NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

WEIGHT STANDARDS
AND
MARINE CORPS ATTRITION

by

KEVIN A. JACKSON

June, 1991

Thesis Advisor: Professor George W. Thomas

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Naval Postgraduate School 6b. OFFICE SYMBOL (*If applicable*) 36	7a. NAME OF MONITORING ORGANIZATION Naval Postgraduate School
6c. ADDRESS (*City, State, and ZIP Code*) Monterey, CA 93943-5000	7b. ADDRESS (*City, State, and ZIP Code*) Monterey, CA 93943-5000
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (*If applicable*)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (*City, State, and ZIP Code*)	10. SOURCE OF FUNDING NUMBERS Program Element No / Project No / Task No / Work Unit Accession Number

11. TITLE (*Include Security Classification*)
WIEGHT STANDARDS AND MARINE CORPS ATTRITION

12. PERSONAL AUTHOR(S) KEVIN ADRIAN JACKSON

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (*year, month, day*)	15. PAGE COUNT
Master's Thesis	From To	1991, JUNE, 20	63

16. SUPPLEMENTARY NOTATION
The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

17. COSATI CODES			18. SUBJECT TERMS (*continue on reverse if necessary and identify by block number*)
FIELD	GROUP	SUBGROUP	

19. ABSTRACT (*continue on reverse if necessary and identify by block number*)

THE PURPOSE OF THIS THESIS WAS TO EVALUATE THE EFFECTS ON ATTRITION OF MARINE RECRUITS FAILING TO MEET HEIGHT/WEIGHT STANDARDS AT TIME OF ACCCESSION. THIS WAS ACCOMPLISHED BY ESTIMATING TWO MAXIMUM-LIKELIHOOD, LOGIT MODELS USING DIFFERENT SAMPLES OF HISTORICAL MARINE CORPS ATTRITION DATA. THE BOOT CAMP MODEL EXAMINED ATTRITION FOR THE FIRST THREE MONTHS OF ACTIVE DUTY. THE FIRST-TERM MODEL FOCUSED ON ATTRITION FROM THE END OF BOOT CAMP TO THE END OF THE FIRST ENLISTMENT TERM. THE RESULTS OF THE STUDY IDENTIFIED FAILURE TO MEET HEIGHT/WEIGHT STANDARDS AS THE MOST SIGNIFICANT VARIABLE IN THE BOOT CAMP MODEL. THE SIFNIFICANCE OF THE VARIABLE WAS SUPERCEDED IN THE FIRST-TERM MODEL BY EDUCATION, MENTAL GROUP, AND PROGRAM CONTRACT. ATTRITION PROBABILITIES PROVED TO BE SIGNIFIC/.NTLY HIGHER FOR OVERWEIGHT RECRUITS, BUT DECREASED IF THE INDIVIDUAL PARTICIPATED IN THE DEP, HAD AN AVIATION CONTRACT GUARANTEE, OR ATTENDED RECRUIT TRAINING AT SAN DIEGO.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION	
☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS REPORT ☐ DTIC USERS	UNCLASSIFIED	
22a. NAME OF RESPONSIBLE INDIVIDUAL GEORGE W. THOMAS	22b. TELEPHONE (*Include Area code*) 646-2741	22c. OFFICE SYMBOL AS/TE

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFED

Approved for public release; distribution is unlimited.

Weight Standards
and
Marine Corps Attrition

by

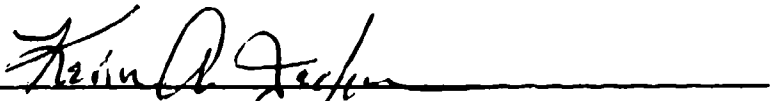
Kevin A. Jackson
Captain, United States Marine Corps
B.A., University of Florida 1980

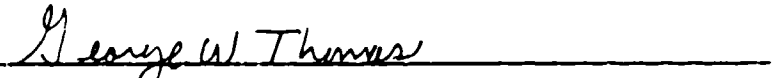
Submitted in partial fulfillment
of the requirements for the degree

