arturo Herrera-Rosas, Maria Fabiola Serratos-Canales, Mireya Leon-Hernandez, Antonio Gonzalez-Chavez, Srinivas Mummidi, Ravindranath Duggirala, and Juan Carlos Lopez-Alvarenga, “Family History and Obesity in Youth, Their Effect on Acylcarnitine/Amino Acids Metabolomics and Non-Alcoholic Fatty Liver Disease (NAFLD) Structural Equation Modeling Approach,” *PLoS ONE* 13, no. 2 (2018), doi:10.1371/journal.pone.0193138.

⁷² Sarah O. Meadows, Charles C. Engel, Rebecca L. Collins, Robin L. Beckman, Matthew Cefalu, Jennifer Hawes-Dawson, Molly Doyle, Amii M. Kress, Lisa Sontag-Padilla, Rajeev Ramchand, and Kayla M. Williams, *Are They Living Healthy? How Well Are Soldiers Taking Care of Themselves?* (Santa Monica, CA: RAND Corporation, 2018), accessed 2 February 2019 <https://www.rand.org/pubs/infographics/IG129z4.html>.

⁷³ Ibid.

⁷⁴ Friedl, “Body Composition and Military Performance.”

performance than body fat mass, and that excess body weight negatively affected running performance. The report stressed the importance of adequate lean mass and physical performance capability over body composition, but did note that there are negative health consequences of increased body fat.⁷⁵

Understanding that obesity and overweight have negative effects on health and fitness, it is important to try to understand the effect that this problem has had on the United States Army recently. COL Deydre S. Teyhen, Lead for the System for Health & Performance Triad, Office of the Surgeon General, noted in the October 2014 Land Warfare Paper on the professional soldier athlete that, despite standards intended to counteract overweight and obesity, based on her data 12% of soldiers were clinically obese.⁷⁶ These findings were consistent with other contemporaneous sources, as data from the following year found that roughly 6.4% of female soldiers and 13.5% of male soldiers met criteria for obesity.⁷⁷ In contrast to prior research, particularly in the 80s and 90s, which did not find a consistent relationship between body composition and physical performance, subsequent research found that overweight recruits were more prone to injury and had a higher utilization of healthcare resources than normal weight recruits.

⁷⁵ Friedl, "Body Composition and Military Performance."

⁷⁶ Teyhen, *Professional Soldier Athlete*.

⁷⁷ Elena A. Spieker, Tracy Sbrocco, Kelly R. Theim, Douglas Maurer, Dawn Johnson, Edny Bryant, Jennifer L. Bakalar, Natasha A. Schvey, Rachel Ress, Dean Seehusen, David A. Klein, Eric Stice, Jack A. Yanovski, Linda Chan, Shari Gentry, Carol Ellsworth, Joanne W. Hill, Marian Tanofsky-Kraff, and Mark B. Stephens, "Preventing Obesity in the Military Community (POMC): The Development of a Clinical Trials Research Network," *International Journal of Environmental Research and Public Health* 12 (2015): 1189, doi:10.3390/ijerph12021174.

Specifically, COL Teyhen noted a 47% higher chance of injury and a 49% higher utilization rate of health care resources.⁷⁸

With the demonstrated increase in injury rates seen in overweight and obese soldiers, it begs the question of what proportion of the 76,700 soldiers evaluated for medical discharge over a 5-year period had injuries in which overweight or obesity was a factor? COL Teyhen also noted a radical decline in the physical performance of basic trainees, with fitness test failure rates raising from 4% to 40% in males and 12% to 54% in females from 2000-2010. Of the soldiers who failed fitness tests, 31% became injured in the first 90 days of service.⁷⁹

In accounting for the variance between prior studies that were more concerned with adequate skeletal mass, and later data indicating the increasing problem of body composition, it is important to consider first improvements in the knowledge of obesity given the staggering increase in obesity prevalence. Whereas experts previously thought fat mass had little effect on muscular function, further research into patients with severe obesity has found otherwise. Recent studies indicate that increases in fat in muscle cells, as well as fat between muscle cells (e.g. intramuscular and intermuscular fat respectively), resulted in reduced muscle function and reduced strength compared to healthy muscle of the same size. Further, researchers found excessive fat mass to be the primary determinant of decreased relative muscle strength.⁸⁰

⁷⁸ Spieker, "Preventing Obesity in the Military Community," 1189.

⁷⁹ Ibid.

⁸⁰ Alexandre Vieira Gadducci, Roberto de Cleve, Gabriela Correia de Faria Santarem, Paulo Roberto Santos Silva, Julia Maria Dandrea Greve, and Marco Aurelio

Second, with the significant increases in obesity prevalence, further trends emerged, and one source noted that overweight and obese soldiers are 36% less likely to be deployable than those of healthy weight.⁸¹ With an exponential rise in the prevalence of obesity, something greater than a 750% increase since September 11, 2001, the cascading effects of these negative readiness trends became much more observable.

In addition to the impact on military readiness and the probability of disease, overweight and obesity also confer a disturbing risk of death, which has long been recognized.⁸² A recently published report from the Norwegian Research Council on Cohort Norway demonstrated a sharply rising, in the literature described as a J-shaped, mortality curve. This curve demonstrated a sobering increase in all-cause and cardiovascular mortality related to increases in body mass index. This and other studies looked at hazard ratios, or its synonym odds ratios, which are common statistical measures of risk in the medical field and in epidemiology. A hazard ratio measures the association between an exposure or variable and an outcome, or the odds that an outcome will occur given a particular exposure or variable, compared to the odds of the outcome

Santo, "Muscle Strength and Body Composition in Severe Obesity" *Clinics* 72, no. 5 (2017): 272-275, doi:10.6061/clinics/2017(05)03.

⁸¹ Kelli M. Harr, "Trimming the Force," (Paper, United States Army Sergeants Major Academy, Fort Bliss, TX, 28 March 2018).

⁸² Eugenia E. Calle, Michael J. Thun, Jennifer M. Petrelli, Carmen Rodriguez, and Clark W. Heath, "Body-Mass Index and Mortality in a Prospective Cohort of U.S. Adults," *New England Journal of Medicine* 342 (7 October 1999): 1097-1105, doi:10.1056/NEJM19991007311501.

occurring in the absence of that exposure.⁸³ For instance an odds ratio of 2.0 would indicate an outcome was twice as likely given an exposure. The study found a hazard ratio of 2.27 in males and 2.01 in females for mortality among the obese in Norway relative to those of a healthy weight.⁸⁴ International findings of obesity related mortality parallels U.S. domestic findings in an analysis of 1.46 million white adults, in which overweight and obesity were clearly associated with increased all-cause mortality. Compared to adults with BMI 22.5-24.9, hazard ratios for all-cause mortality for class I obesity was 1.44, for class II obesity was 1.88, and for class III or morbid obesity was 2.51.⁸⁵ The largest global data analysis of BMI and mortality, which followed over 10 million individuals for five years, found a 1.46 hazard ratio for class I obesity and a 2.76

⁸³ Magdalena Szumilas, "Explaining Odds Ratios" *Journal of the Canadian Academy of Child and Adolescent Psychiatry = Journal de l'Academie Canadienne de Psychiatrie de l'Enfant et de l'Adolescent* 19, no. 3 (2010): 227-229.

⁸⁴ Marte K.R. Kjøllesdal, George Davey Smith, Inger Ariansen, Jonas Minet Kinge, Eirik Degerud, and Øyvind Næss, "The Association Between BMI and Mortality Using Early Adulthood BMI as an Instrumental Variable for Midlife BMI," *Scientific Reports* 8, no. 11499 (2018), doi:10.1038/s41598-018-29089-z.

⁸⁵ Amy Berrington De Gonzalez, Patricia Hartge, Cerhan James R, Alan J. Flint, Lindsay Hannan, Robert J. MacInnis, Steven C. Moore, Geoffrey S. Tobias, Hoda Anton-Culver, Laura Beane Freeman, W. Lawrence Beeson, Sandra L. Clipp, Dallas R. English, Aaron R. Folsom, D. Michal Freedman, Graham Giles, Niclas Hakansson, Katherine D. Henderson, Judith Hoffman-Bolton, Jane A. Hoppin, Karen L. Koenig, I-Min Lee, Martha S. Linet, Yikyung Park, Gaia Pocobelli, Arthur Schatzkin, Howard D. Sesso, Elisabete Weiderpass, Bradley J. Willcox, Alicja Wolk, Anne Zeleniuch-Jacquotte, Walter C. Willett, and Michael J. Thun, "Body-Mass Index and Mortality among 1.46 Million White Adults," *The New England Journal of Medicine* 363, no. 23 (2010): 2211-2219, doi:10.1056/NEJMoa1000367.

hazard ratio for class III (morbid) obesity.⁸⁶ In review of the evidence, the health risks attendant to obesity are indisputable. The health risks related to obesity are perhaps unsurprisingly related to degree, with greater deterioration in health being seen the more severe the obesity class.⁸⁷

The problem of obesity in the military is not by any means restricted to the United States. A recent study of the Republic of Korea Armed Forces found that 20.6% of soldier participants were obese compared to 29.2% civilian participants.⁸⁸ Citing Public Health England, British Army Major Oliver D. Burwell, in his Art of War Scholarship paper on readiness of the British Army, noted a 11.2% and 10.4% rise in obesity prevalence for British men and women over a 21-year period.⁸⁹ This calculates to an 84% increase in obese males and a 62% increase in obese females over this period.

Nonetheless, MAJ Burwell asserted in spite of these trends that, in the context of the

⁸⁶ The Global BMI Mortality Collaboration, “Body-Mass Index and All-Cause Mortality: Individual-Participant-Data Meta-Analysis of 239 Prospective Studies in Four Continents,” *Lancet* 388 (2016): 776-786. doi:10.1016/S0140-6736(16)30175-1.

⁸⁷ Do, et al, “Association Between Cardiorespiratory Fitness and Metabolic Risk Factors in a Population with Mild to Severe Obesity.”

⁸⁸ Jung Hwan Lee, Da Hea Seo, and Min Jung Nam, Geon Hui Lee, Dong Hee Yang, Min Joo Lee, Ung-Rim Choi, and Seongbin Hong, “The Prevalence of Obesity and Metabolic Syndrome in the Korean Military Compared with the General Population,” *Journal of Korean Medical Science* 33, no. 25 (18 June 2018), doi:10.3346/jkms.2018.33.e172.

⁸⁹ Oliver D. Burwell, “Society and the British Army: Implications for Fighting Spirit,” (Monograph, School of Advanced Military Studies, U.S. Army Command and General Staff College, Fort Leavenworth, KS, 25 May 2017), 40-41.

British Army service in Afghanistan, “the Army still consisted of tough, resilient soldiers even as society grew increasingly unfit.”⁹⁰

In his Army Readiness Guidance, Calendar Year 2016-2017 memorandum, the Chief of Staff of the Army, General Mark A. Milley, declared “Readiness is #1...and there is no other #1.”⁹¹ In spite of this, the emergent evidence has inversely related obesity to military readiness. The available data from the 2017 Health of the Force report found that 17.3% of soldiers were obese.⁹² Further confirming this trend, a review of over 731,000 army accessions from 1 January 2001 through 31 December 2011 found that 10.0% of recruits were obese, and that these soldiers left service earlier than other soldiers and had at least double the risk of incident cardiometabolic disease.⁹³

Although the Army identifies body composition as one of the five components of fitness in Field Manual (FM) 3-22.20 *Army Physical Readiness Training*, there is very little discussion or recommendation for overweight or obese soldiers in this document. It instead defers to Army Regulation 600-9 *Army Weight Control Program*.⁹⁴ (note; in 2013 AR 600-9 was renamed the *Army Body Composition Program*). Similarly, AR 40-501

⁹⁰ Burwell, “Society and the British Army,” 41.

⁹¹ GEN Mark A. Milley USA, *Army Readiness Guidance, Calendar Year 2016-2017*, 20 January 2016.

⁹² Surgeon General, *2017 Health of the Force Report*, 48-51.

⁹³ Adela Hruby, Lakmini Bulathsinhala, and Craig J. McKinnon Owen Hill, Scott Montain, Andrew Young, and Tracey Smith, “Body Mass Index at Accession and Incident Cardiometabolic Risk Factors in U.S. Army Soldiers, 2001-2011,” *PLoS ONE* 12, no. 1 (2017), doi: 10.1371/journal.pone.0170144.

⁹⁴ Lowman. “Does Current Army Physical Fitness Training Doctrine Adequately Prepare Soldiers for War?” 102-103.

Standards of Medical Fitness defines obesity in frustratingly vague language and does not address obesity in Chapter 3, *Medical Fitness Standards for Retention and Separation Including Retirement*. The regulation defines obesity as: “Excessive accumulation of fat in the body manifested by poor muscle tone, flabbiness and folds, bulk out of proportion to body build, dyspnea and fatigue upon mild exertion, and frequently accompanied by flat feet and weakness of the legs and lower back.”⁹⁵ Although descriptive enough, this definition provides little in the way of measurable or quantifiable information.

With the passage of Public Law 92-129 in 1971, the United States Army transitioned away from the draft and became an all-volunteer force.⁹⁶ However because of criminality, substance use, single parenthood, poor educational attainment, and obesity, only slightly more than 1 in 4 young people age 17-24 are qualified for military service.⁹⁷ These numbers indicate that if current trends do not improve then for the U.S. Army to remain an effective force, it will need to more effectively recruit from a smaller manpower pool, as well as understand what the impact of obesity is on the active deployable force and find effective means to mitigate that impact.

⁹⁵ Headquarters, Department of the Army (HQDA), Army Regulation (AR) 40-501, *Standards of Medical Fitness* (Washington, DC: Government Publishing Directorate, 14 June 2017), 149.

⁹⁶ Krug, “Sustaining the Quality of the All-Volunteer Force,” 21.

⁹⁷ *Ibid.*, 26.

CHAPTER 3

RESEARCH METHODOLOGY

The researcher's intent was to ascertain the prevalence of obesity in the military and compare it against historical rates. Further, the researcher analyzed the correlation between body mass index as a variable for several outcomes, with emphasis on rank and on medical profiling. In the U.S. Army, medical professionals communicate with commanders about the physical condition and limitations of soldiers using the medical profile system, and documents that detail such limitations are known as profiles.⁹⁸

The research hypothesis was that for complex reasons, there was a significant population of U.S. Army soldiers who are not within regulation regarding obesity and body composition that the Army had not identified as being outside of standards. The researcher speculated the Army is currently not effective in addressing the issue of obesity within the ranks and that the prevalence of obesity was rank dependent. The researcher speculated that high body mass index is associated with early separation from service. Furthermore, the researcher hypothesizes that obesity is a risk factor for nondeployability and for medical profiles. The desired end state is to provide a quantifiable measure of the extent of obesity in today's Army.

Army Medical Command (MEDCOM) maintains data repositories of clinically relevant information on soldiers, as well as unit aggregate medical readiness. The Medical Readiness Assessment Tool, or MRAT, uses electronic health record and other systems of record data inputs. By entering a Unit Identification Code (UIC), the MRAT

⁹⁸ HQDA, AR 40-501.

can retrieve individual soldier variables for all the soldiers assigned to a specific unit. It categorizes soldiers as being permanently, medically non-available (MNA3) corresponding generally to those undergoing the lengthy medical evaluation board separation process. The next category is soldiers on a maternity profile, and the final category is all other soldiers. Variables that the MRAT provides are individual name, social security number (SSN), rank, BMI, length of duty limiting profiles, number of medical appointments on and off post, number of radiographic studies, prescriptions that can affect deployability, and tobacco use.

The research queried records on 15 distinct active duty brigades (BDE), extracted the data of 52,435 soldiers into Microsoft excel, immediately deleted personally identifiable data (PII), and then analyzed the data. The researcher identified three Stryker brigade combat teams (SBCTs), three armored brigade combat teams (ABCTs), three infantry brigade combat teams (IBCTs), an engineer BDE, a military police BDE, a field artillery BDE, a combat aviation brigade (CAB), a signal BDE and a sustainment BDE from a representative sample of active duty installations in the continental United States (CONUS). The researcher performed a statistical analysis of each brigade and compared these findings to the other brigades in the study population with respect to aggregate BMI data and medical profiles. The researcher only sought to incorporate permanent profile data and did not analyze temporary medical profiles or other causes of non-deployability such as legal/criminal investigations, etc. In sensitivity to operational security the researcher did not analyze or incorporate system of record aggregate readiness data for included units or contemporaneous Forces Command (FORSCOM) averages.

Of note, because of the sensitive nature of readiness data, just as the researcher has deleted individual personally identifiable information (PII) of soldiers, the researcher has re-identified units with a Greek letter and their unit type, with removal of all unit identification codes and reference to locations. To avoid confounders, the researcher has deliberately selected CONUS units, due to the unavailability of medical boards and disability assessment infrastructure overseas in locations such as South Korea. The study variables of greatest interest are body mass index (BMI), permanent profiles, and rank.

Operating assumptions with respect to medical profiles include that permanent profiles are written in accordance with published regulation. AR 40-501 *Standards of Medical Fitness* Chapter 7-3 details the medical profile serial system. The system is partitioned into six factors known as PULHES; P-Physical Capacity or Stamina, U-Upper extremities, L-Lower extremities, H-Hearing, E-Eyes and S-Psychiatric. A profiling physician assigns a numerical designator for each factor; specifically categorizing each as: “(1) An individual having a numerical designation of “1” under all factors is considered to possess a high level of medical fitness. (2) A physical profile designator of “2” under any or all factors indicates that an individual possesses some medical condition or physical defect that may require some activity limitations. (3) A profile containing one or more numerical designators of “3” signifies that the individual has one or more medical conditions or physical defects that may require significant limitations. The individual should receive assignments commensurate with his or her physical capability for military duty. (4) A profile serial containing one or more numerical designators of “4”

indicates that the individual has one or more medical conditions or physical defects of such severity that performance of military duty must be drastically limited..⁹⁹

Further, Army Regulation 40-501 Chapter 7-4 explains the differences in temporary and permanent profiles and states “All permanent “3” and “4” profiles, for Soldiers on active duty, will be reviewed by a Medical Evaluation Board (MEB) physician or physician approval authority. An MEB physician is an MTF dedicated subject matter expert trained to perform disability evaluations per guidelines established in DODI 1332.38 (see AR 40–400 for MEB process).”¹⁰⁰

⁹⁹ HQDA, AR 40-501, ch. 7-3.

¹⁰⁰ Ibid., ch. 7-4.