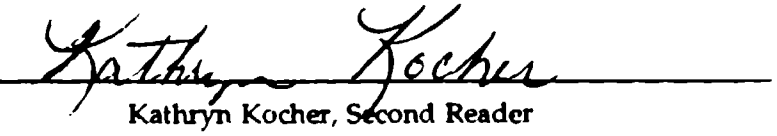
MASTER OF SCIENCE IN MANAGEI

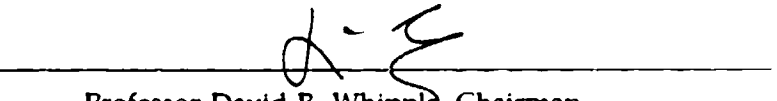
from the

NAVAL POSTGRADUATE SCHOOL
June 1991

Author: 
Kevin A. Jackson

Approved by: 
Professor George W. Thomas, Thesis Advisor


Kathryn Kocher, Second Reader


Professor David R. Whipple, Chairman
Department of Administrative Science

ABSTRACT

The purpose of this thesis was to evaluate the effects on attrition of Marine recruits failing to meet height/weight standards at time of accession. This was accomplished by estimating two maximum-likelihood, logit models using different samples of historical Marine Corps attrition data. The boot camp model focused on attrition through the first three months of active duty. The first-term model examined attrition from the completion of boot camp to the end of the first enlistment term. The results of the study identified failure to meet height/weight standards as the most significant variable in the boot camp model. The significance of the variable was superceded in the first-term model by education, mental group, and program contract. Attrition probabilities proved to be significantly higher for overweight recruits, but decreased if the individual participated in the DEP, had an aviation contract guarantee, or attended recruit training at San Diego.

TABLE OF CONTENTS

I. INTRODUCTION

A. BACKGROUND

One of the great challenges of the 1990s, from a military perspective, will be maintaining the quality of the force in the face of significant end strength reductions. Corresponding budgetary constraints will no doubt increase the emphasis devoted to attrition and its causes. Military manpower planners will want to maximize their return on investment, which may translate into reducing attrition.

Historically, nearly 35% of Marine Corps recruits fail to complete their initial obligation. [Ref. 1] This represents a considerable loss on investment. A 1986 study estimated Marine Corps first term attrition costs to be nearly $3,000 per contract. [Ref. 1]

The battle against attrition is driven by several issues. As previously indicated, economic concerns are certainly at the forefront. The costs described, which in current dollars are undoubtedly greater, reflect only separation and replacement costs. There are, however, other considerations. For example, how does attrition impact force quality and readiness? What will it cost to reduce attrition? Will better screening (higher screen scores) actually result in lower attrition?

Future prospects of mandated personnel cuts and dwindling resources mean that the military will have to do more with less. Such requirements will accent the importance of productivity. Because of the nature of many military occupational specialties, acquiring the requisite skill level is both time consuming and costly. Premature losses represent forfeited training dollars and the undesirable turbulence associated with personnel turnover. As such, they detract from force readiness as well as overall quality.

Substantial research has been done attempting to profile those who would meet with success from the standpoint of completing their initial service obligations. It has been well-documented that a high school diploma is among the single best determinants of predicting first term retention. Mental aptitude has also been strongly linked to trainability and productivity. [Ref. 2] Such conclusions have prompted the military to actively pursue the recruiting of "high quality" individuals.

Success indicators are becoming increasingly important. In a time of diminishing financial resources, the military is also faced with a declining youth population (age 17-21 years old) through 1995 and a slow recovery thereafter. Keen competition for qualified young men and women is likely to grow and recruiting efforts may well feel the effects of the 15-20 percent drop in the youth population experienced during the 1980s. [Ref. 3] The ability to identify those

individuals with the greatest chances of survival is extremely beneficial to the military.

The Navy has employed a model to predict the success chances of their recruits since the late 1970s. The model, developed by Robert Lockman, evaluates potential recruits on the basis of age, educational level, mental category, and dependent status. [Ref. 4] These qualities are equally important to the Marine Corps as determinants of first term attrition [Ref.6]. While the magnitude of these characteristics enable predictions to be made about the likelihood of completing the first term, including an additional variable might be of further benefit. Height/weight standards, like mental aptitude or demographic characteristics, may well be predictors of success. However, because body composition can change, unlike the other attributes described, physical standards can be specific grounds for separation even after successful completion of basic training, whereas the others are not.

Because of the rigors of Marine Corps recruit training and the emphasis later placed on fitness and military appearance, accession weight standards relative to in-service Marine Corps weight standards should be examined.

B. THESIS OVERVIEW

1. Focus

This study will examine the effects on attrition of Marine recruits failing to meet Marine Corps in-service height/weight standards at time of accession. Such a comparison will provide insight into the effectiveness of existing accession weight standards and whether or not a need exists to modify them.

2. Scope

This study will use multi-variate regression analysis to evaluate the attrition behavior of Marine recruits. Two models will survey the effects of not meeting height/weight standards at time of accession on boot camp and first-term attrition behavior. Each model will use a separate sample of historical Marine Corps attrition data. The boot camp model will focus on recruits accessed in 1989 and 1990 and will look at attrition during the first three months of active duty. The first-term model will concentrate on recruits accessed between 1981-1984. The attrition behavior of these individuals will be examined from the end of boot camp to the end of the first enlistment term.

The two samples identified above will be further evaluated in two additional areas: geographic location of basic training and contract type. The former will offer insights into climatic effects on recruits who don't meet

height/weight standards. This should prove an interesting comparison as Parris Island is exposed to far more dramatic seasonal fluctuations than is San Diego. Contrasting the attrition rates of recruits with ground contracts against those having aviation guarantees might suggest differences in the physical demands of the two communities and their potential effect on the success chances of recruits relative to their height/weight status.

3. Outline

This thesis is composed of five chapters. The first chapter provides an introduction to the research area including, a background, thesis overview, and research questions. Chapter II is a review of the current literature on Marine Corps attrition, subjects dealing with height/weight standards and recruit fitness. Chapter III is a presentation of the data used in the study and the study method employed. Chapter IV analyzes the data to derive answers to the research questions and presents the results. Chapter V provides conclusions and recommendations.

C. RESEARCH QUESTIONS

1. Does the attrition behavior recruits not meeting height/weight standards significantly differ from their contemporaries?

2. Is there a pronounced difference in the attrition behavior among these groups relative to geographic area of

basic training? (San Diego or Parris Island: does climate play a part?)

3. Is there a difference in the attrition behavior of those not meeting height/weight standards with ground contracts as opposed to those having aviation guarantees, over the course of an enlistment period?

4. What effect, if any, does participation in the Delayed Entry Program have on the attrition rates of recruits who do not meet the height/weight standards at time of accession?

II. LITERATURE REVIEW

A. GENERAL

This thesis, by its very nature, combines a variety of collateral topics. One can not simply analyze the effects of not meeting active duty weight-for-height standards at time of accession without also looking at other things such as recruit screening criteria, attrition trends, weight standard issues, and the question of physical fitness. Since this thesis also seeks to evaluate the effects on attrition of overweight recruits participating in the Delayed Entry Program (DEP), the DEP is another topic of consideration. The discussion of existing manpower literature follows from the division of collateral issues identified.

B. RECRUIT SCREENING

Due to the Navy's concern regarding first-term attrition, a study was commissioned in 1975 to develop a model of first year losses which could be used to screen applicants for enlistment. The author, Robert F. Lockman, acquired data on 67,000 non-prior service male recruits who entered the Navy in CY 1973. The data, obtained from the Navy Recruiting Command and the Bureau of Naval Personnel, contained background information, service history, and reasons for discharge. Background data came from the Armed Forces Entrance and

Examining Stations (AFEES) via the Navy Recruit Training Command (RTC).

Lockman developed a model to estimate first year losses using the following explanatory variables: education, mental group, age, race, and primary dependent status. Combining these variables with group loss rates, he ran a weighted linear regression to estimate first year losses. All five variables proved significant at the 99 percent confidence level. Subtracting this predicted loss rate from 100 resulted in the chances of surviving the first year of service. This model was adopted by the Navy to screen potential recruits on 1 October 1976.

The value of the model was not limited to the screening of applicants for enlistment. The program could also aid in calculating accession goals to fill specific categorical requirements, based on the survival probabilities generated by the model.

The Success Chances of Recruits Entering the Navy (SCREEN) model developed by Robert Lockman has undergone several revisions and revalidations. The model evolved from its original linear form to one using a Cox regression [Ref. 4]. The desire for reduced operating costs, a need for applicability to cross sectional data, and the potential to generate survival curves rather than point estimates precipitated revisions. Additionally, the recoding of age and minority variables from the original model resulted in their

effects being subsumed by the education variable. As such, both were omitted from the model.

The SCREEN model was last revalidated in 1980. The purpose of the validation was to see whether the relationship between recruit characteristics and first year survival was the same for 1973 and 1979 data. Lockman concluded that the characteristics were indeed similar and that the model was suitable for continued use for non-prior service males.

The Marine Corps, like the Navy, is very much interested in identifying the characteristics of successful recruits. Recognizing the value of recruiting high quality individuals, the Marine Corps has increased the proportion of high school graduates and recruits testing in the top half of the Armed Forces Vocational Aptitude Battery (ASVAB).

Aline Quester, James North, and Theresa Kimble sought to expand on the research of the 1970s in their study by evaluating both background characteristics and Marine Corps environmental characteristics with variables associated with successful adaptation to the Marine Corps [Ref. 6].

In addition to Lockman's explanatory variables, this study included gender, race, geographic region of origin, and marital status as background characteristics. For Marine Corps environmental variables, the authors included: whether or not the recruit came from the DEP; if so, the number of months spent in the DEP; whether the recruit had an aviation or ground contract; the season of accession; and whether or

not the recruit was overweight by active duty standards at time of accession. Finally, the measures of successful adaptation to the Marine Corps consisted of completion of 45 months of service[1], completion of 45 months of service and promotion to corporal (E-4), and lastly, retention beyond the first term of enlistment.