CHAPTER 4

ANALYSIS

Using the Medical Readiness Assessment Tool (MRAT) the researcher obtained data on 15 active duty continental United States Forces Command (FORSCOM) brigades, with a result of 52,435 soldiers, as a convenience as described in chapter 3 sample. The researcher immediately deleted all Personally Identifiable Information, which is not in any way retained or recoverable. Of the MRAT parameters the researcher focused on the variables of rank, body mass index, and PULHES data as defined in chapter 3. To enable analysis, the researcher designated soldiers as being “red,” “amber” or “green” based on their PULHES data. Based on annotated PULHES data, soldiers were designated as red if they had one or more permanent 3 or 4 level profiles, of the remainder each soldier was designated as amber if they had one or more permanent 2 but not 3 or 4 level profiles, and soldiers with PULHES 111111 were designated as green. The researcher used the augmented PULHES data with the cited decision rule to categorize the profile data into the red-amber-green ordinal categories. The researcher additionally assessed for rank as ordinal categorical data.

For 1002 soldiers, the MRAT recorded BMI was zero, presumably indicating an absence of available height and weight data. Using WHO standards for BMI, as discussed in Chapter 2 page 10, there were 140 soldiers who were underweight (BMI<18.5), 18,312 soldiers who were normal weight (BMI between 18.5 and 25), 25,401 who were overweight (BMI between 25 and 30), 6,908 with Class I obesity (BMI >30 less than 35), 637 with Class II obesity (BMI>35 less than 40) and 35 soldiers with Class III or morbid obesity (BMI>40). There was a demonstrated increase in rates of obesity as enlisted

soldiers became more senior in rank, a trend that was also seen to a lesser extent in warrant officer and officer ranks. The researcher observed an increase in permanent profiles of both P2 and P3 level as rank increased. Of the research population an overall roughly 2.5% were P3 and 15% approximately were P2.

In conjunction with subject matter expertise provided by DR David Bitters, CGSC Staff Statistician, and Dr Shanda Lauer, Army University Research Psychologist, the researcher performed a logistic regression to estimate probability of readiness based on BMI as an entry variable. Also, the researcher employed an inverse cumulative odds ratio. At a threshold of 33 for BMI it was determined that the readiness of the population began to decline markedly based on assessment of the point estimates. In general terms, the data from this study showed significant variability at extremes of body mass index. Using Tukey's comparison of the best fit, the researcher found that those with higher BMI had a statistically significant probability of greater risk of Permanent PULHES level 3 profile

Active Duty Military Personnel by Rank/Grade

Department of Defense					
Active Duty Military Personnel by Rank/Grade					
August 31, 2018					
Rank/Grade	Services				Total Services
	Army	Navy	Marine Corps	Air Force	
GENERAL -ADMIRAL	14	8	4	14	40
LT GENERAL -VICE ADMIRAL	43	40	22	42	147
MAJ GENERAL -REAR ADMIRAL (U)	123	63	29	97	312
BRIG GENERAL -REAR ADMIRAL (L)	141	109	41	149	440
COLONEL -CAPTAIN	4,092	2,906	646	3,296	10,940
LIEUTENANT COL-COMMANDER	8,876	6,312	1,900	9,842	26,930
MAJOR -LT COMMANDER	15,225	10,161	3,880	13,616	42,882
CAPTAIN -LIEUTENANT	28,443	19,884	6,165	20,841	75,333
1st LIEUTENANT-LIEUTENANT (JG)	11,499	6,765	3,427	6,882	28,573
2nd LIEUTENANT-ENSIGN	8,961	6,952	3,096	7,791	26,800
CHIEF WARRANT OFFICER W-5	592	85	109	0	786
CHIEF WARRANT OFFICER W-4	2,085	396	303	0	2,784
CHIEF WARRANT OFFICER W-3	3,969	662	649	0	5,280
CHIEF WARRANT OFFICER W-2	5,351	606	837	0	6,794
WARRANT OFFICER W-1	2,382	0	287	0	2,669
TOTAL OFFICER	91,796	54,949	21,395	62,570	230,710
E-9	3,559	2,669	1,585	2,645	10,458
E-8	10,780	6,664	3,920	5,097	26,461
E-7	35,541	21,372	8,640	25,328	90,881
E-6	54,037	49,585	14,397	39,551	157,570
E-5	66,006	68,161	25,739	61,837	221,743
E-4	105,407	52,213	35,427	51,008	244,055
E-3	50,329	41,603	43,248	55,253	190,433
E-2	29,276	15,165	20,801	7,441	72,683
E-1	24,044	12,966	9,309	10,208	56,527
TOTAL ENLISTED	378,979	270,398	163,066	258,368	1,070,811
CADETS-MIDSHIPMEN	4,592	4,462	0	4,270	13,324
GRAND TOTAL	475,367	329,809	184,461	325,208	1,314,845

Source: Defense Manpower Data Center, Office of the Secretary of Defense, “Active Duty Military Personnel by Rank/Grade,” last modified 31 August 2018, accessed 2 October 2018, <https://dmdcrs.dmdc.osd.mil/dmdcrs/>.

Before the researcher could assert any inference about the generalizability of the research results, it was first necessary to consider if the sample was reasonably representative of the Army. In assessing the representativeness of the sample, the researcher compared the distribution of ranks of the study population to that of actively

serving soldiers as reported by DMDC. Table 2 details the distribution of army rank structure as of 31 August 2018.

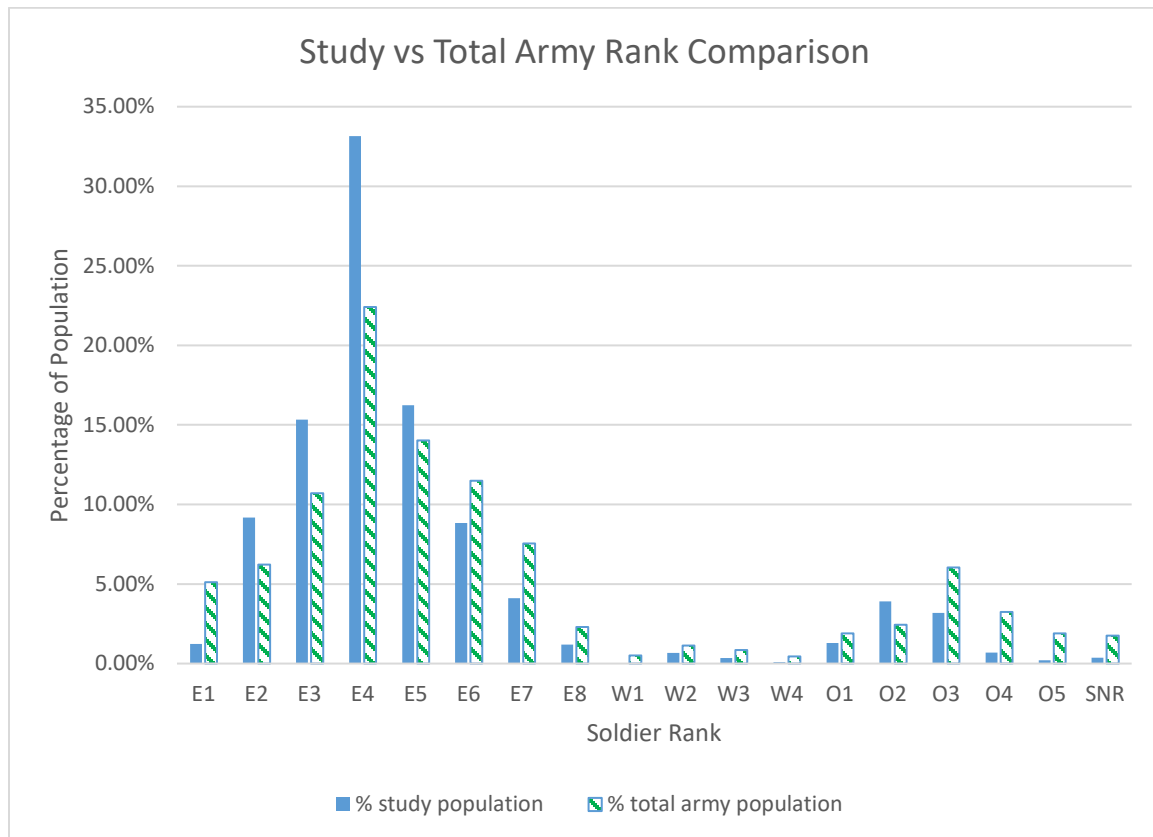


Figure 1. Study vs Total Army Rank Comparison

Source: Created by author using data from Defense Manpower Data Center, Office of the Secretary of Defense, “Active Duty Military Personnel by Rank/Grade,” last modified 31 August 2018, accessed 2 October 2018, <https://dmdcrs.dmdc.osd.mil/dmdcrs/>.

As Figure 1 Study vs Total Army Rank Comparison indicates, the proportions of the various ranks collected in this study fairly approximated those of the total Army. Distinguishing the sample population from the total army composition was a lower incidence of E6 and higher ranks as well as a lower proportion of the most junior enlisted

and officer ranks. Conversely in this sample there was a higher proportion of enlisted ranks Private to Sergeant (E2-E5) as well as the First Lieutenant (O2) officer rank. This comports with what is typical for operational army units, as the Private E1 and Second Lieutenant O1 ranks undergo initial entry training for several months before reporting to operational units and will normally promote only several months after arrival. Also soldiers in the more senior ranks will work in other assignments such as training units, etc. As a result of the distribution of the more senior enlisted (E6 and higher) and officer ranks (O3 and higher) to other components of the force structure where they engage in duties not immediately related to deployment and combat, these ranks were underrepresented in the survey population. As the survey population was selected from deployable combat units in the continental United States this variation is expected.

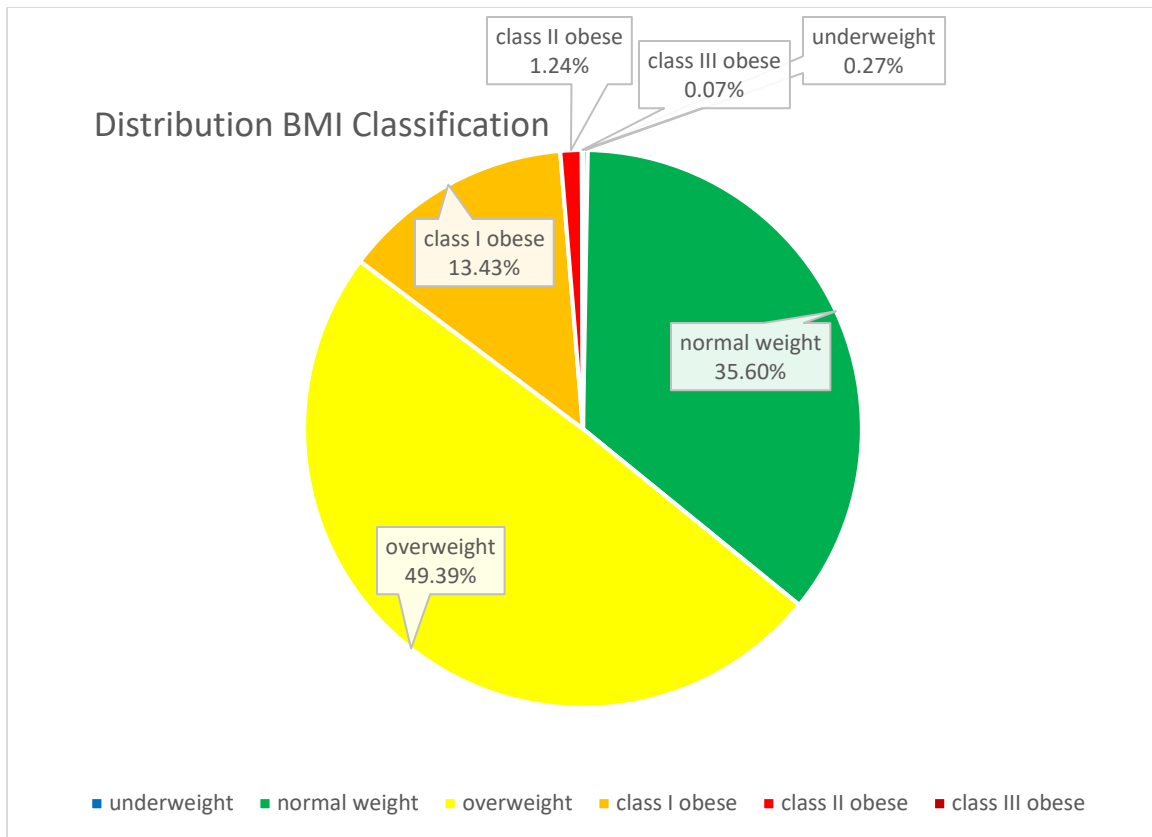


Figure 2. Distribution BMI Classification

Source: Created by author.

The total aggregate numbers from this study population in each WHO category of BMI were used to create Figure 2 Distribution BMI Classification. We see in this figure that in the study population, 49% of soldiers were overweight followed by 36% normal weight. Given the general military expectations of physical fitness it was perhaps unsurprising that there were few soldiers either underweight or with Class II (severe) or Class III (morbid) obesity. Also, consistent with the Rand study findings on army

overweight and obesity.¹⁰¹ and other findings in the literature review, a majority of soldiers in the survey population were overweight or obese. In this study population the incidence of obesity was 14.46% and the incidence of severe obesity was 1.28%.

████████ BMI and Aggregate Population Percentiles by PULHES Status

<i>BMI</i>	<i>Percentile Green</i>	<i>Percentile Amber</i>	<i>Percentile Red</i>
<17	0.03%	0.00%	0.00%
17.0-17.9	0.09%	0.05%	0.23%
18.0-18.9	0.54%	0.28%	0.53%
19.0-19.9	2.15%	1.01%	1.59%
20.0-20.9	5.35%	2.36%	3.49%
21.0-21.9	11.03%	4.47%	6.07%
22.0-22.9	18.44%	8.27%	10.33%
23.0-23.9	28.54%	14.09%	17.01%
24.0-24.9	39.14%	20.35%	23.01%
25.0-25.9	53.62%	30.52%	32.65%
26.0-26.9	64.40%	40.49%	40.02%
27.0-27.9	74.35%	51.68%	50.49%
28.0-28.9	82.34%	61.49%	58.01%
29.0-29.9	88.43%	71.15%	67.43%
30.0-30.9	92.89%	79.46%	74.72%
31.0-31.9	95.98%	86.07%	81.70%
32.0-32.9	97.63%	90.57%	86.48%
33.0-33.9	98.65%	94.12%	90.28%
34.0-34.9	99.27%	96.53%	92.94%
35.0-35.9	99.60%	97.95%	95.44%
36.0-36.9	99.80%	98.61%	96.89%
37.0-37.9	99.88%	99.21%	97.95%
38.0-38.9	99.93%	99.64%	98.41%
39.0-39.9	99.96%	99.87%	99.24%
≥40	100.00%	100.00%	100.00%

Source: Created by author.

¹⁰¹ Meadows, et al. *Are They Living Healthy?*

Table 3: BMI and Aggregate Population Percentiles by PULHES Status, depicts the distribution in percentiles of the study population broken out by permanent profile status. As aforementioned those without permanent profiles were indicated as “green” while those with a profile designator of 2 were indicated as “amber.” Soldiers with PULHES designator of 3 or 4 were designated as “red” and as previously discussed personnel with these profiles are, by regulation, referred to a Medical Evaluation Board to determine suitability for service.

Ideally the number of soldiers who have no restrictions should be as high for deployable units as is practically achievable. Due to acute and chronic injuries and other issues, a perfect rate of 100% is not possible. However, army units closely monitor levels of soldier readiness and manage limitations resulting from medical problems. Army leaders work closely to monitor the progress of level 3 profiles especially, and the 2.5% incidence of permanent level 3 profiles in this population can be identified as a population of interest. Soldiers with these designations are unable to contribute to the combat strength of the organization while undergoing lengthy disability evaluation that, in most cases, results in medical separation from service. Interventions that could reduce the number of soldiers in this category are therefore of particularly high importance.

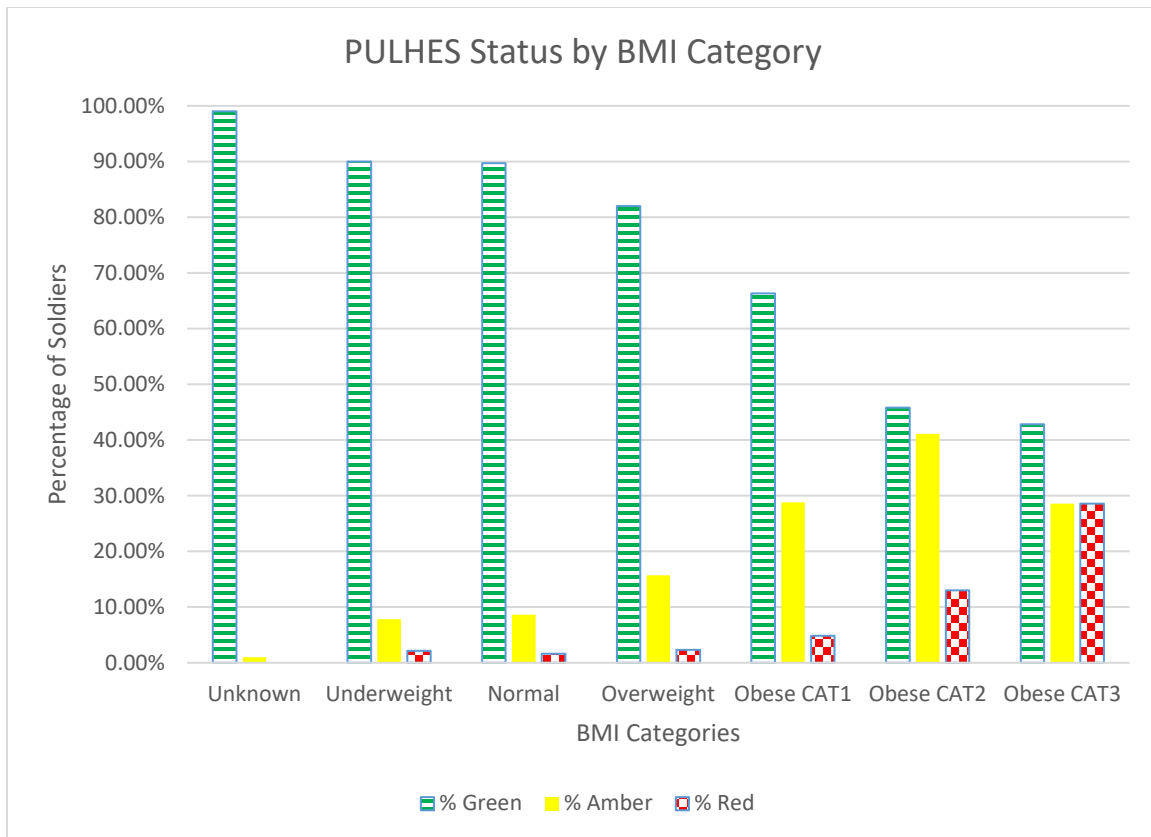


Figure 3. PULHES Status by BMI Category

Source: Created by author.

In Figure 3 PULHES status by BMI category, soldiers were organized into WHO classifications of body mass index, as previously described and then assessed for permanent profiles. The analysis noted that in the study population overall, as soldiers increased in body weight, the probability for both amber and red severity permanent profiles increased. This finding was expected by the researcher from anecdotal observation. Notably, as injured soldiers who do not perform adequate aerobic exercise tend to gain weight, at the same time overweight and obesity are themselves risk factors for developing musculoskeletal injury. A working hypothesis for the researcher at this

point became that obesity and permanent profiles were covariate, or linked variables, in this population.

PULHES Categories and Odds Ratios by BMI Categories

	All	UND	NML	OW	OB-1	OB-2	OB-3	Obese	SV Obese
Green	42272	126	16427	20831	4581	292	15	4888	307
Amber	7844	11	1585	3985	1991	262	10	2263	272
Red	1317	3	300	585	336	83	10	429	93
Total	51433	140	18312	25401	6908	637	35	7580	672
%Green	82.19%	90.00%	89.71%	82.01%	66.31%	45.84%	42.86%	64.49%	45.68%
%Amber	15.25%	7.86%	8.66%	15.69%	28.82%	41.13%	28.57%	29.85%	40.48%
%Red	2.56%	2.14%	1.64%	2.30%	4.86%	13.03%	28.57%	5.66%	13.84%
OR Red-All	1.00	0.84	0.64	0.90	1.90	5.09	11.16	2.21	5.40
OR Red-NML	1.56	1.31	1.00	1.41	2.97	7.95	17.44	3.45	8.45
OR Amber-All	1.00	0.52	0.57	1.03	1.89	2.70	1.87	1.96	2.65
OR Amber-NML	1.76	0.91	1.00	1.81	3.33	4.75	3.30	3.45	4.68

Source: Created by author.

Table 4: PULHES Categories and Odds Ratios by BMI Categories, depicts the actual numbers of individuals meeting criteria demonstrated in Figure 5. Further, this table demonstrates the calculated Odds Ratios (OR) for having Red and Amber permanent PULHES status as previously discussed. Of note for both Amber and Red status, the Odds Ratio for obese soldiers relative to soldiers of normal weight were 3.45, indicating that obese soldiers were almost 3 and 1/2 times more likely to have a permanent profile.

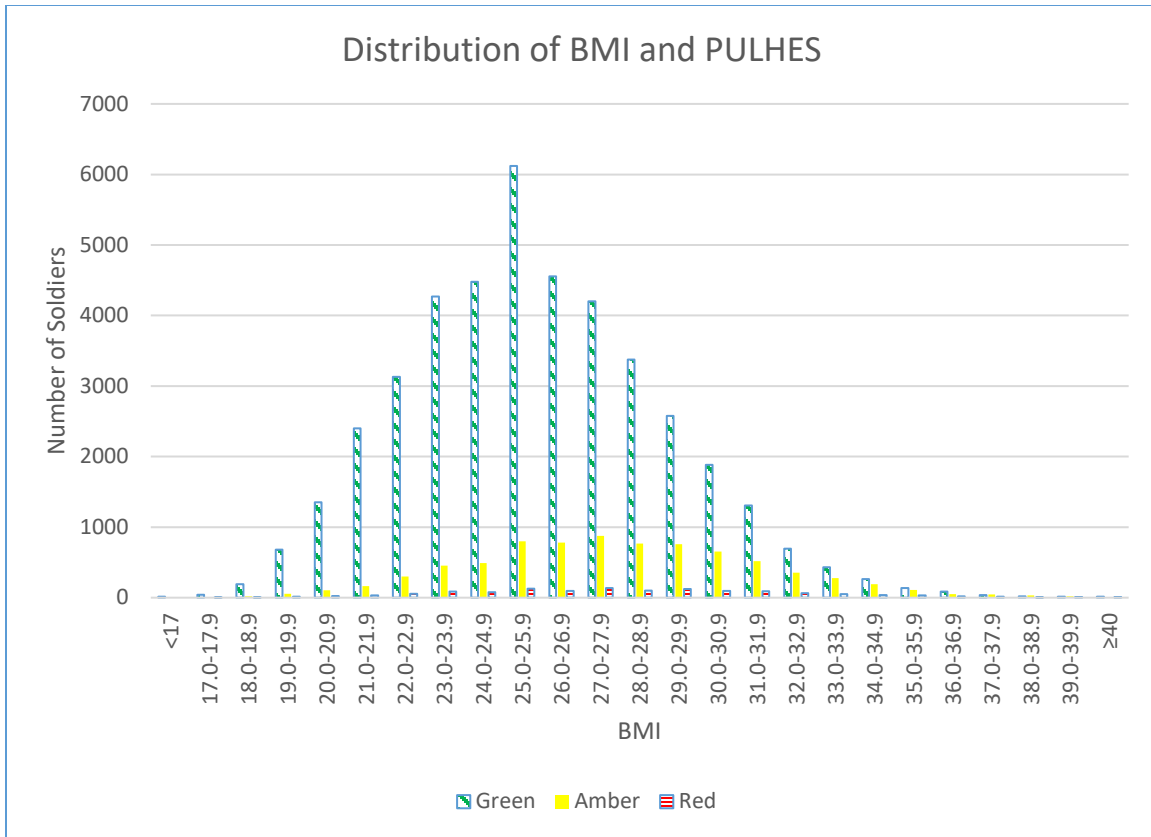


Figure 4. Distribution of BMI and PULHES

Source: Created by author.

Figure 4 Distribution of BMI and PULHES depicts the total numbers of soldiers by permanent PULHES category against their BMI value, as grouped by whole number intervals in kg/m^2 , of the study population. As previously discussed, the substantial majority of soldiers were in the green category, and that generally speaking at any BMI, there were smaller populations of amber and red soldiers as well. This observation however was not valid in the outlier populations of the underweight ($\text{BMI} < 18$) and severely obese ($\text{BMI} > 35$).

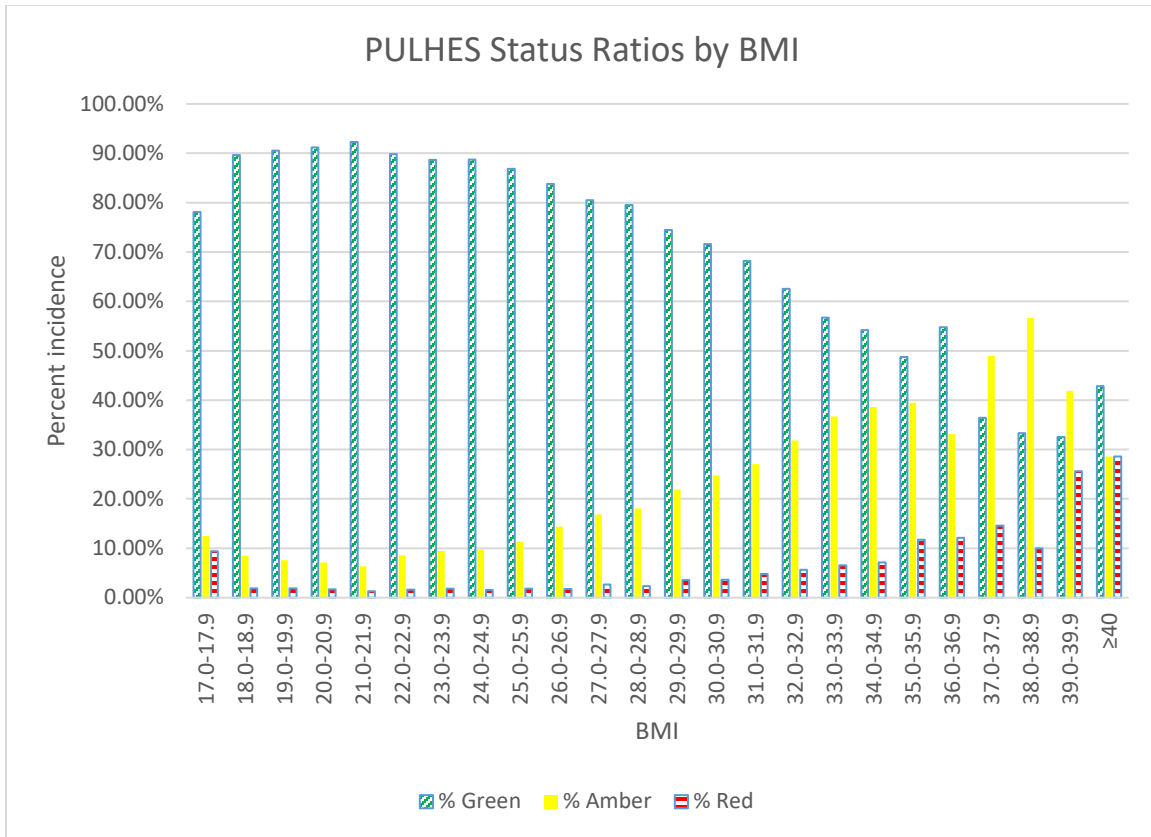


Figure 5. PULHES Status Ratios by BMI

Source: Created by author.

Figure 5 PULHES Status Ratios by BMI, depicts the percentages of soldiers per permanent PULHES category against their BMI value, as grouped by whole number intervals in kg/m^2 , of the study population. The information is the same as that shown in Figure 6, however it is graphically depicted in this format to show the proportion of soldiers in each BMI interval with each permanent PULHES category. We see in this figure, as in Figure 5, that as BMI increases the incidence of green permanent PULHES status decreases. Conversely the rates of red and amber permanent PULHES categories rise in incidence as BMI increases.

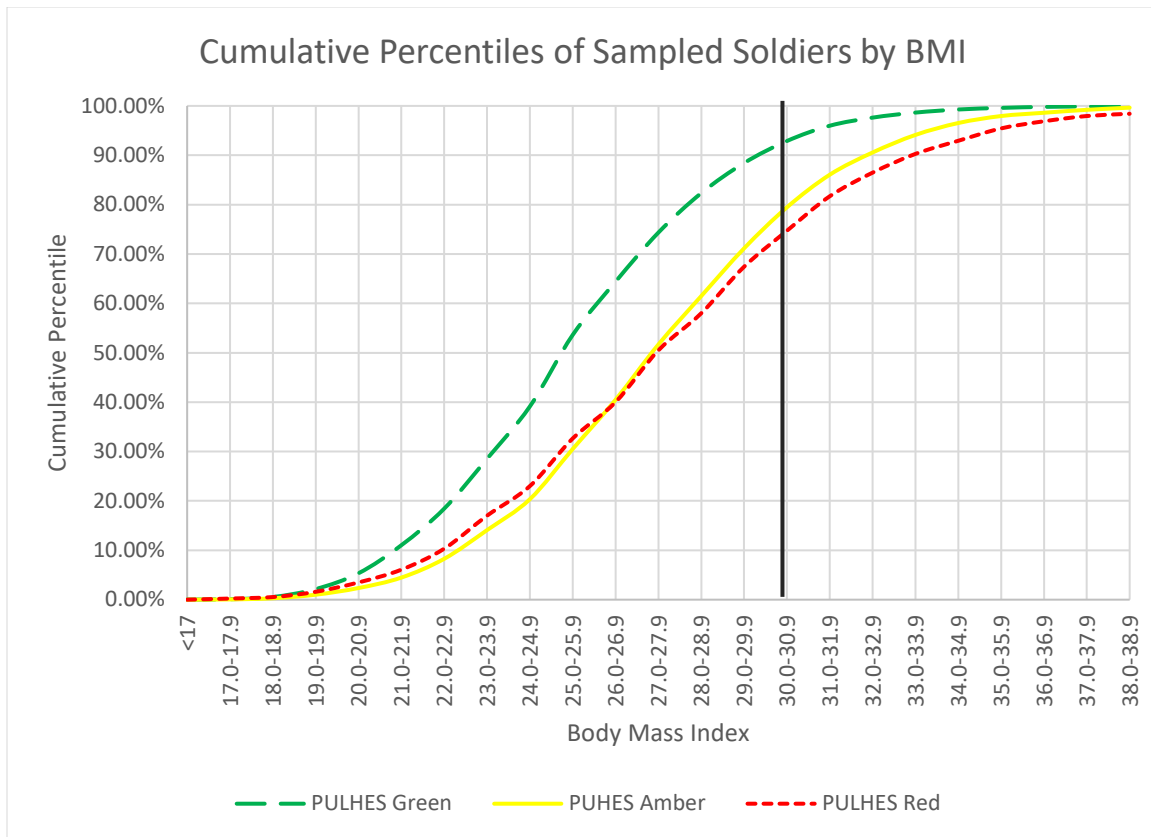


Figure 6. Cumulative Percentiles of Sampled Soldiers by BMI

Source: Created by author.

Figure 6 Cumulative Percentiles of Sampled Soldiers by BMI graphically depicts Table 2 data. The difference between those soldiers without permanent profile is distinct from those with permanent profiles, as it pertained to body mass index. For soldiers with generally healthy BMIs between 17 and 30 kg/m², a larger percentage of soldiers were green than amber or red. This distinction was especially pronounced in the overweight BMI range, or BMI 25-30, where for example at a BMI 27.0 to 27.9, roughly 75% of green soldiers are included at or below this BMI, however only roughly 50% of those amber or red. Superimposed on this graph is a vertical line at the threshold of Obese BMI

(30 kg/m²), highlighting the significant gap between the cumulative percentile curves between green and the other categories

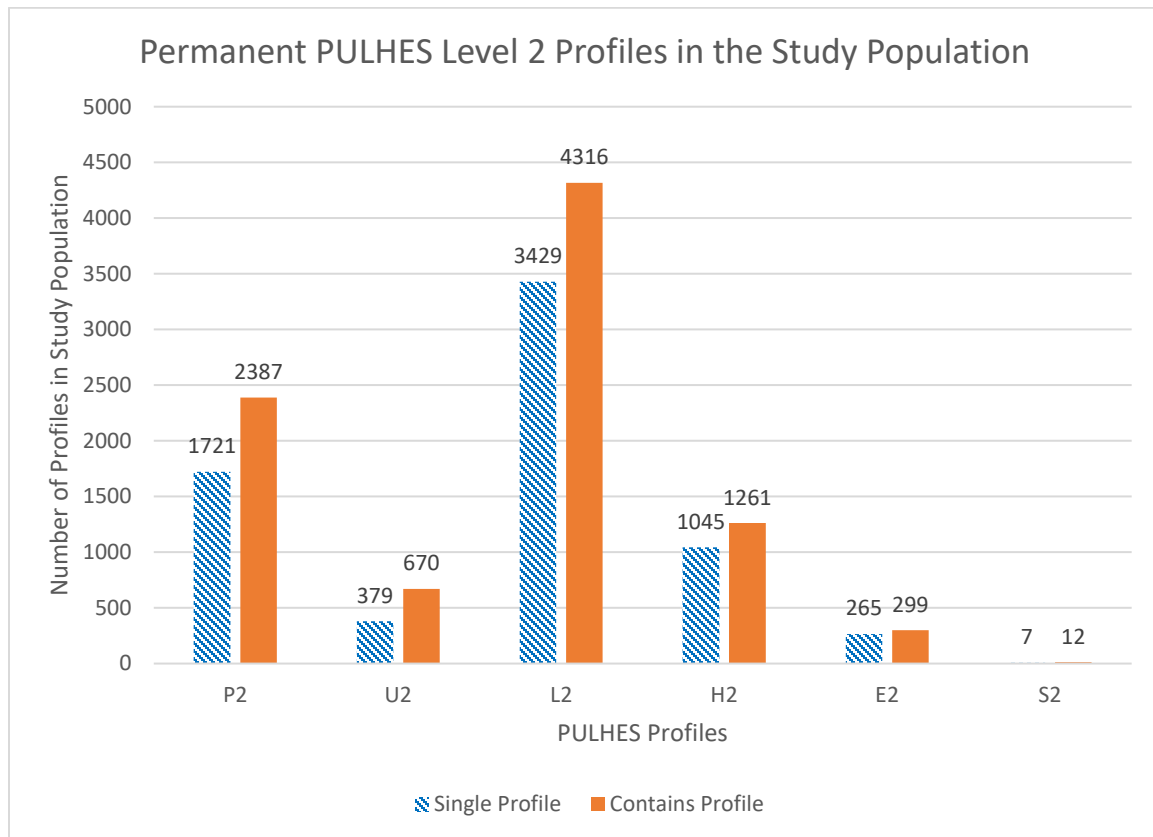


Figure 7. Permanent PULHES Level 2 Profiles in the Study Population

Source: Created by author.

Figure 7 Permanent PULHES Level 2 Profiles in the Study Population depicts the distribution of specific profiling domain limitations among the amber permanent PULHES category. Overall 55% of all level 2 permanent profiles included limitations of the lower extremity (L2), as opposed to only 8.5% of level 2 permanent profiles including

upper extremity limitations (U2). Roughly 14% of the PULHES amber population had more than one permanent level 2 profile indicating limitations in two or more domains.

That limitations of the lower extremity were prominent in the permanent PULHES amber population was a significant finding. Such L2 profiles would generally be issued for conditions of the low back, hip, knees, ankles and feet in addition of the bones and muscles of the lower extremities. The researcher has both authored and professionally reviewed many such profiles in past assignments. Although the specific restrictions or causes for individual profiles of the soldiers in the study population were not reviewed, in accordance with the study design, the author is generally informed of typical profile content from personal knowledge these profiles. Most frequently L2 profiles contain prohibitions against certain strenuous tasks or forms of exercise, and are provided when soldiers have persistent pain and/or difficulty performing these tasks or exercises. This would include prohibitions against lifting and carrying over certain amounts of weight, or against running for exercise or road marching. L2 profiles frequently restrict Army Physical Fitness Test events and authorize soldiers to perform alternate events, such as the bike or walk test. L2 profiles also generally restrict activities that the soldier would otherwise be expected to perform, but with limitations presumably below the “severe limitations” that would require a P3 profile as previously discussed.