These variables were used in estimating a maximum-likelihood model, which resulted in predictions of the probability of success. These estimates were generated for recruits with differing backgrounds to identify the characteristics of successful enlistees. The base case for this exercise was a male recruit scoring in the upper AFQT category[2]. Beyond that, educational level, DEP participation, and weight categories were varied.

The study concluded that background characteristics associated with success were generally the same for all three measures. Those recruits who appear to adapt well to Marine Corps life are high school degree graduates (HSDG) and high school certificate graduates (CERT) over 20 years of age, who fall into AFQT categories I-IIIA, participated in the DEP, and who met the in-service weight standard for their height, at time of accession.

---

[1] The authors contend that 45 month attrition rates are the standard by which four year contracts are measured because recruits may satisfactorily complete contractual obligations up to three months early.

[2] AFQT categories I-IIIA.

C. ATTRITION TRENDS

Research on attrition trends is in many ways a precursor to recruit screening because it provides insight into the characteristics of those least likely to succeed. By using these profiles, recruiters can concentrate on those individuals who are most likely to succeed. On the other hand, from the standpoint of natural progression, these attrition trends are products of the screening and accession process and as such, measure the effectiveness of that process. That is, attrition trends provide an indication of the effectiveness of screening criteria, after the fact.

James North and Adebayo Adedeji ranked the historical attrition rates of Marine Corps recruits to help identify risk potentials of perspective enlistees [Ref. 1]. Using the Marine Corps Attrition Interactive Database (MCAID) to evaluate the attrition rates of recruits accessed from fiscal 1979 to fiscal 1985, data on nearly 183,000 non-prior-service male and female recruits with contract lengths of four years or greater were examined. A ranking system was developed from this analysis to provide recruiters with attrition probability information which could help in identifying recruits with high attrition risk.

The findings of this analysis support the Quester et al. study and arrive at the same profile for first-term survival success. The distinction of this study relative to previous research is that it accounts for the interaction of

characteristics on attrition behavior. The authors contend that evaluating 72 different categories for males and 30 for females is equivalent to regressing an equation with as many interactive terms. The result of such an extensive investigation was the identification of sub-groups, believed to be easily recruited, who have historically low attrition risk.

Richard Buddin conducted a study in 1988 to determine why military attrition rates have not increased as expected in response to improved quality of recruits [Ref. 11]. Attrition rates were compared across several training bases as well as the trends at individual bases to see if there were differences in the interpretation and implementation of service policies between bases. These trends were evaluated during basic training, follow-on training, and post-training enlistment time frames. Each service, gender, and training phase was analyzed using logistic regression.

The data used in this study were obtained from the Defense Manpower Data Center (DMDC). They included non-prior-service high-quality[3] accessions between fiscal 1982 and fiscal 1985.

Buddin concluded that cohort characteristics alone do not determine attrition rates. He based this conclusion on the difference in attrition behavior of like-quality recruits trained at different bases. Thus, he stated that "while

---

[3] High school diploma graduates scoring in the upper fifty percentile on the AFQT.

recruit characteristics can be used to rank perspective recruits by relative risk category, different interpretation and enforcement of service policies seem to critically affect the actual attrition level."[4]

Buddin claims that the Marine Corps' mean basic training attrition rate during the study period was 10 percent. He found the attrition rates of comparable quality men to vary from the mean by as much as five percent between the training bases. This is particularly relevant to the Marine Corps since it has only two recruit training depots.

D. WEIGHT STANDARDS

"Military recruits may be medically overweight and yet still be fit and eligible for Service."[5] This is because the criteria for being overweight are different for the military than they are for the medical community. The difference in the standards reflect a difference of purpose. Medical standards are used to promote health, whereas military standards are used to screen recruits who might not be capable of withstanding the rigors of military training. This may seem a juxtaposition when one considers that military standards exclude only about four percent of the traditional youth population from military service in spite of the fact

---

[4] [Ref. 6, p. 56]

[5] [Ref. 8, p. 1]

that almost 14 percent of that same population is medically overweight.[6] The question then, is what effect does the difference in these standards have on attrition?

Richard Buddin extended his research on the attrition trends of high-quality recruits in a 1989 study which sought to determine whether or not attrition rates vary with body mass [Ref. 8]. He again employed the DMDC database of high-quality recruits accessed between fiscal 1982 and fiscal 1985. As with his earlier study, he used logistic regression to calculate the effects of recruit characteristics, branch of service, training base location, and entry cohort on attrition.

A multivariate model was specified in different ways to identify the effects of each of the characteristics. The author suspected that bodymass might differ by service because of both varying enlistment standards and physical demands of the different services. Thus there was a need to examine each service independently. Gender was evaluated separately because females are subject to stricter accession weight standards and higher attrition rates than males. Finally, to assess the effect of bodymass on attrition relative to service policy changes, separate equations were estimated by entry cohort.