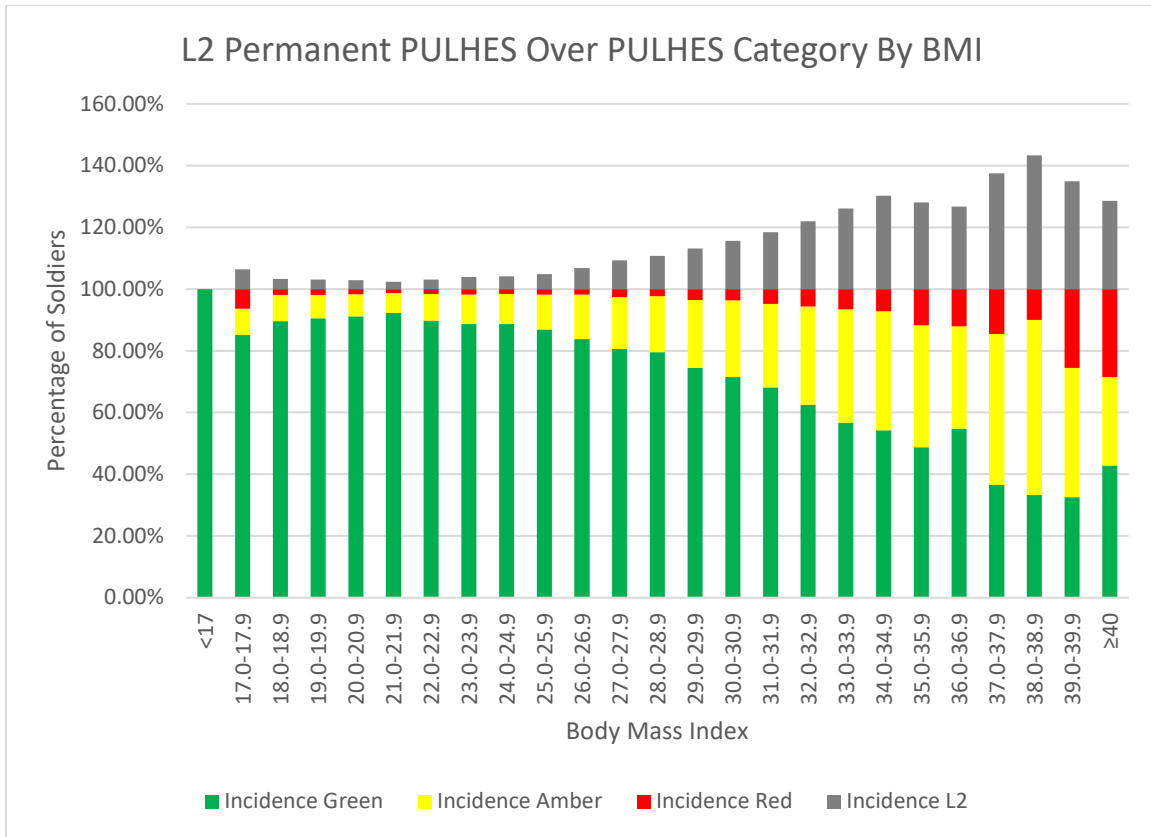


Figure 8. L2 Permanent PULHES Over PULHES Category by BMI

Source: Created by author.

Figure 8 L2 Permanent PULHES Over PULHES Category by BMI depicts the incidence of L2 profiles, which were superimposed over a stacked chart of the relative incidences of permanent PULHES profile categories. As with Figure 7, we find the majority of all PULHES level 2 permanent profiles were L2, indicating lower extremity disorders, while reinforcing the findings of Figure 7 that linked increasing BMI to decreasing PULHES green incidence. There is a close approximation in the proportional prevalence of amber, red, as well as L2 profiles across the study population, with proportional changes being observed in the unrestricted green PULHES group.

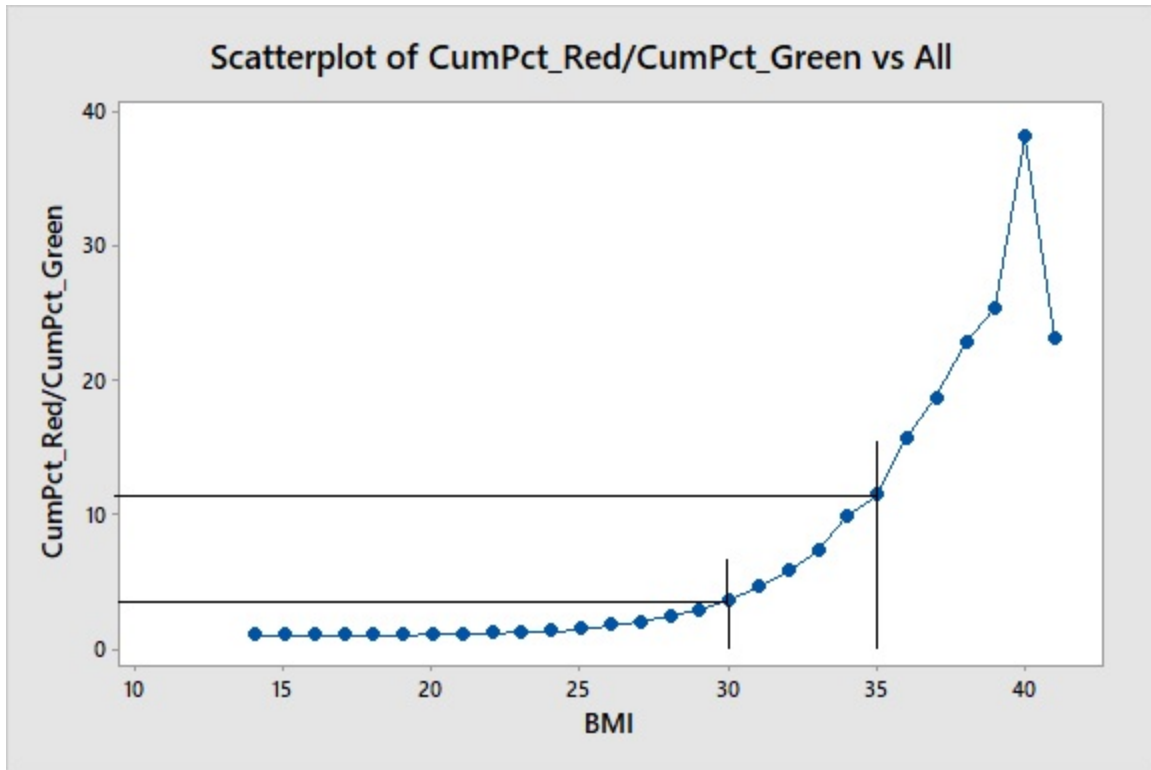


Figure 9. Inverse Cumulative Odds Ratio; Red to Green Ratios by BMI

Source: Created by author.

In Figure 9 Inverse Cumulative Odds Ratio, Red to Green Ratios by BMI shows a scatterplot produced from the inverse cumulative odds ratio shows the relationship between the increasing risk of red status as BMI increases with respect to having green status. As the observer will note there is a significant increase in the slope of the curve beyond a BMI of 30 and this curve increases nearly exponentially beyond 35. Due to low numbers and the presence of outliers, the slope of the curve deviated at the extreme end of BMI. Also using the inverse of the cumulative curve it was calculated that the probability of BMI greater than 30 given a red category was 3.5 times that of the probability of BMI greater than 30 given a green category.

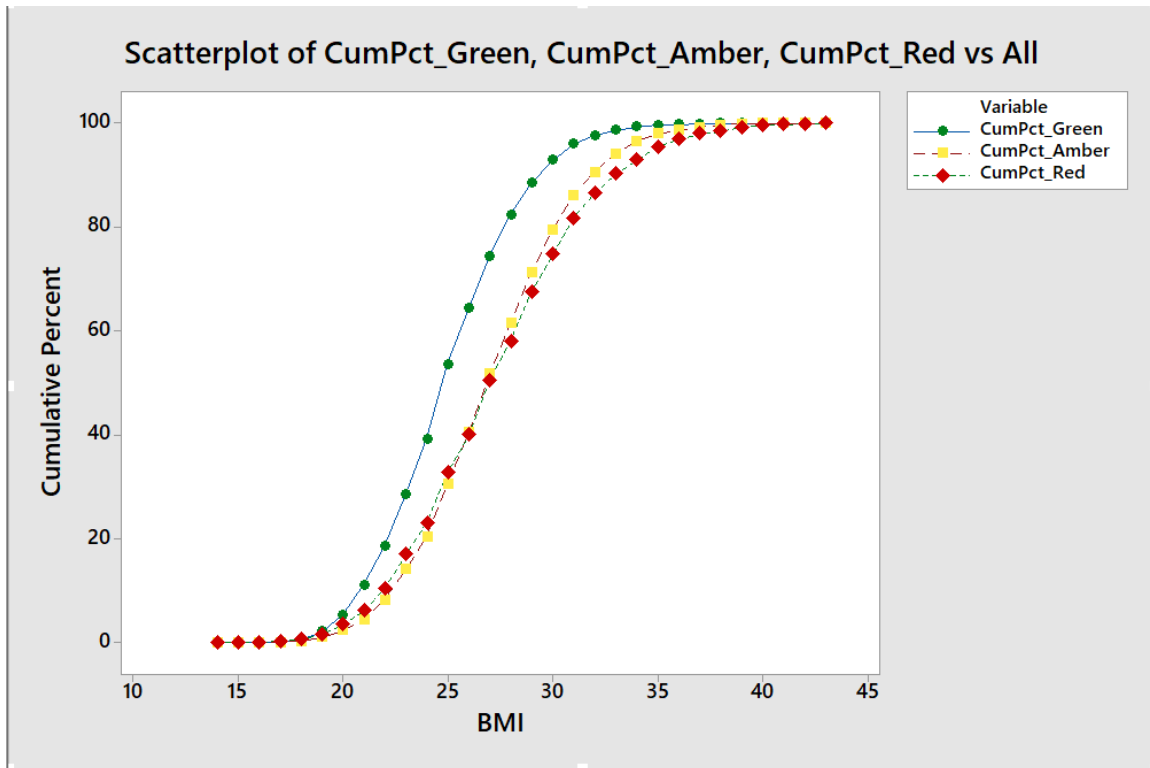


Figure 10. Minitab Scatterplot of Cumulative Green, Amber and Red PULHES by BMI
Source: Created by author.

The researcher created Figure 10 Minitab Scatterplot of Cumulative Green Amber and Red PULHES by BMI to show the cumulative percentiles of the green, amber and red categories of PULHES data measured against body mass index values. Of note this graphically demonstrates the different mean body mass index and relative prevalence of soldiers below the indicated body mass index value. The distribution indicated a clear distinction between the green population from the red and amber populations. This supports the working hypothesis that BMI and permanent profiles were covariate in this population.

The observer will note that following a BMI of 20 there is a notably greater rate of increase for the curve of green soldiers than either the amber or red category. As an example, for the upper limit of normal BMI at 25, we see that more than half of the green soldiers are included at around 56% but only roughly 33% of the amber or red soldiers. The observer will note that the slope of the green curve tapers rapidly beyond a BMI of 31 but the curves of amber and red category curves remain offset until at or past BMI of 35 where distinctions are no longer discernable.

Having detected that there were apparent differences between the green, amber and red PULHES categories, the researcher with the assistance of Dr. Bitters and Dr. Lauer conducted an Analysis of Variance (ANOVA) to determine if the differences in mean BMI were statistically significant differences between these categories with respect to BMI. With a null hypothesis of no difference between categories and the alternative hypothesis of at least one of the categories being different, an ANOVA was conducted. The ANOVA tests the strength of the relative confidence of a Type 1 error of a false conclusion to a 95% level of significance. The outcome of the ANOVA demonstrated the means between PULHES categories were not equal, with $F(2, 51.430)=698.25$, $p<0.001$, allowing the rejection of the null hypothesis with 95% confidence and supporting the premise that at least one of the PULHES categories was different from the other two.

Subsequently, being confident that at least one of the categories were significantly different from the other two, the next step in analysis was to determine which category or categories demonstrated statistically significant differences from the other categories. By this, the investigator sought to determine through a Pairwise Comparison more specifically what the differences between the categories were. Using Tukey's Pairwise

Comparison the investigator determined confidence intervals for all pairwise differences between the category BMI means while controlling the family error rate to a 5% risk of type 1 error. As for a series of comparisons there is an inherently greater error rate, due to the cumulative effects of uncertainty in an iterative series, Tukey's Pairwise Comparison controls for this effect by restricting the confidence level for the individual comparison between each category. In Table 5, the BMI means, standard, deviations, and 95% confidence intervals for each PULHES categories are displayed. This allows for a 5% chance or less that the mean for each category is outside of the listed interval.

Means, Standard Deviations and 95% Confidence Intervals by PULHES Category				
Category	Number	Mean BMI	St-Deviation	95% CI
Green	44,223	26.0610	3.3195	(26.0291, 26.0930)
Amber	2,977	27.3060	3.8319	(27.1828, 27.4292)
Red	233	27.9047	4.1805	(27.8014, 28.0080)

Source: Created by author.

These confidence intervals were then compared against each other using Tukey's Simultaneous 95% Confidence Interval Comparison, as found in Table 5. Using Tukey's pairwise to cross estimate of probability given the variables of PULHES status against body mass index. It was noted with use of the point estimates that at the extremes of body mass index there was marked variability. This comparison shows that each PULHES category was found to be significantly different from each other with respect to mean BMI.

[REDACTED] Tukey's Simultaneous 95% Confidence Interval Comparison			
PULHES Category	Number	Mean	Grouping
Red	4233	27.9047	A
Amber	2977	27.3060	B
Green	44223	26.0610	C

Source: Created by author.

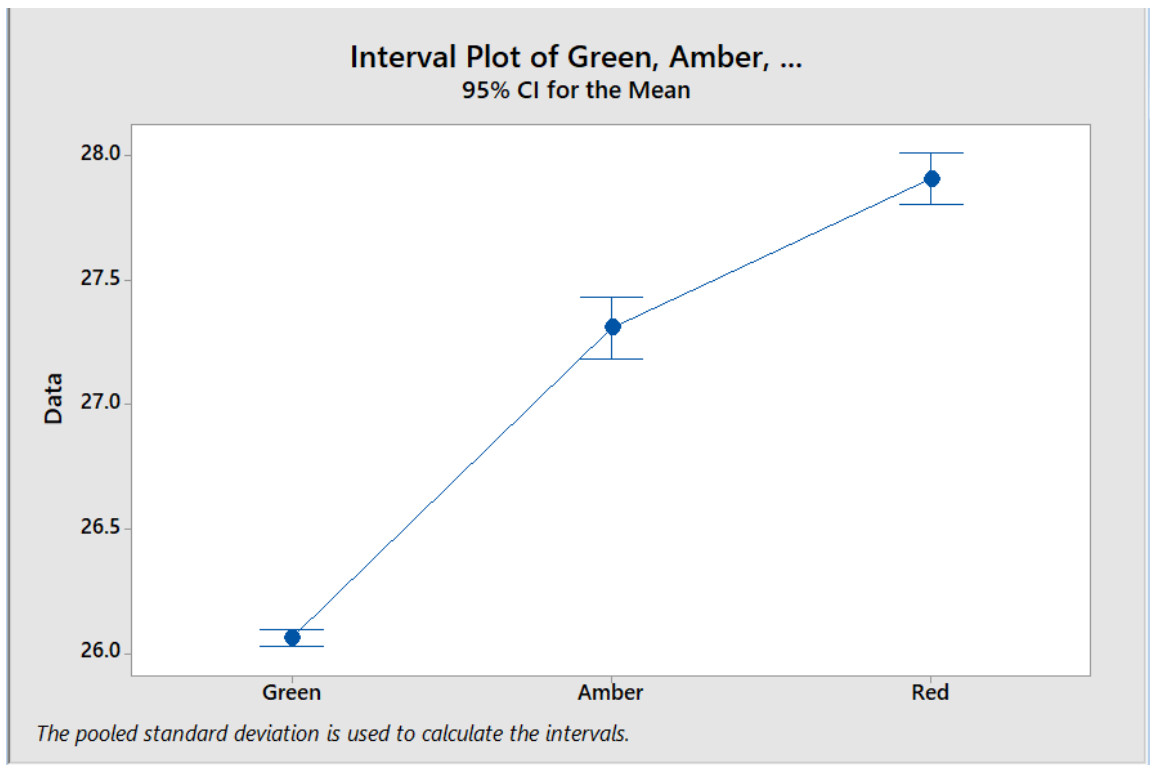


Figure 11. Interval Plot Mean BMI 95% Confidence Intervals

Source: Created by author.

Figure 11 Interval Plot Mean BMI 95% Confidence Intervals provides a graphical depiction of the information included in Table 5 and Table 6. The observer will note that for each confidence interval there is no overlap with respect to the other confidence

intervals, indicating that the PULHES categories are distinct with respect to median BMI values. The implication is that with increasing severity of restriction on physical limitation by permanent medical profiling, there is an observed increase in soldier's average BMI. This raises the credible possibility that physical restriction and BMI are covariate in the active duty army population.

In order to assess the validity of the one-way ANOVA, the author reexamined the statistical assumptions made in modeling the population. To determine whether or not there were statistically significant differences between the green, amber and red groupings of soldiers based on permanent PULHES data, the researcher with the help of Dr. Bitters and Dr. Lauer reviewed the assumptions inherent to ANOVA. There are six assumptions required for this test in order for the results to be interpreted as valid. Assumption #1 is that the dependent variable, in this case BMI, is continuous in nature. Assumption #2 is that the independent variable consists of two or more categorical, independent groups, which were green, amber and red in this case. Assumption #3 is that there is independence of observations. Assumption #4 is that there should be no significant outliers. Assumption #5 is that the dependent variable should be normally distributed, and assumption #6 is that there needs to be homogeneity of variances, or that for each PULHES category there is equal variance between categories and that the samples were of near equal sizes.¹⁰²

¹⁰² Adam Lund and Mark Lund, "One-way ANOVA in SPSS Statistics," Laerd Statistics, 2018, accessed 8 April 2018 <https://statistics.laerd.com/spss-tutorials/one-way-anova-using-spss-statistics.php>.

In this study population there was a detectable asymmetry for each category that skewed the distribution from normal. In light of the presence of outliers, assumption #4 was violated, and because the population was not normally distributed around body mass index, assumption #5 was violated. Given that the sample sizes were markedly different and because the variance of the categories were not similar, assumption #6 was also violated.

In light of the multiple violations of the assumptions #4, 5 and 6 for an ANOVA analysis, it was necessary to re-analyze the data with different or more strict testing to determine statistical significance. It is important to note the presence of a small number of statistical outliers at the extremes of BMI, both below 19 kg/m² and above 35 kg/m², and that at these extremes previously observed patterns deteriorated and broke down. Outliers, such as purportedly green or amber soldiers with severe or morbid obesity, undermined the effect of the regular one-way ANOVA.

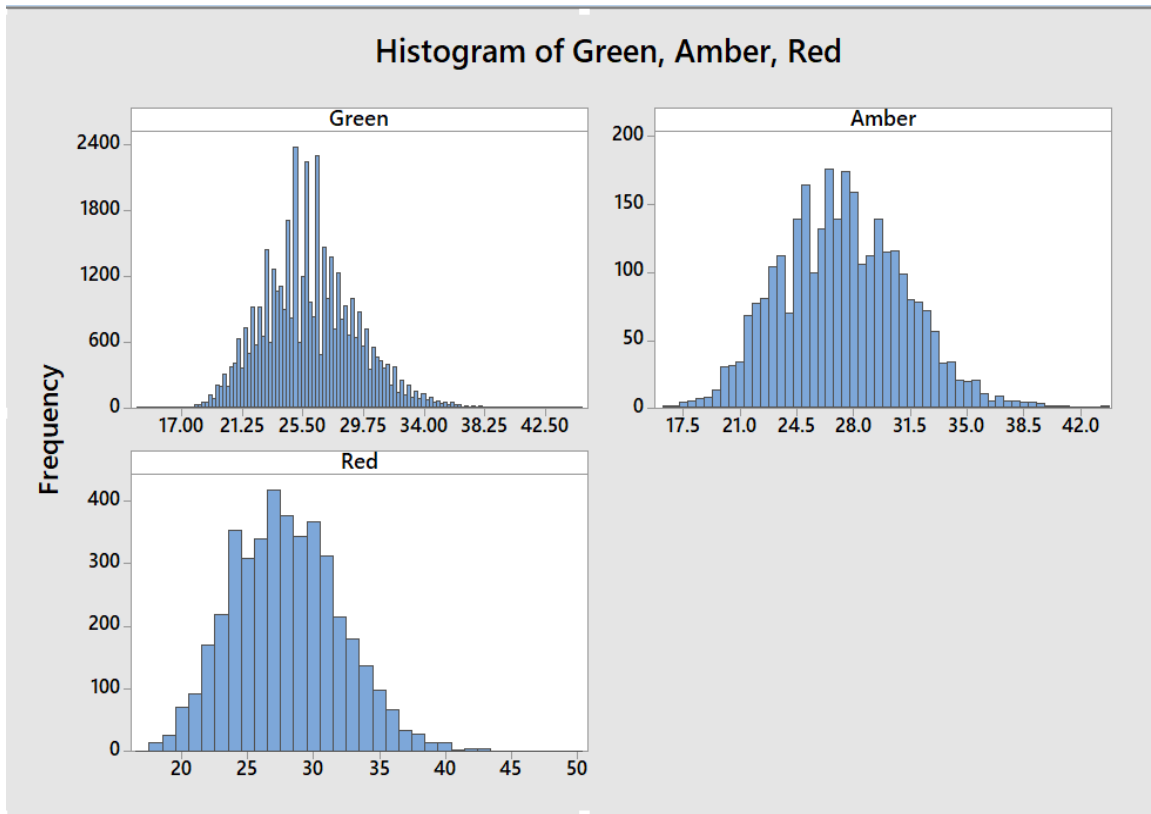


Figure 12. Comparative Frequency Histograms of PULHES categories by BMI

Source: Created by author.

In Figure 12 Comparative Frequency Histograms of PULHES categories by BMI, the observer will note that although the distribution of BMI for each category was slightly irregular and was not strictly, but was approximately normal in their distribution and that for each category the distributions were relatively equal and did not demonstrate skewing. It is important to note however that the categories were of unequal size. With the population of green PULHES being several times larger than the other categories, the standard assumptions for ordinary ANOVA were violated.

To estimate the Standard Deviation of each population, the investigator created Bonferroni Confidence Intervals on the acceptably normal distribution of the PULHES categories. These intervals indicate a 95% confidence that in the aggregate for all confidence intervals in this group there is a true standard deviation for each category. Additionally, there was 98.33% confidence in each individual category. This information is depicted in Table 7 95% Bonferroni Confidence Intervals for Standard Deviation.

95% Bonferroni Confidence Intervals for Standard Deviation			
PULHES Category	Number	Standard Deviation	Confidence Interval
Green	45107	4.88397	(4.78039, 4.99006)
Amber	2980	3.92672	(3.75931, 4.10489)
Red	4234	4.20194	(4.08166, 4.32821)

Source: Created by author.

To assess for equal variance, the researcher with the assistance of Dr. Bitters and Dr. Lauer conducted multiple comparison tests, seeking to establish with 95% confidence that there was at least one category with unequal variance. In Table 8 Test for Equal Variation Within the Three PULHES Categories, we investigate multiple comparisons and Levene's test, which given a p-value of 0.000 shows that the standard deviations are not equal.

Test

Null hypothesis	H ₀ : All variances are equal
Alternative hypothesis	H ₁ : At least one variance is different

Test for Equal Variation Within the Three PULHES Categories		
Method	Test Statistic	P-Value
Multiple Comparisons	=	0.000
Levene	11.30	0.000

Source: Created by author.

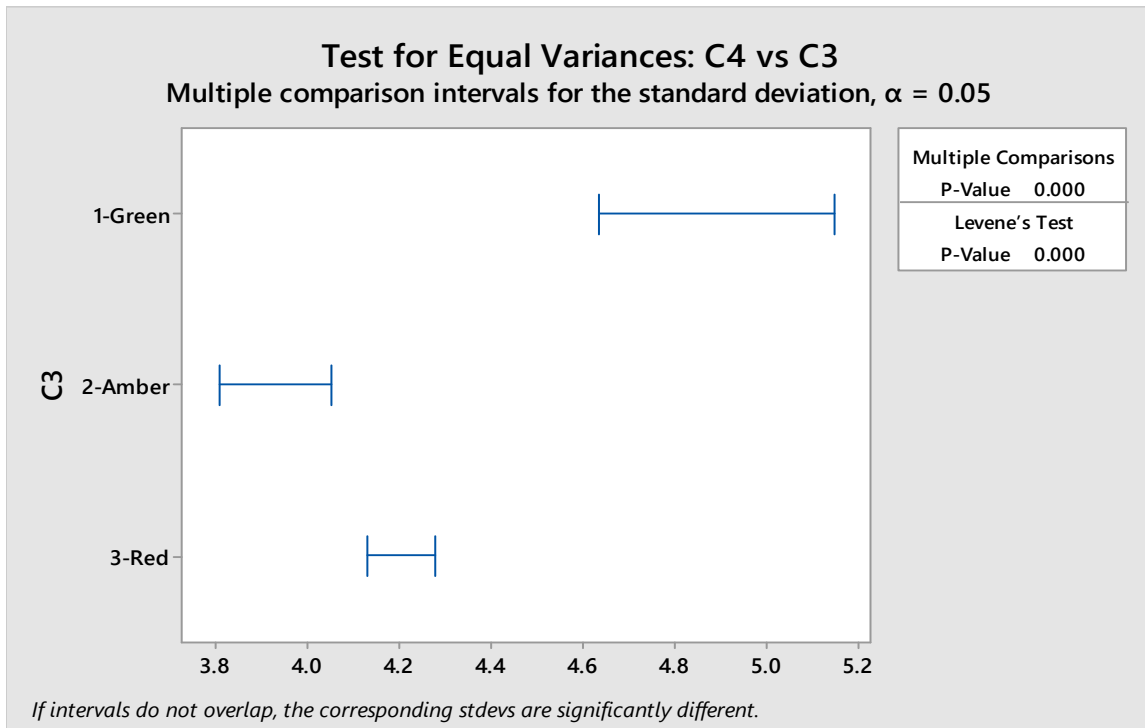


Figure 13. Test for Equal Variances

Source: Created by author.

In Figure 13 Test for Equal Variances, with the help of Dr Bitters and Dr Lauer, the researcher conducted a test for equal variance, which investigates pairs of standard deviations that are equal. As seen in Table 7 95% Bonferroni Confidence Intervals for Standard Deviation, the figure validates that the variance between the PULHES

categories were unequal. Given that none of the intervals overlap, the observer can be confident that the variance in each category is statistically significant. Having established unequal variance between the PULHES categories, in order to determine if the categories were distinct from each other, further testing was needed.

The violations of assumptions were mitigated through the use of Welch's method of Analysis of Variance (ANOVA). This was appropriate because the Welch's ANOVA can account for unequal variances and unequal sample sizes which were present in this population. Using the hypothesis that the population of medically unrestricted soldiers, green PULHES soldiers would be distinct from those with documented permanent medical restrictions, the mean BMI of each population was calculated with standard deviations.

With a level of significance set to 95%, the outcome of the Welch's ANOVA demonstrated that the means between PULHES were not equal, $F(2, 3,194.49) = 1,172.21, p < 0.000$. This result allowed for the researcher to reject the null hypothesis of equality of PULHES groups and establish that the means within the sample were not equal.

To further characterize the results, a pairwise-comparison post-hoc test was performed using the Games-Howell method in order to compare the PULHES categories against each other, while controlling for Type 1 error. This method was selected because it can be employed when categories do not have equal variance. The results of this assessment are noted in Table 9 Games Howell Post hoc Test.

Games-Howell Post-Hoc Test			
PULHES Category	N	Mean	Grouping
red	1317	28.188	A
amber	7844	27.9569	A
green	42272	25.9153	B

Source: Created by author.

The observer will note that both the red and amber PULHES category resulted in the same grouping, and that their mean values were very similar as compared to the green category.

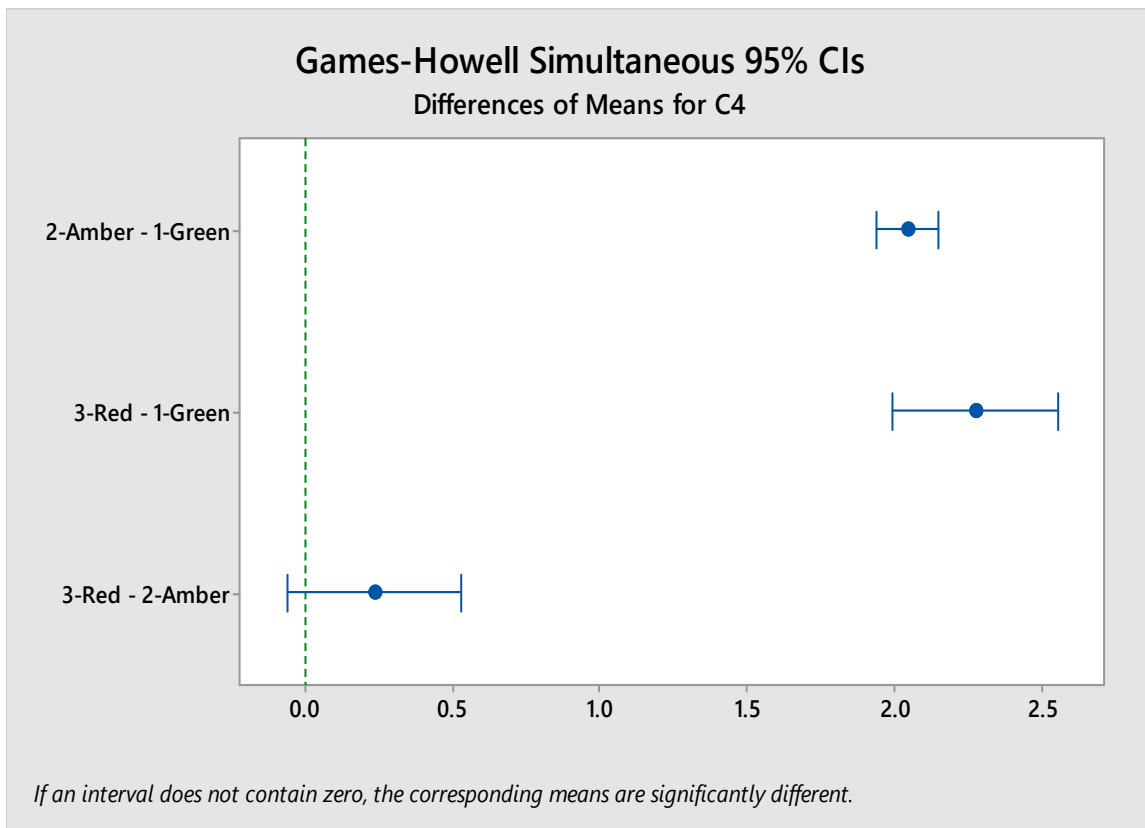


Figure 14. Games-Howell Simultaneous 95% Confidence Intervals

Source: Created by author.

In Figure 14, as in Table 9, we see a graphical depiction of the Games Howell post hoc pairwise comparison test. As the figure displays, the pairwise comparison between red and amber had a confidence interval that included zero, which indicated that any distinction between the two categories with respect to BMI could not be said to be statistically significant, and that instead the means were in fact similar. Although there was a statistically significant difference between the amber and green populations, as well as the green and the red populations, there were no statistically significant differences noted between the red and amber populations. Therefore, with the Games Howell testing, both the amber and red categories were grouped together and these categories had very similar mean values for BMI.

The final test of the population was to perform an ordinal logistic regression in order to examine the relationship between the variables of interest. The data was inherently ordinal data in nature, in that the values are ranked by name but not necessarily by a continuous scale. The purpose of this regression was to determine if it was possible to make predictions about BMI and PULHES categories using statistical modeling. This was performed twice; first with a less conservative set of parameters to create the model, followed by a more conservative, or restrictive, ordinal logistic regression.

For an ordinal regression there are four key assumptions. The first of which is that the dependent variable is of an ordinal measure. The second assumption is that the independent variables are either continuous, categorical or ordinal. Third, that there is no multi-collinearity where the variables are closely linked, and last, that there are

Proportional Odds, where each independent variable has an identical effect on the cumulative outcome.¹⁰³

The intent of the logistic regression was to determine to what extent army readiness as indicated by lack of permanent PULHES 2 or 3 profiles could be predicted based on BMI. A recognized constraint of the model was the unequal sample size of the different categories. The result of the ordinal regression was a predictive model based on the large sample size of this population. However, the PULHES categories contained unequal variance the predictive model was not able to account for the variance between the groups. Two tests as measures of association were run, The Somers D, and the Goodman-Kruskal Gamma tests, with scores of 0.31 and 0.34 respectively. The interpretation for these scores was that they were marginal results and indicated that the fit between the data and the model was suboptimal. A third test of association, The Kendall's Tau-A, was then performed and the result was 0.09, which supported the findings from the first two tests of association.

In summary, although the Ordinal Logistic Regression did produce a model, the model did not hold at the extremes of BMI. It was also a suboptimal fit to the data. As an initial attempt, this model was predictive and significant. However, the model could be rebuilt in the future, adding additional independent variables such as temporary profiles, patterns of medical utilization, missed appointments, tobacco use, etc. to consider as additional variables. Some or a combination of these other potential variables may

¹⁰³ Adam Lund and Mark Lund, "Ordinal Regression using SPSS Statistics," Laerd Statistics, 2018, accessed 1 May 2019 <https://statistics.laerd.com/spss-tutorials/ordinal-regression-using-spss-statistics.php>.

significantly enhance the value of the model, in a way similar to how the MRAT was designed to predict risk of non-deployability. This would be necessary in order for the model to explain more of the variance we observed in this study population.

In seeking to define an association between BMI, PULHES profile status, and Rank, the author used Microsoft Excel to ascertain the relative prevalence of each of these variables and tabulated this information in Table 10 BMI and Profile Distribution vs Rank.

BMI and Profile Distribution vs Rank

<i>Rank</i>	<i>Totals</i>	<i>BMI>30</i>	<i>%BMI>30</i>	<i>BMI>35</i>	<i>%BMI>35</i>	<i>P3 Profile</i>	<i>%P3 Profile</i>	<i>P2 Profile</i>	<i>%P2 Profile</i>	<i>P1 unrestricted</i>	<i>% P1 by rank</i>
E1	648	50	7.72%	2	0.31%	7	1.08%	20	3.09%	621	95.83%
E2	4816	332	6.89%	31	0.64%	20	0.42%	131	2.72%	4665	96.86%
E3	8035	798	9.93%	85	1.06%	118	1.47%	416	5.18%	7501	93.35%
E4	17380	2391	13.76%	222	1.28%	461	2.65%	2134	12.28%	14785	85.07%
E5	8517	1404	16.48%	114	1.34%	278	3.26%	1874	22.00%	6365	74.73%
E6	4633	1202	25.94%	103	2.22%	231	4.99%	1480	31.94%	2922	63.07%
E7	2159	628	29.09%	68	3.15%	105	4.86%	935	43.31%	1119	51.83%
E8	620	152	24.52%	13	2.10%	23	3.71%	228	36.77%	369	59.52%
W1	1	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%
W2	350	67	19.14%	6	1.71%	11	3.14%	99	28.29%	240	68.57%
W3	178	38	21.35%	3	1.69%	4	2.25%	82	46.07%	92	51.69%
W4	42	10	23.81%	0	0.00%	3	7.14%	18	42.86%	21	50.00%
O1	679	36	5.30%	3	0.44%	2	0.29%	15	2.21%	662	97.50%
O2	2052	142	6.92%	6	0.29%	16	0.78%	78	3.80%	1958	95.42%
O3	1665	212	12.73%	12	0.72%	21	1.26%	211	12.67%	1433	86.07%
O4	362	68	18.78%	2	0.55%	7	1.93%	57	15.75%	298	82.32%
O5	105	10	9.52%	0	0.00%	1	0.95%	10	9.52%	94	89.52%
SNR	193	40	20.73%	2	1.04%	9	4.66%	66	34.20%	118	61.14%
total	52435	7580	14.46%	672	1.28%	1317	2.51%	7854	14.98%	43264	82.51%

Source: Created by author.

Soldiers of the highest ranks, with rank of E9, W5 and O6 were aggregated into a single row for senior personnel (SNR). Although overall obesity prevalence indicated that about one in seven soldiers were obese, nearly one in five Majors (O4) were obese and more than one in four Staff Sergeants (E6) and Sergeants First Class (E7) were obese. The prevalence of severe obesity was also pronounced in the E7 rank with rates nearly two and a half times higher than the overall prevalence. Also, readily apparent was an inverse correlation between rates of obesity and P1 status.