---

[6] [Ref. 8, p. V]

The results of this research led to the conclusion that medically overweight young men have attrition rates significantly higher than their contemporaries of normal weight. Furthermore, some of these Army and Marine Corps recruits experience basic training attrition rates two to three times greater than the average recruit. Interestingly enough, however, Buddin found that post-training attrition rates are not significantly affected by bodymass. It is unclear whether this is due to attrition occurring during earlier training weeding out the unfit, or if the rigors of a post-training military lifestyle are simply less demanding.

Timothy Rupinski conducted two studies in 1989, concerning Marine Corps weight standards. In the first, he examined the relationship between height-weight standards and recruit attrition throughout recruit training and the first enlistment term [Ref. 6]. Current accession weight standards are less stringent than active duty Marine Corps weight standards. This means that overweight individuals, by active duty standards, can be recruited into the Marine Corps.[7] This also allowed the author to evaluate the success of overweight recruits losing weight by comparing the attrition rates of overweight Marines with individuals meeting active duty weight standards.

---

[7] A 5'9" male can be accessed at weights 23-29 pounds over the maximum active duty Marine Corps standard.

The data for this study were divided into two groups. A three month sample composed of some 193,000 individuals accessed between fiscal 1982 and fiscal 1987 was used in analyzing boot camp attrition. A 48 month sample made up of approximately 59,000 recruits who entered the Marine Corps in fiscal 1982 and fiscal 1983 was used to examine attrition for the first enlistment term. This sample was limited to four year obligors and restricted to two accession years in order to allow the cohort to reach the end of its original contract.

The results of this study show that overweight recruits separate at significantly higher rates than normal weight recruits. The proportion of overweight recruits attriting from boot camp is 21.1 percent.[8] The boot camp attrition rate of those who are not overweight is 12.2 percent. First term separation rates after boot camp for overweight recruits failing to conform to active duty weight standards is 7.5 percent. The proportion of non-overweight Marine separating for the same reason is only .2 percent.

Rupinski concludes that the difference between active duty and accession weight standards is an important determinant of first term attrition. He further contends that the greater the difference between them, the higher the first term attrition rate. It is here that he introduces the tradeoffs inherent in closing the gap between the standards. If

---

[8] Fiscal 1982 to fiscal 1987.

accession standards are tightened, the eligible civilian population will be reduced. If active duty standards are relaxed, the Marine Corps could face a lower level of physical fitness. The latter relationship remains uncertain because currently not supporting data exist.

In his second study, Rupinski investigated the effects of realigning height-weight standards on recruit quality [Ref. 7]. The purpose of the realignment was to make weight standards between genders more equitable. The equity is measured by civilian eligibility differences attributed to maximum accession weight standards. Quality areas receiving specific attention were education, first-term attrition, and physical fitness.

The author indicates the proportion of overweight men accessed for fiscal 1982 to fiscal 1987 rose from 9.8 to 13.1 percent. The proportion of overweight females increased by only .1 percent over that same period. The diversity between the two can be attributed to the difference in accession standards. Males can be accessed from between 23 to 29 pounds above the active duty weight standard; females only seven pounds.[9] By current standards, only four percent of the eligible male population would be excluded from Marine Corps service whereas 25 to 30 percent of the female population would be ineligible.

---

[9] These weights reflect the current standards for the median height of each gender.

Because of the emphasis placed on quality recruits, the Marine Corps has increased its proportion of high school degree graduates in recent years. Rupinski credits the increase in overweight recruits with the substitution of overweight high school degree graduates for non-high school degree graduates of normal weight.

While the purpose of this study was to improve the equity between male and female weight standards, the author was constrained by the need to maintain quality. To accomplish the former, either male standards could be tightened or female standards could be loosened, or both. Any of these options might solve the equity issue, but would likely run afoul of the constraint to maintain quality. Tightening male standards might require accessing lower quality recruits in order to meet endstrengths. Conversely, relaxing female standards might well reduce the fitness levels of female recruits. In the final analysis, policy makers will have to weigh the tradeoffs between quality and fitness to arrive at appropriate height-weight standards.

E. PHYSICAL FITNESS

The Marine Corps places a premium on the physical fitness of its personnel. Fitness is construed not only as an integral component of combat readiness, but also of the day to day performance of Marines. As such, the Marine Corps is

interested in the impact of weight standards on physical fitness.

Timothy Rupinski conducted a study in 1989 to determine if maximum weight standards are justified on the basis of physical fitness [Ref. 10]. As with his previous studies discussed thus far, his sample consisted of non-prior-service Marine recruits accessed from fiscal 1982 through fiscal 1987. The final sample included 113,332 males and 7,151 females between 17 and 30 years of age.