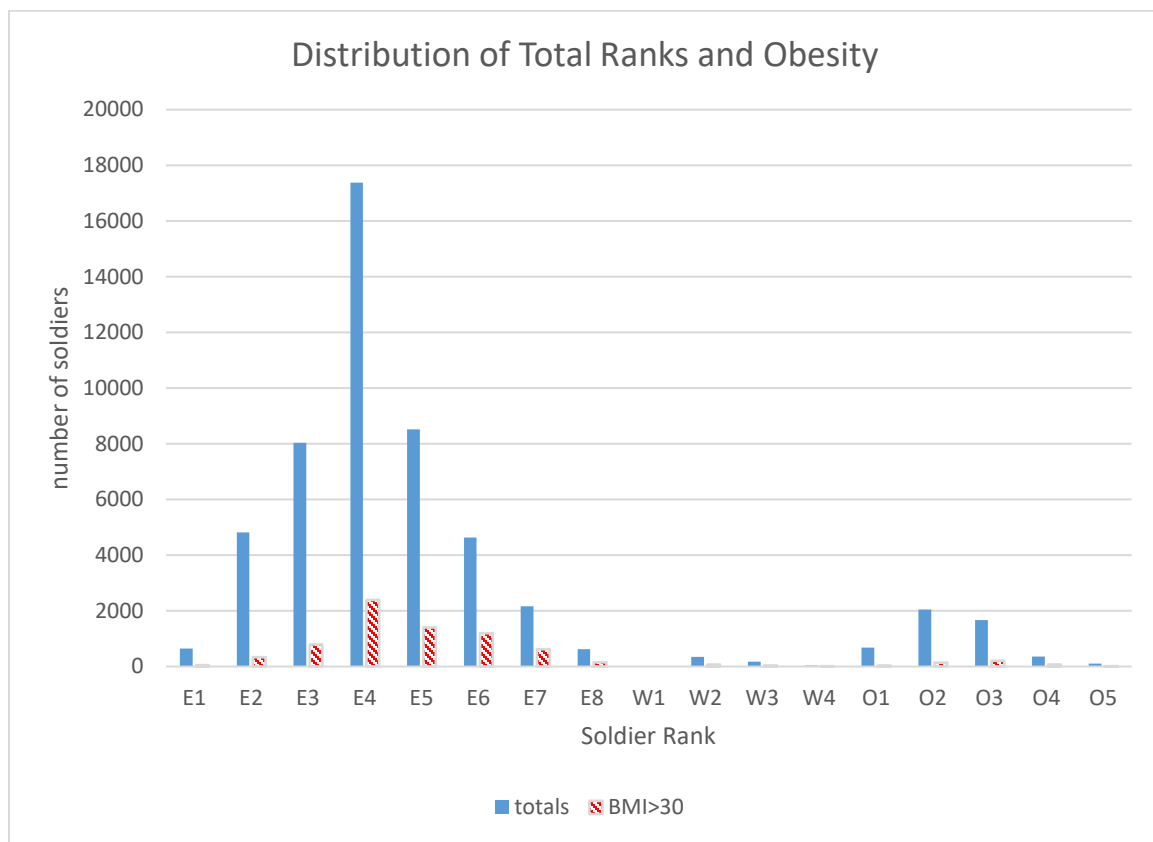


Figure 15. Distribution of Total Ranks and Obesity

Source: Created by author.

Figure 15 Distribution of Total Ranks and Obesity reflects the overall population of each rank as well as the numbers of obese soldiers in each rank as computed by BMI data. Consistent with expectations the vast majority, nearly three quarters (73.9%) of soldiers were in the rank Private to Sergeant (E2-E5). Of soldiers in these ranks, there were 9.4% who were obese. In contrast, all other soldiers including E1 privates, senior NCOs, officers and warrant officers comprised slightly more than one quarter (26.1%) of soldiers of which 19.4% were obese. In terms of rank, the rank with the lowest demographic of soldiers with an obese BMI was the Private (E2) rank, with a 6.89% rate of obese BMI. The rank with the highest proportion of soldiers with an obese BMI was the Sergeant First Class (E7) rank, with a 29.09% rate of obese BMI.

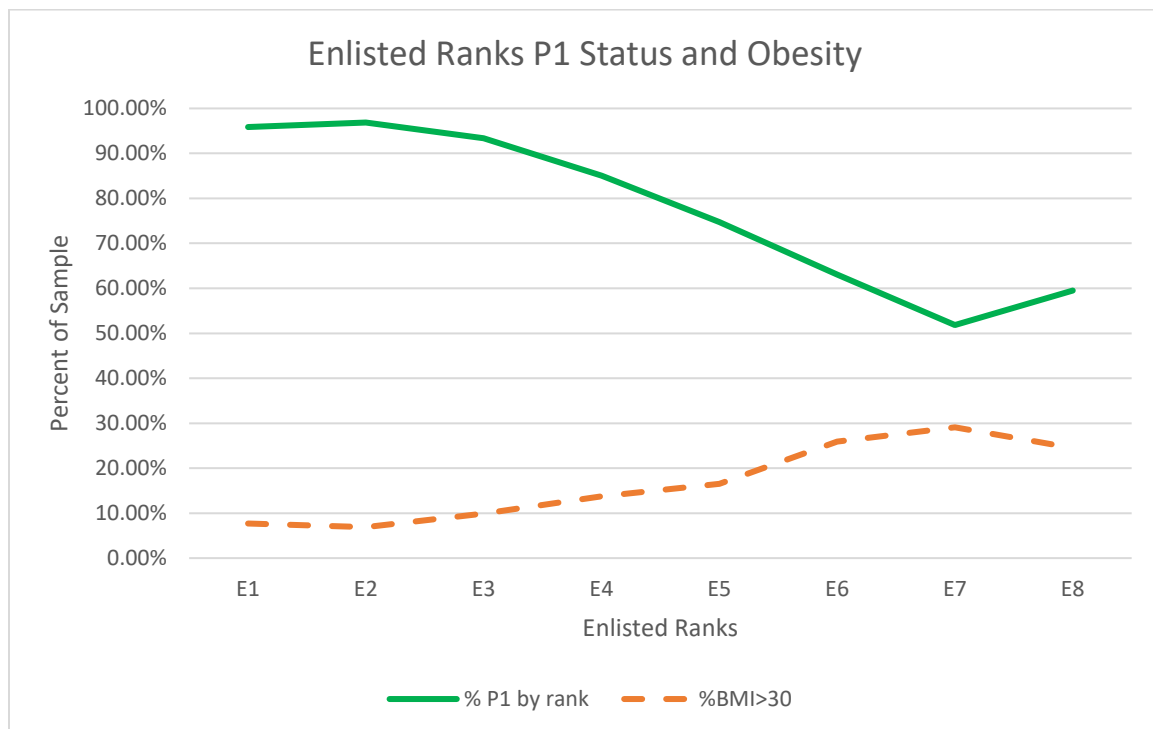


Figure 16. Enlisted Ranks P1 Status and Obesity

Source: Created by author.

Figure 16 Enlisted Ranks P1 Status and Obesity depicts the rates of enlisted members who had “green” PULHES data indicating that they did not have permanent medical profiles (P1) as well as the rate at which soldiers were obese by BMI measure; i.e. $BMI \geq 30 \text{ kg/m}^2$. As enlisted members gained seniority the probability of P1 permanent profile status, (blue line) declined and the probability of obese BMI status (lower, orange line) increased. Among enlisted, the overall probability of having an obese BMI rating was 15.19%. Both of these trends reversed slightly after E7 rank for the most senior enlisted members, indicating that a lower proportion of E8 and E9 ranks were obese and a higher proportion did not have permanent profiles in comparison to E7 rank.

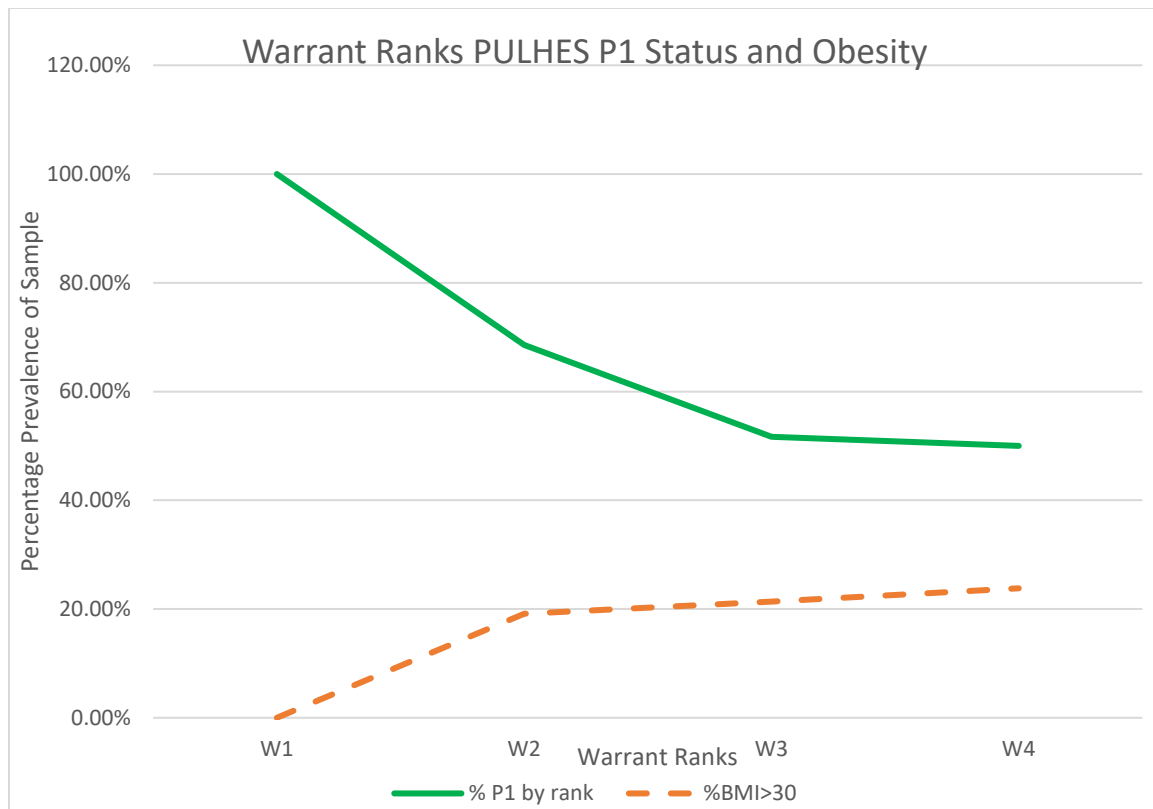


Figure 17. Warrant Ranks P1 Status and Obesity

Source: Created by author.

Figure #17 Warrant Ranks P1 Status and Obesity depicts the rates of warrant officers members who had “green” PULHES data indicating that they did not have permanent medical profiles (P1), as well as the rate at which soldiers were obese by BMI measure; i.e. $BMI \geq 30 \text{ kg/m}^2$. Overall the number of warrant officers in this study was low, comprising just 579 soldiers or 1.1% of the study population. As warrant officers gained seniority in rank the probability of P1 permanent profile status declined and the probability of obese BMI ($\geq 30 \text{ kg/m}^2$) status increased. Among warrant officers overall the probability of having an obese BMI was 19.86%.

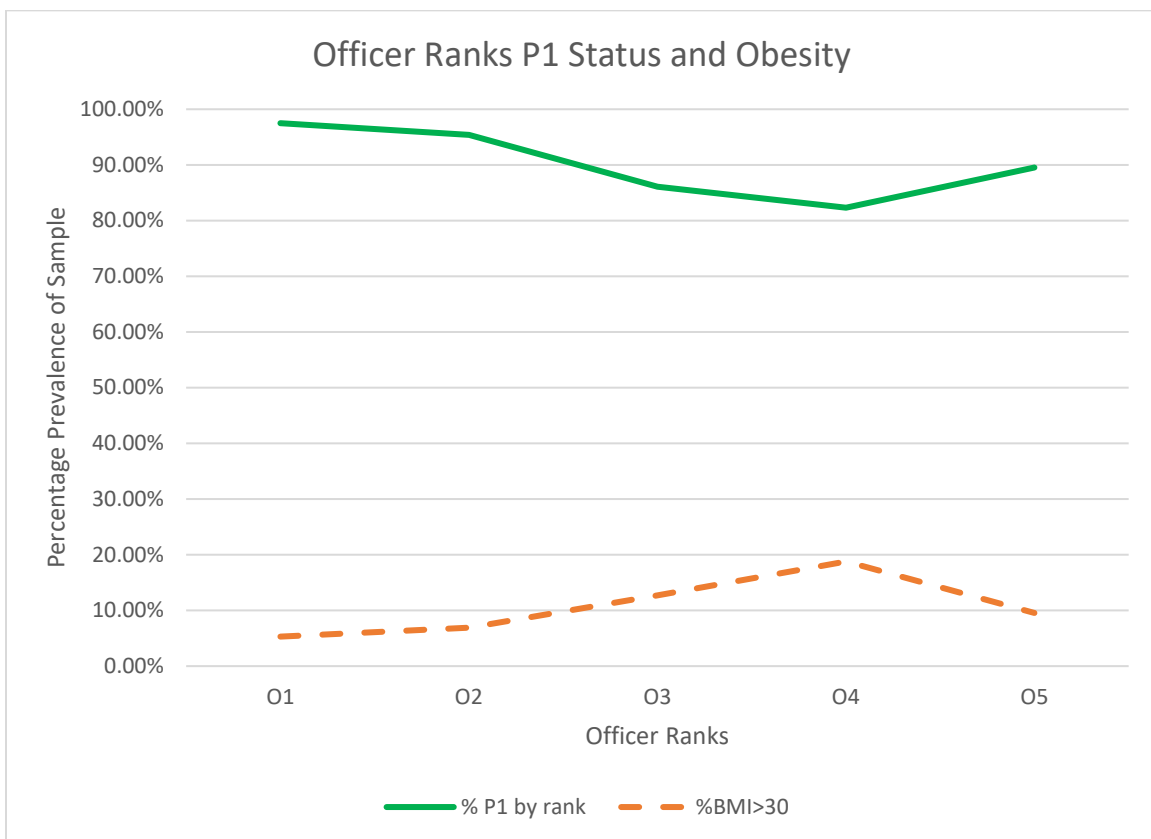


Figure 18. Officer Ranks P1 Status and Obesity

Source: Created by author.

Figure #18 Officer Ranks P1 Status and Obesity depicts the rates of officers who had “green” PULHES data indicating that they did not have permanent medical profiles (P1) as well as the rate at which soldiers were obese by BMI measure; i.e. $BMI \geq 30 \text{ kg/m}^2$. Overall the officers ranks represented 9.3% of the study population. As with enlisted and warrant officer ranks, as officers gained seniority the probability of P1 permanent profile status declined and the probability of obese BMI ($\geq 30 \text{ kg/m}^2$) status increased, with a reversal of both trends at the transition of rank between Major (O4) and Lieutenant Colonel (O5). The author speculates that the reason for this reversal is that there is either reduced rates of promotion or increased rates of separation between Major and Lieutenant Colonel, or both. Slightly more than half of all officers were Second or First Lieutenants (O1/O2), and the rate of obesity among Lieutenants was 6.5%. In the survey population it was found that 12.7% of Captains (O3) and 18.8% of Majors had an obese BMI. Overall among officers the probability of having an obese BMI was 9.6%.

In reviewing the ranks of all servicemembers and the trends in both PULHES green status and obesity prevalence, it appears consistent that rates of permanent profile and obesity increase with increases in rank, although these trends reverse slightly at the highest officer and enlisted ranks. In evaluating for the possibility of differences in obesity and prevalence among different units, it is perhaps to be expected that variance will be noted that reflects different proportion of seniority of soldiers as well as different physical requirements in different units. For example a signal brigade would have a higher proportion of older, more experienced but also heavier soldiers in relation to an

infantry brigade combat team with both younger soldiers and more strenuous physical requirements.

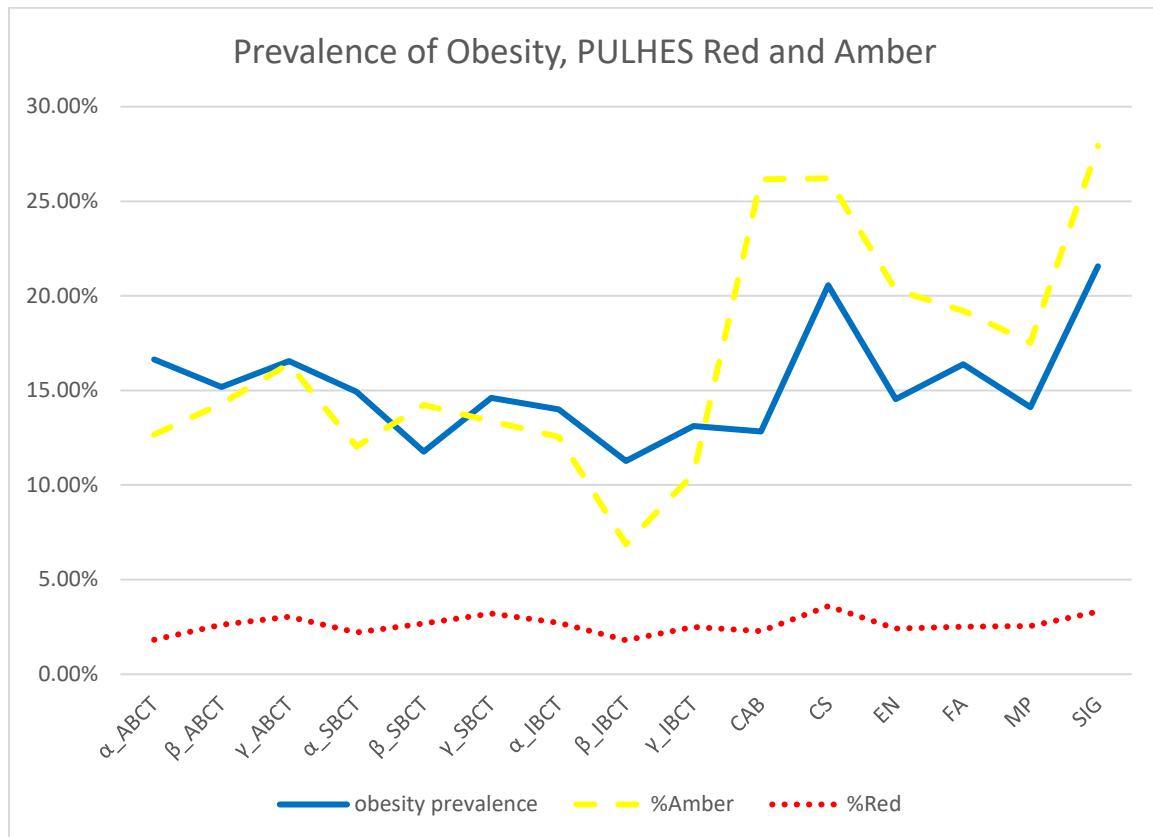


Figure 19. Prevalence of Obesity, PULHES Red and Amber

Source: Created by author.

In assessing for obesity prevalence across units there was an observed close correlation between the prevalence of obesity and the prevalence of permanent profiling, particularly with regard to P2 profiles. Figure 19 Prevalence of Obesity, PULHES Red and Amber depicts the incidence of obesity prevalence as well as incidence of red and amber PULHES categories for each unit. There were apparent differences between units with regard to both profile and obesity rates.

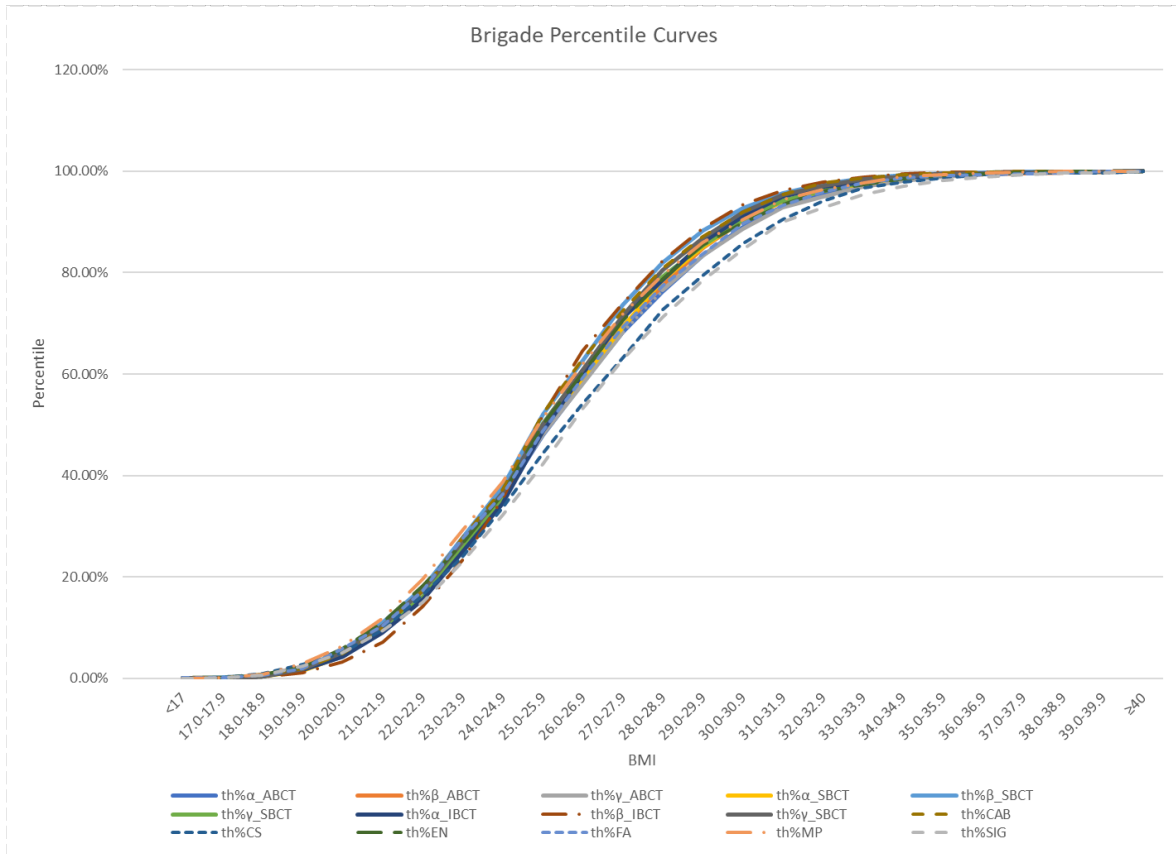


Figure 20. Brigade Percentile Curves

Source: Created by author.

As discussed with Figure 19, Figure 20 Brigade Percentile Curves shows the cumulative percentile curves of the different brigades plotted against each other overall there was perceivable variation among the 15 brigades assessed with respect to BMI. This, however, was somewhat difficult to appreciate given the general confluence of the cumulative percentile curves. Interestingly, the brigades followed generally the same trends.

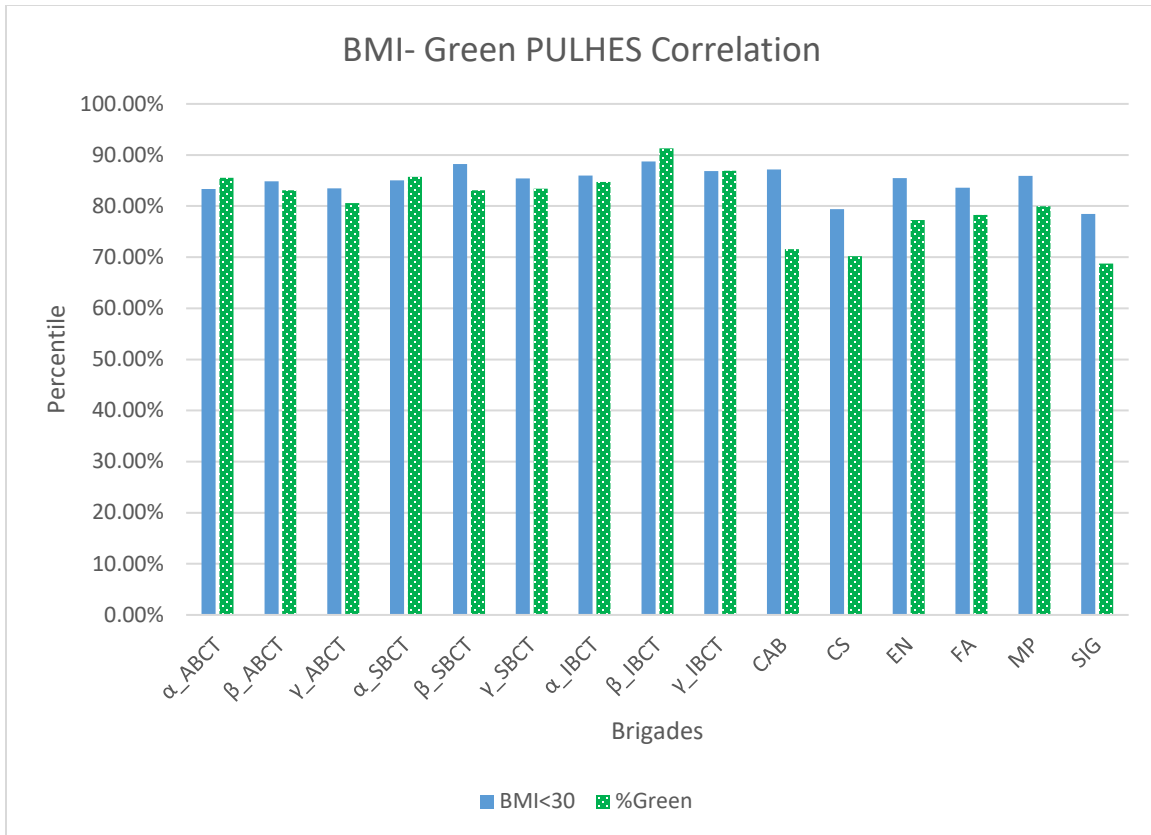


Figure 21. BMI-Green PULHES Correlation

Source: Created by author.

To better appreciate the differences units discussed in Figure 20, in Figure 21 BMI Green PULHES Correlation the various units were directly compared against each other with respect to BMI and Green PULHES prevalence. An interesting observation was that in the brigade combat teams, whether armor, stryker, or infantry, it was observed that the rates of non-obese BMI and green PULHES were fairly comparable, as opposed to the other brigades where there was less agreement between the rates of these variables.

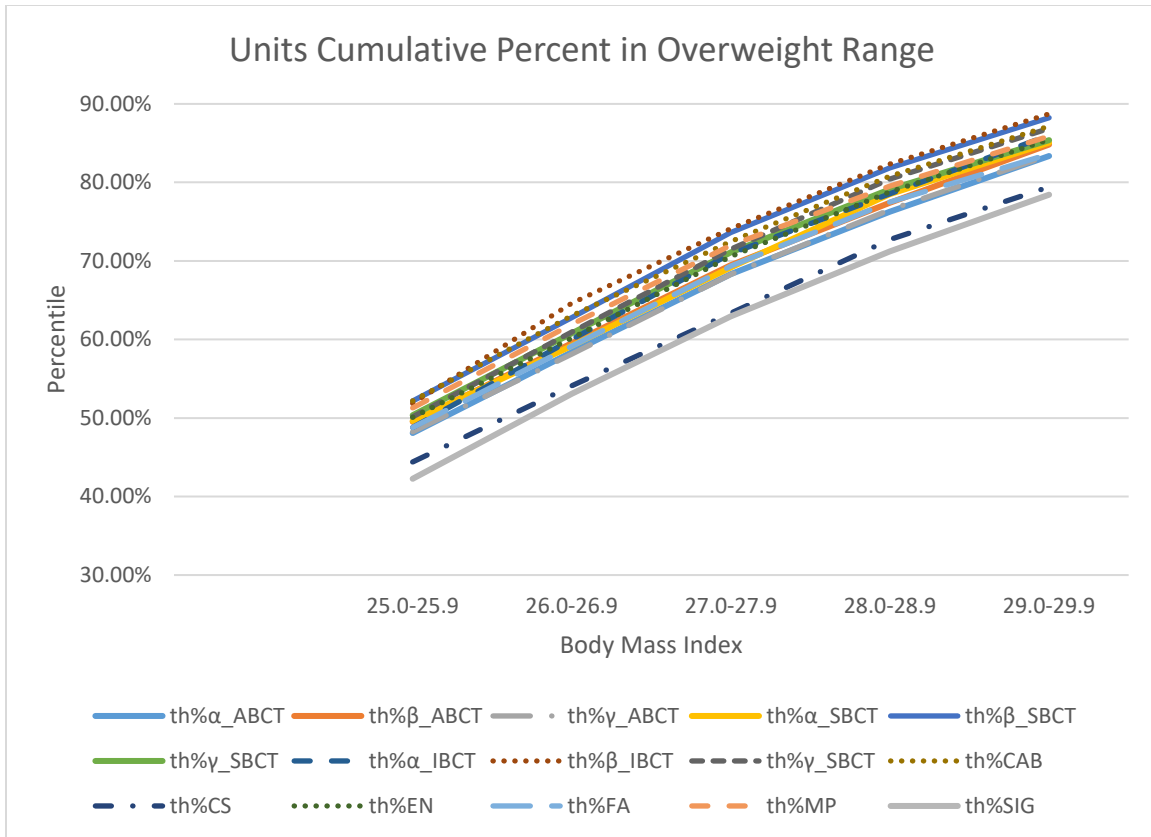


Figure 22. Units Cumulative Percent in Overweight Range

Source: Created by author.

Figure 22 Units Cumulative Percent in Overweight Range depicts the rates of soldiers in the various brigades with body mass index in the obese range. As in the last graphic there was significant variation between the units however they followed largely similar trend lines.

From the units with the highest (signal brigade, 21.56%) to the lowest (β-infantry brigade combat team, 11.27 %) rate of obese BMI there was a greater than 10% difference between incidence, and in the signal brigade the incidence of obesity was more than 187% higher than the rate of the cited infantry unit, indicating that the signal brigade

soldiers were nearly twice as likely to be obese relative to the soldiers in the infantry brigade. Both the age and the physical duties of the soldiers are likely factors, since the signal soldiers will generally have more older, and therefore more likely heavier soldiers, and their physical requirements tend to be less vigorous.

Further, it is of significant value to consider options which might reduce the proportion of soldiers who have physical limitations, and thereby increase the population of unrestricted, P1 physical classification soldiers. An important consideration is the question of if there is a body mass index at which a soldier should be categorically considered disqualified for service based on the probability of physical limitation.

With a hypothetical goal, arbitrarily determined by the researcher, of reducing overall permanent profiles by 20%, a 20% reduction in P2 profiles in this population would reduce prevalence to 12%, and a 20% reduction in P3 profiles would reduce prevalence to 2% of the population. To accomplish this goal the researcher sought to determine a decision rule based on body mass index. In this study population, soldiers with BMI greater than or equal to 31kg/m^2 , included 20.54% of all P2 profiles and 25.28% of all P3 profiles. This population also included 7.11% of soldiers without permanent profiles (At a BMI of 33kg/m^2 , including 2.37% of unprofiled soldiers, 9.43% of P2 profiles and 13.52% of P3 permanent profiles). Finally, those with severe obesity with a BMI of 35kg/m^2 included 0.73% of unprofiled soldiers, 3.47% of P2 profiles and 7.06% of P3 profiles.

Based on reviewed literature it is likely that the majority of the soldiers with a BMI over 30 have excess body fat.¹⁰⁴ It appears that current standards, if effectively and equitably enforced would therefore be sufficient to achieve the stated goal of a 20% reduction in all permanent profiles. Such a reduction would represent a substantial improvement in total force readiness and would have dramatic and salutary effects which could take effect fairly rapidly. Stated another way, we can fairly justifiably attribute 20% of both the Army's P2 and P3 permanent profiles to soldiers who are obese and very likely do not meet standards for body composition as they are prescribed by existing regulation. Improving the efficacy of the Army's body composition program could therefore dramatically improve the readiness of the current force.

¹⁰⁴ Okorodudu et al., "Diagnostic Performance of Body Mass Index to Identify Obesity as Defined by Body Adiposity," 798.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In this study, the principle research question at outset was to investigate the impact of obesity on the Army. With regard to the implicit question of readiness; the ability of soldiers and units to deploy and accomplish their mission, there is a clear case to be made that physical limitations indicated by P3 profiles absolutely and P2 profiles incrementally have a direct negative impact on army readiness. Therefore, the answer to that question based on this study is that there is significant measurable negative impact on the physical capabilities of soldiers that has direct links to obesity, as measured by permanent PULHES profiles. Importantly, this research supports the hypothesis that obesity and physical limitation by permanent PULHES are covariate, or linked variables. In fact, the Odds Ratio for both P2 and P3 profiles was 3.45 in comparing soldiers with an obese BMI relative to soldiers with a normal BMI. Again, importantly, this study establishes that there is a strong association of both obesity and higher rank, which has important implications for the Army as it modernizes.

As to the observation that this study did not directly measure individual or aggregate readiness by the Army's system of record, this point is acknowledged. The reason this was not assessed or considered is that unit readiness status is a matter of national security and its classification is therefore beyond the scope of this research, but is a potentially fertile area for further study at the appropriate classification level.

Furthermore, the sub questions of this research as presented in chapter 1 were as follows:

- 1) What proportion of soldiers in the deployable active force are obese?

- 2) Does a relationship exist between obesity and PULHES limitations?
- 3) Is there a BMI difference between red and amber PULHES?
- 4) Are there disparities in relationship between active duty rank and obesity?
- 5) How effective is the Army at addressing obesity in soldiers?

In terms of the proportion of soldiers who are obese, consistent with the review of the literature, a significant percentage of soldiers meet criteria for obesity and the proportion of soldiers who are obese has seen a significant recent historical rise. The contention that there has been deterioration in the efficacy of the Army's ability to control overweight and obesity since the engagement in combat operations after September 11, 2001 appears well supported by this study and review of literature. It is important to point out that the increase in obesity during this time frame has been near exponential. In the study the researcher found that 14.46% of soldiers in the study population were obese. Using a low estimate of pre- War on Terror obesity rate of 1.6%, this study population has a more than 900% higher incidence of obesity than the U.S. Army of 2001.

Regarding the relationship between obesity and PULHES limitations, analysis of the study data reveals several important findings. The first is that soldiers with an obese body mass index were more than twice as likely to have a permanent level 3 profile and nearly twice as likely to have a permanent level 2 profile when compared to the baseline rate of the study population. This analysis also demonstrates that the risk of permanent profiles highly correlates to the severity of obesity, as soldiers with a BMI over 35 kg/m² were over five times as likely to have a permanent level 3 profile when compared to baseline of the study population. Thus, the higher a soldier's BMI is, the more probable it

becomes that he will have documented permanent physical limitations as indicated by PULHES.

We see in this study that among a large sample of active duty soldiers, obesity correlates with both level two “limiting” and level three “severely limiting” permanent medical profiles. A surprising finding of this study was the close similarities and lack of variance between those with level 2 and level 3 permanent PULHES with respect to body mass index. An operating assumption of the PULHES system is that those with level 2 PULHES have some degree of physical limitation but are otherwise generally fit and physically capable of doing required activities necessary to deploy and accomplish the Army’s wartime mission, while those with the more severe level 3 categorization are not. The surprising significant similarity between the amber and red permanent PULHES classifications with respect to BMI suggest the possibility that the distinction between limited and severely limited may not be as definitive or objective as army policy makers have assumed. The clear distinction between the unrestricted population and those with limitations or severe limitations suggests to the author that those without restrictions are engaging in a meaningfully higher degree of physical activity and exercise than the other two categories.

Moving forward, this analysis should be used to inform future decisions regarding cutoffs for medical retirement and/or retention point determinations. The interrelationship between BMI, rank and physical limitations prior to this study was not well understood, and this knowledge can be applied to improve the Army and the health of active soldiers. In addition, using logistic regression and additional health and strength variables such as physical fitness test scores, temporary profiles, and aberrant care utilization patterns, etc.,

it may be possible to create a more accurate model with a higher degree of sensitivity and specificity to identify at risk soldiers and create opportunities for intervention to improve force readiness.

Although the provisions of the Army Body Composition Program have generally not changed, the incidence of obesity has increased sharply. It is also apparent that both obesity and permanent medical profiles increase with seniority in rank. Evaluation of the causes of this deterioration are complex and beyond the scope of this study as delimited in chapter 1. The researcher suggests it is sufficient to establish that the findings of obesity and physical limitation with respect to military purposes are closely linked.

It is not altogether surprising that as soldiers increase in rank, they have an increased tendency to have higher body mass index, because as people age, they have a greater tendency to gain weight. Arresting the tendency to gain weight with age is a complex and difficult problem, as we observe a 422% increase in the rate of obesity between the rank of Private (E2) and Sergeant First Class (E7) in this study population, roughly the span of a military career in terms of rank advancement. This rate of increase, it should also be noted, is likely underestimated by the known tendency for individuals to gain fat mass and lose fat free mass as age increases,¹⁰⁵ making body mass index less sensitive to detection of obesity. It is particularly important because of the role that more senior soldiers have in leading the younger soldiers, and their requirement to both set the example and enforce the standards of service. A cause for further concern is the size of

¹⁰⁵ Baumgartner, Heymsfield, and Roche, "Human Body Composition and the Epidemiology of Chronic Disease," 73-95.

the highest risk noncommissioned officer population. As of 31 August 2018, roughly 55% of the active duty Army was in the grade of E5 to E7, nearly 261,000 soldiers.¹⁰⁶

A reassuring statistic, which may give some perspective regarding how effective the Army is at addressing obesity, is the very low rate of morbid obesity in this study population relative to the general population. In the general adult U.S. population, the prevalence of morbid obesity was found in a recent study to be 7.7%,¹⁰⁷ but in the study population it was 0.068%. Thus, although the rate of obesity in the Army is high, the prevalence of obesity deteriorates sharply as obesity becomes more severe, and morbid obesity is 11,323.53% more prevalent in the general U.S. adult population than it is in the study population. This suggests that although the level of fitness in the military has perhaps reduced since 11 September 2001, it remains much more fit than the general U.S. adult population.