A model was developed using weight, height, body mass, body mass percentile, age, race, number of months between physical fitness test (PFT) and original training start date, and number of fiscal years between original training start date and fiscal 1982. The model was specified four different ways to account for height-weight measures. In the first, height and weight were used as separate variables. The second combined height and weight into a single variable called body mass, defined as weight in kilograms divided by height in meters. The height figure was squared for males and raised to the 1.5 power for females. The third specification converted body mass into percentiles based on civilian data from the second National Health and Nutrition Examination Survey, which uses the body masses of 20 to 29 year old youth as its reference group to define overweight. The final specification of the model includes 19 dummy variables for percentiles of

body mass to determine if the effects of being under or overweight are the same on physical fitness.

All variables except age were statistically significant at the .01 significance level. The regression estimates showed that the body mass variable had the greatest effect on PFT scores. A two standard deviation increase in body mass resulted in a 13.8 point drop in PFT scores for males and a corresponding 19.2 point drop for females.

The study concludes that physical fitness, as measured by PFT score, is inversely related to body mass. Male PFT scores showed a 3.5 point decrease for each additional ten pounds in accession weight. For females, that ten pound increase translated to an 8.4 point decrease in PFT scores. This demonstrated decline in PFT scores relative to body mass, Rupinski suggests, justifies the use of maximum weight standards.

F. DELAYED ENTRY PROGRAM

The Delayed Entry Program (DEP) is a system used by the military services which allows an individual to enlist in a branch of service prior to graduating from high school while further enabling him to choose a preferred enlistment option and the month in which he will report to basic training. This is a mutually beneficial arrangement for both the individual and the military. The recruit has some influence on his situation and the military has the opportunity to even out its

monthly accessions. Furthermore, it is able to enlist high-quality recruits while they are still in high school.

The value of participation in the DEP is recognized and has been documented in military manpower research along with other variables contributing to recruit success. In 1990, James North conducted a study to analyze the relationship between length of time in the DEP and subsequent Marine Corps active duty attrition rates.

Not inclined to accept the assumption of a linear relationship between months in the DEP and subsequent active duty attrition, North elected to estimate six and 45 month survival rates of non-prior-service recruits with four year obligations, who enlisted in fiscal 1984. Length of time in the DEP, educational level, AFQT category, weight category, race, contract type, season of accession, marital status, and region of accession were used as explanatory variables in a logit model. A special form (spline) was used to allow for slope changes at four, seven, and ten month periods in the DEP. Because of the difference in attrition behavior between men and women, different survival probabilities were estimated for each.

The results of the study confirm earlier research in that length of time in the DEP has been shown to have a positive effect on survival probabilities. That positive effect appears to be related to the "filtering effect," which allows individuals with greater propensities to quit to do so before

being shipped. However, this effect seems to level off after three months in the DEP. Furthermore, this "filtering effect" does not appear to apply to females.

While recruit characteristics were included in the model as explanatory variables, no direct relationship between participation in the DEP and these variables was addressed. It would be interesting to see, however, if DEP participation has any impact on attrition rates of overweight recruits.

G. SUMMARY

It should now be readily apparent that the issue of weight standards is influenced by a variety of collateral concerns. Five such concerns have been identified in the form of recruit screening, attrition trends, height-weight standards, physical fitness, and participation in the DEP.

The literature reviewed in this section either directly or indirectly suggests the following:

- weight standards are an important determinant of first term attrition,
- these standards are gaining attention in the quest to identify potentially successful recruits,
- overweight recruits have attrition rates significantly higher than recruits of normal weight - in some cases two to three time higher,
- there is a great disparity between accession and active duty weight standards,
- body mass has been found to be inversely related to physical fitness test scores,

- the incidence of overweight recruits is forcing potential tradeoffs between quality and fitness,
- while participation in the DEP nas been shown to have a positive effect on attrition, its individual influcnce on characteristics such as being overweight is not known.

Many of the effects on attrition of being overweight have been documented. Whether responding to the question of equity, the tradeoff between quality and fitness, or that of civilian eligibility, the issue of weight standards in the Marine Corps will need to be dealt with. The balance of this study will attempt to revalidate previous findings and to provide additional insights into new areas such as the effect of DEP participation on the attrition of overweight recruits and the attrition behavior of overweight recruits relative to contract type. To accomplish this, two models will be created to estimate the effects of these variables and others known to influence attrition.

III. DATA AND METHOD

A. DATA

1. Database

Data for this study are derived from the Marine Corps Attrition Interactive Database (MCAID), an attrition retrieval program developed by the Center for Naval Analyses [Ref. 13]. The MCAID software tabulates historical attrition rates for Marine Corps recruit cohorts entering the service between the years 1979-1990 on the basis of the following characteristics:[10]

- Fiscal year of accession,
- Recruit gender,
- Marine Corps recruit depot,
- Accession program,
- Delayed Entry Program (DEP) or shipped within the month the contract was signed (direct ship),
- Race/ethnic,
- Meets/does not meet in-service weight standards for height,
- Age at accession,
- Armed Forces Qualification Test (AFQT) score category,
- Educational background.

---

[10] [Ref. 13, p. 1]

The historical data compiled by CNA came from the Recruit Accession Management System (RAMS) and the Accession Recruit Management System (ARMS). Information on losses was obtained from the Marine Corps transaction files (ARSTAT).

To facilitate the multivariate analysis necessary for this thesis research, the data were separated from the retrieval program and uploaded to the Naval Postgraduate School's AMDAHL model 5990 mainframe computer. A Fortran program, appearing in appendix A, was written to match key and data files of the MCAID program. Frequency analysis was then conducted to ensure comparable results between the new individual-level data and MCAID data.

The initial sample contained 431,339 observations. That sample reflected the total number of enlisted individuals accessed into the Marine Corps between the beginning of fiscal 1979 and the end of the first quarter of fiscal 1990.

Past research has indicated that because female accession height/weight standards are significantly more stringent than male standards, the incidence of overweight female accessions is minimal. Cross-tabulating the height/weight and sex variables supports this claim. Of the original sample of 431,339 recruits accessed between fiscal 1979-1990, only 25,115 were female. Of those, 1,648 or 0.38 percent did not meet the height/weight standard. Because of the scarcity of overweight female accessions and the fact that women are trained at only one location, precluding their use

in assessing the influence of training location on attrition, this thesis will focus on only male attrition.

In order to evaluate boot camp attrition, a representative sample was selected which included individuals with four, five, and six year contract lengths. The frequency distribution of program type identified two accession years, fiscal 1988 and 1989, which had relatively level accessions, making them desirable for this analysis. Imposing these restrictions, the data set yielded 61,060 observations for the boot camp attrition model.

Specific interest in the relationship between program type and first-term attrition, relative to height/weight standards, forced an additional restriction on the data. Because of the desire to differentiate between contract types and a need for sufficient data to evaluate a cohort to the end of its first term of service, the data set for the first-term attrition model is limited to four year contract holders accessing between fiscal 1981-1984. This restriction results in a first-term attrition model containing 94,159 observations.

2. Model Specification

a. Dependent Variable

Because this study focuses on the relationship between recruit characteristics and boot camp and first-term attrition, two models were used. In each case, the dependent

variable is dichotomous reflecting the historical attrition behavior of **separating** or **staying** measured against a prescribed point in time. Boot camp attrition, denoted by the variable **BOOTATTR** identifies those recruits separating with less than three months of service. First-term attrition is designated by the variable **T1NOBOOT** depicting those individuals who leave after three months but prior to 45 months of service. Both variables are coded with values of "1" to represent leaving and "0" to signify staying.

*b. **Explanatory Variables***

(1) YEAR. This variable is based on an individual's active duty base date (ADBD) which, is the date on which a recruit reports to active duty. The boot camp attrition model is restricted to two accession years, fiscal 1988 and 1989. The model for first-term attrition evaluates fiscal 1979-1984. In each case the variable is made into a dummy variable and coded "0" or "1" to capture the influence of the years of interest.

(2) MCRD. This category denotes the location at which a recruit underwent basic training. It is obtained from the first Unit Identification Code (UIC) found for the recruit. Since females have been omitted from the study, the variable can take on values of "0" or "1" representing recruit depots at Parris Island and San Diego, respectively.

(3) PROG. This variable combines the recruit's enlistment program (air, ground, or open contract) and the length of his initial contract. It was transformed into a set of dummy variables and coded "0" or "1" to capture the effects of different contract types. The boot camp attrition model is restricted to four (ground and open contracts), five (general), and all six year contract holders. The first-term attrition model is likewise restricted and includes only four-year obligors.

(4) DEP. This is a dichotomous variable which is coded "0" or "1" to denote participation in the Delayed Entry Program or non-participation in the program. For recruits entering the Marine Corps prior to fiscal 1986, if the difference between pay entry base date (PEBD) and ADBD is greater than one month, they are considered DEP participants. Those accessing after this date are coded by Headquarters Marine Corps as DEP participants for easy identification.

(5) RACE. This variable identifies a recruit by his race or ethnic persuasion. Dummy variables coded "0" or "1" are used to represent white, black, and hispanic individuals.

(6) HTWT. This is a dichotomous variable which is based on the use of active duty weight standards to determine whether or not a recruit is overweight at time of accession. It does not provide the degree of variation from

the standard, but is simply the snapshot determination of compliance and is coded "0" or "1" to reflect that either the recruit did or did not meet the standard on the day he was accessed.

(7) AGE. This was a categorical variable in the MCAID program which consisted of six groups. For purposes of this study, the categories were reduced to three groups and coded as dummy variables. The classifications include 17-19 year olds, 20-21 year olds, and 22 olds and up.