Both the Army and the nation have a vested interest in maintaining the fittest population of soldiers that is possible. In light of this, early identification and intervention in the medical care of overweight and obese soldiers in accordance with Veterans Administration and Department of Defense clinical practice guidelines cannot be overemphasized. Correctly identifying soldiers as overweight and obese allows for screening and treatment of comorbid medical conditions, as discussed in chapter 1 page

¹⁰⁶ Defense Manpower Data Center, “Active Duty Military Personnel by Rank/Grade.”

¹⁰⁷ Craig Hales, Margaret D. Carroll, Cheryl D. Fryar, and Cynthia L. Ogden, “Trends in Obesity and Severe Obesity Prevalence in U.S. Youth and Adults by Sex and Age, 2007-2008 to 2015-2016,” *Journal of the American Medical Association* 319, no. 16 (2018): 1723–1725, doi:10.1001/jama.2018.30601723-1725.

3, and for education and guidance in the areas of proper exercise and nutrition..¹⁰⁸

Appendix A includes a line-wire diagram from the VA-DOD Guidelines that details the evaluation and treatment of overweight and obesity from an algorithmic approach. This promotes not just the health of the soldier but a salutary effect on their military readiness and an improved ability to meet the physical demands of soldiering.

Recommendations

The author proposes three changes to existing policy; eliminating the tape test, imposing auditing/verification mechanisms for compliance, and graduating administrative procedures aimed at addressing body composition. In applying the Capabilities Based Assessment portion of the Joint Capabilities Integration and Development System framework of defense acquisitions, one identified problem is that the weight for height tables surprisingly contains no maximum, but instead have weights that trigger the tape test. No matter how fit, soldiers above a certain size are a liability in combat, and weight and fitness in the obese population are inversely correlated..¹⁰⁹ To phrase it another way, the fitness for service of the overweight is questionable, but as obesity becomes more severe the more dubious fitness becomes. The Army should therefore lower barriers for ABCP enrollment in the overweight, but should identify and closely monitor the obese and more efficiently separate the severely obese from service.

¹⁰⁸ Department of Veterans Affairs and Department of Defense, “Clinical practice guideline for screening and management of overweight and obesity,” 2014, <https://www.healthquality.va.gov/guidelines/CD/lipids/VADoDDyslipidemiaCPG2014.pdf> accessed 5 April 2019

¹⁰⁹ Do et al., “Association between Cardiorespiratory Fitness and Metabolic Risk Factors in a Population with Mild to Severe Obesity.”

Specifically, the author recommends expedited separation of all service members with a BMI over 35, which corresponds to stage II obesity. A compelling argument could be made for expedited separation at a lower threshold BMI of 33, but the researcher will defer on the question of the absolute maximum BMI that should be considered tolerable.

Second, the internal administration of ABCP in army units promotes a data integrity problem that is resolvable with external audit. As explained earlier, in performing the tape test a soldier's waist, neck and height measurements are used in the estimation of body fat percent in men, and in women the waist, hips, neck and height measurements are used.¹¹⁰ In both males and females, neck circumference is subtracted from the other measurements to determine a "circumference value" that is used in a standardized table B5 for males and B6 for females in AR 600-9. Near universally the soldier, and often the evaluator, have a vested interest in the tested soldier being found in compliance, it is unsurprising that soldiers will consistently seek to present their anthropometric measurements as favorably as possible. It is almost as if soldiers didn't know that they can flex their neck and inspire to have normal variation favor their measurements. Also, the author has many times observed soldiers making disproportionate efforts to exercise their neck muscles, which has very questionable health and fitness benefits. However, clearly these efforts have administrative incentive due to the current structure of the ABCP.

Further, the author specifically questions the utility of neck circumference for soldiers with an obese BMI. The regulation appears to make the assumption that a thick

¹¹⁰ HQDA, AR 600-9, 14-39.

neck is a muscular and therefore fit neck. In obese individuals however the evidence suggests that thicker necks are in fact associated with insulin resistance in the presence of Nonalcoholic Fatty Liver Disease (NAFLD), indicating thicker necks in obese individuals are in fact more dangerous.¹¹¹ Clinical measurement for excess neck circumference may in fact be a good test to screen for risk of metabolic syndrome and the incident risk of hypertension, diabetes, hypertriglyceridemia, and other health problems.¹¹² Measurement of waist circumference on the other hand is recommended in the evaluation of obesity.¹¹³

The author suggests that a waist to height ratio (WHtR) is much more appropriate in evaluating for excess body fat mass and metabolic risk, and provides one fewer data point subject to manipulation. With a proposed cutoff value of 0.5 (keeping waist circumference below half of a person's height), the performance of WHtR by some studies has been found to be superior to BMI in predicting obesity comorbidities including metabolic syndrome, hypertension, hyperlipidemia, and diabetes. Further,

¹¹¹ Laura Boemeke, Fabiana Viegas Raimundo, Márcia Bopp, Lara Rigon Leonhardt, Sabrina Alves Fernandes, and Cláudio Augusto Marroni, "The Correlation of Neck Circumference and Insulin Resistance in NAFLD Patients," *Arquivos de Gastroenterologia* (18 March 2019), doi: 10.1590/S0004-2803.201900000-06.

¹¹² Ibid.

¹¹³ Ana Isabel De Cos, Sonsoles Gutierrez Medina, Bogdana Luca, Alba Galdon, Juan Simon Chacin, Maria Luisa De Mingo, Daniela Trifu, Sara Artola, Isabel Egocheaga, Teresa Soriano, Clotilde Vazquez, "Recommendations for Clinical Practice in Diabetes and Obesity. The Madrid Agreements. Document agreed by the working groups of the scientific societies: SENDIMAND, SOMAMFYC, SEMG Madrid, SEMERGEN Madrid and RedGDPS," *Nutricion Hospitalaria* 35, no. 4 (2 August 2018): 971-978, doi:10.20960/nh.1646.

WHtR appears to be superior to BMI in detecting incident cardiovascular disease and both cardiovascular specific and all-cause mortality”¹¹⁴

Also, since the utility of the tape test is arguably less than ideal, an updated AR 600-9 *Army Body Composition Program* could better promote fitness by changing weight for height tables to establish graduated standards such as “yellow”, “red” and “black” lines that would trigger ABCP enrollment, suspension of favorable action, and separation respectively. The Army should take measures to change the paradigm where there exists a dichotomous approach to overweight and obesity, under which soldiers of marginal fitness are either ignored or administratively persecuted.

Soldiers need to be identified when they are marginally overweight and in a non-punitive manner encouraged to lose weight. A goal of the program should be to increase Army Wellness Center (AWC) visits, where professionals employ superior methods to assess body composition and work closely with individual soldiers to promote fitness. Ideally this will enable more soldiers to maintain suitable body composition and will reduce the numbers of those whom out of necessity must be separated for not doing so.

The author stipulates that there is a need for a second threshold for standards as it pertains to body mass. Based on current systems there is a lack of discrimination between a soldier slightly overweight vs a soldier severely obese. For the significantly obese soldier, even in the (rare) presence of excellent fitness there is the reality that at a certain point one’s physical size becomes a liability. This is because in combat it is predictable

¹¹⁴ Savvas C. Savva, Demetris Lamnisis, and Anthony G. Kafatos, “Predicting Cardiometabolic Risk: Waist-to-Height Ratio or BMI. A Meta-Analysis,” *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy* 6 (23 October 2013): 403-419, doi:10.2147/DMSO.S34220.

that soldiers may become incapacitated in combat, and when a soldier becomes incapacitated, he must be physically carried by his or her comrades. This is under the hypothetical situation that obese soldiers are generally fit, yet what this research illustrates is that as the severity of obesity increases there is a rising probability the soldier has physical limitations as measured through permanent physical profiles. It is the opinion of the author that there is a certain intellectual poverty in stipulating that a soldier can be suitable for combat even in the case of severe obesity and identified physical limitations. It is also generally apparent that the greater the degree of obesity is for an individual, the less that it is appropriate that they remain in active military service.

At a body mass index of 33 kg/m^2 , in the study population the proportion of soldiers with Permanent P2 or P3 profiles crosses 40%. This suggests strongly that at or near this body mass index the physical limitations correlated with increased weight become increasingly problematic. There is a need for the Army to define what body mass, independent of composition, should categorically disqualify a soldier for combat service. This is not only because of the soldiers diminished capacity for strenuous physical tasks but also because of the inability for fellow soldiers to evacuate them safely in the event of incapacitation. Using the author as an example, with a height of 71 inches the author has a screening table weight of 194 pounds and an allowable body fat percentage of 24% according to the provisions of AR 600-9. The author's target weight, based on a 95% level of screening table weight, is therefore below 185, however the author's last assessed weight was 201 pounds (and the author met standards for allowable body fat). At a weight of 215 pounds the author would have a BMI of 30 kg/m^2 at the

threshold of obesity, and at a weight of 251 pounds the author would have a BMI of 35 kg/m² at the threshold of severe obesity.

The author admits to a certain hypocrisy in advocating for weight control policies while personally being above screening table weight. Although meeting the army standard, the author acknowledges that he should lose 10 pounds and through diet and exercise, he endeavors to do so. At present the author has no physical limitations and exercises regularly, and considers himself generally fit for service in an austere environment. The author imagines this would still be true at 215 pounds, but considers that at 251 pounds the prospect of performing strenuous physical activity to the same standard would be increasingly difficult. The author is also very certain that the amount of knee, foot and back pain he occasionally experiences would be greatly exacerbated by increased excess body weight.

General Robert Scales, in his book *Certain Victory: The U.S. Army in the Gulf War*, discussed the reforms and changes following the Vietnam war that prepared the U.S. Army for victory in Operation Desert Storm. Following the withdrawal of American forces from the Vietnam war in 1973, the Army of the early seventies was significantly demoralized and was affected by indiscipline, drug use, crime and desertion.¹¹⁵ With the end of the draft, the Army struggled at first to create an all-volunteer force, but as it did so, the problem of troubled soldiers required redress. To preserve good order and discipline, the Army sought ways to separate from service those who were unrecoverable

¹¹⁵ Robert H. Scales, *Certain Victory: The U.S. Army in the Gulf War* (Fort Leavenworth, KS: U.S. Army Command and General Staff College Press 1994).

in being undisciplined, alienated, unproductive, disaffected, criminal, or drug addicted.

As noted by the U.S. Army Center of Military History:

As recruiting and reenlisting went up, punitive discharges, discharges for misconduct, unsuitability, and unfitness, and discharges for the good of service decreased by nearly 25 percent. This reduction came about even though two new programs were started during the year to discharge substandard soldiers expeditiously. Introduced on 1 September 1973, the Trainee Discharge Program was used to identify recruits who could not adapt to military life or who did not meet minimum standards during the first 179 days of service. About 9 percent of the trainees entering service during fiscal year 1974 were discharged under this program. In October 1973 USAREUR began the Expeditious Discharge Program as a test. This program gave local commanders authority to discharge unproductive soldiers after they had served between twelve and twenty-one months without recourse to an officer board. By the end of the fiscal year, USAREUR had discharged 2,565, and the program was being studied as a possibility for other army commands.¹¹⁶

Noted the following year by the U.S. Army Center of Military History:

Following a successful test in U.S. Army, Europe, the Army broadened coverage of the Expeditious Discharge Program in November 1974 to include U.S. Army Forces Command, U.S. Army Training and Doctrine Command, and Eighth U.S. Army. In May 1975 the Army announced that the program would be expanded Army-wide on 1 July 1975, at which time battalion commanders and lieutenant colonels who command similar-size units will be authorized to discharge personnel.¹¹⁷

Although having obesity and physical limitations is in no way comparable to being culpable in misconduct or indiscipline, this historical example is worth considering.

Faced with an erosion of standards and of good order and discipline, the Army of the 1970s was forced to separate from service those who could not or would not contribute to

¹¹⁶ U.S. Army Center of Military History, Department of the Army Historical Summary: FY 1974, "Personnel," last modified 27 August 2004, accessed 11 March 2019, available from <https://history.army.mil/books/DAHSUM/1974/ch06.htm>.

¹¹⁷ U.S. Army Center of Military History, Department of the Army Historical Summary: FY 1975, "Personnel," last modified 21 September 2004, accessed 11 March 2019, available from <https://history.army.mil/books/DAHSUM/1975/ch05.htm>.

the mission of the organization. Given the geometric rise in the prevalence of obesity and its clear association with physical limitations, the Army should consider a program of expedited separation for those obese soldiers whose ability to perform in combat is most suspect.

The author is aware that such a suggestion may come across as callous or lacking sympathy for soldiers struggling with either body weight issues, physical limitations, or both. It is imperative to stress that neither condition, nor any other, diminishes the worth of these soldiers, nor that either could in any sense erode the obligation that we as a nation have to provide care to these soldiers. The key question to be considered for any soldier remains whether or not they contribute to the effective fighting strength of the Army. In such cases where this is definitively or probably unlikely, the Army must take such actions as are necessary to preserve the health and readiness of the force. If a soldier cannot perform, to not remove him or her from deployable organizations is unfair not just to the other soldiers but to the soldier as well.

As a limitation of this study, it is important to note that the study population was a convenience sample and not a random sample of total army soldiers due to the methodology employed. The author's study population had fewer higher-ranking soldiers and officers than representative of the Army as a whole due to the selection of deployable FORSCOM maneuver and support units. The scope of this analysis did not assess the relationship between body mass index and temporary profiles, nor did it assess non-medical causes of non-deployability or separation from service. Also not assessed was the effect of military occupation or specialty on body mass index or profiling. All of these topics are fertile areas for future research. Also, further research and regression analysis

may yield a predictive model that is more robust, which could further amplify force readiness.

The researcher additionally suggests further research using data from the Defense Manpower Data Center Reporting Center (DMDCRS) on those separated from service over the past 25 years. Looking to assess soldiers particularly after their first term, but before retirement, the researcher suggests emphasis on obtaining data on this population, as well as more general information on separation from military service. Although height and weight data are not available through DMDCRS as this data is not collected in the system, the center does maintain a large repository of data on separations. An analysis of these ranks may provide further insight into the state of army readiness.

GLOSSARY

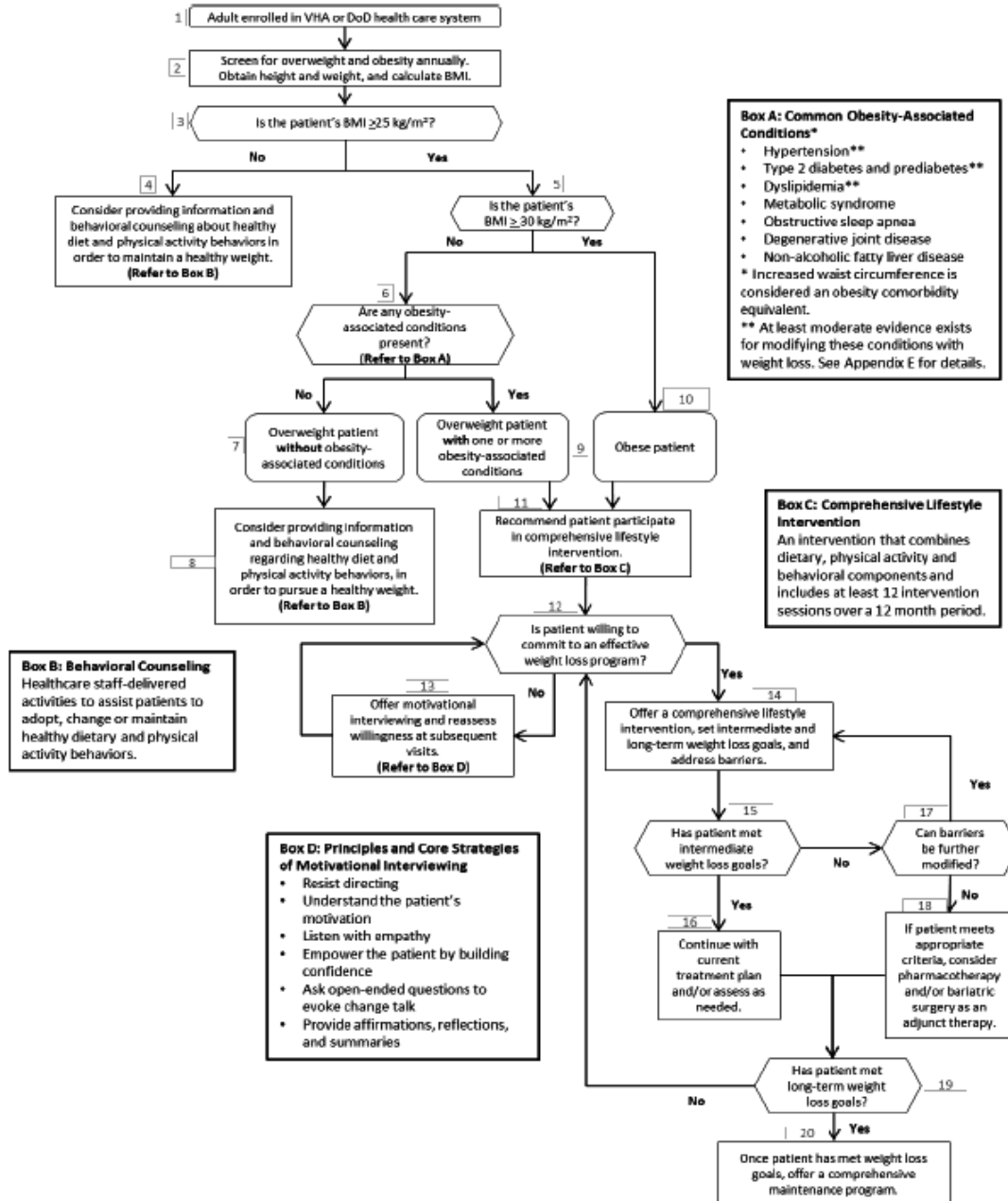
Kwashiorkor. Protein energy malnutrition, which can occur in acute or chronic inflammatory disease in addition to protein poor diet. This disease classically develops over weeks and is characterized by low serum albumin (protein) in addition to poor wound healing, easy (painless) hair pluckability, or Edema (tissue swelling). Classically children will have swollen abdomens but are otherwise slender.

Marasmus. Starvation-related malnutrition, this is a condition of severe, advanced calorie deprivation where starvation, without an underlying illness causing inflammation, eliminates virtually all available body fat stores and fat and muscle wasting is visibly apparent.

APPENDIX A

VA DOD CLINICAL PRACTICE GUIDELINES MANAGEMENT OF OVERWEIGHT AND OBESITY ALGORITHM

Algorithm



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