(8) MG. AFQT categories are arrayed to produce dummy variables. Categories I, II, and IIIA are grouped together to reflect those scoring in the upper 50 percentile of the AFQT. Categories IIIB and IV remain independent groups. Coding is therefore "0" or "1" to capture the effects of the respective groups.

(9) EDUC. This variable reflects the three educational tiers denoted by the MCAID program. Tier I is composed of high school degree graduates (HSDG). Tier II contains high school certificate graduates (CERT). Tier III is made up of non-high school graduates (NHSG). This dummy variable is coded "0" or "1" to indicate the effects of each category.

c. ***Expectations***

Previous research has shown that age, mental group, educational classification, DEP participation, and ability to

meet height/weight standards are important determinants of first-term attrition. Studies have indicated that attrition increases with age, lower mental groupings, lower educational accomplishment, non-participation in the DEP, and failure to meet height/weight standards.

The causal relationship between training base location and attrition has not been documented. Richard Buddin did note differences between the attrition rates of Parris Island and San Diego recruits. According to his research, San Diego suffered higher attrition than did Parris Island. Although differences in policy interpretation and implementation were suggested as possible reasons for the variation in the attrition rates, no specific cause was cited for San Diego's higher rate. In spite of Buddin's findings, when evaluated relative to overweight recruits, it is expected that San Diego recruits will have a lower probability of attrition than Parris Island recruits. This hypothesis is based on the climatic differences between training bases. San Diego is far more temperate than Parris Island which should be more conducive to physical training for overweight recruits.

The results of Buddin's study of attrition of high-quality recruits showed that black males entering the Marine Corps are less likely to attrite than their non-black counterparts. Attrition rates of hispanics produced by the MCAID program are characteristically lower than whites or blacks. Based on these findings, one can probably expect that

blacks and hispanics would have lower levels of attrition than whites.

The following is a list of the independent variables for the attrition models and their hypothesized signs:

- **SDIEGO** (-),
- **AFQT3B** (+), **AFQT4** (+),
- **AIR4** (+), **GRND4** (+), **GEN5** (+), **ALL6** (-),
- **AGE20-21** (+), **AGE22UP** (+),
- **NONDEP** (+),
- **BLACK** (-), **HISP** (-),
- **UNFIT** (+),
- **CERT** (+), **NHSG** (+),
- **FY79** (no expectation), **FY80** (no expectation), **FY81** (no expectation), **FY82** (no expectation), **FY83** (no expectation), **FY84** (no expectation).

B. RESEARCH METHOD

The logit model is used to estimate the models because its S-shaped curve, bounded by the (0,1) interval, lends itself to easy interpretation of qualitative decisions of the stay or leave variety. Furthermore, changes in the probability of attrition relative to the explanatory variables can be calculated from the estimates produced by the regression.

The SAS Logist procedure used calculates the probability that an observation will exhibit a prescribed behavior using

the maximum likelihood method. The following equation describes the logit model (Basic Econometrics, Second Edition):

$$\ln [P_i/(1-P_i)] = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + \ldots + \beta_k X_{ki} + \mu_i$$

where:

P_i = the probability of attriting,

$\ln [P_i/(1-P_i)]$ = the log-odds of not attriting,

X_{ji} = the j^{th} explanatory variable,

β_i = the coefficient of the j^{th} explanatory variable.

IV. ANALYSIS

A. GENERAL

Data restrictions discussed in Chapter III were imposed on the two samples used for the models used in this study. Frequency analysis of the remaining data identified limited observations for two variables in the boot camp model, **AFQT4** and **NHSG**. As a result they were eliminated from the model.

In addition to parameter estimates produced by the regressions, classification tables were generated for each model. The classification table provides insight into the value of the model in terms of its predictive ability. The measure of a model's predictive power is identified in the table by the percentage labelled "correct." This, of course, implies the percentage of the time that the model is correct in predicting actual behavior. Obviously, the higher the percentage, the better its presumed ability to predict.

Since the logit model is non-linear, the slope measures the change in the probability of a behavior for a unit change in X. Because only dummy variables appear in the models used for this study, the slope measures the change in probability of attriting when the dummy variable has a value of one. To determine the partial effects of each variable relative to a base case, the change in probability of attriting was

calculated for each variable and compared to that of a base case, using the following equation:

$$P_i = 1/(1 + e^{-z_i})$$

where

P_i = the probability of attriting,

$z_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + \ldots + \beta_k X_{ki}$,

β_i = the coefficient of the j^{th} explanatory variable,

X_{ji} = the j^{th} explanatory variable.

The base case was defined as a white high school graduate between 17-19 years of age with a four year open contract, who participated in the DEP, attended boot camp at Parris Island, met the height/weight standards at accession, and scored in the upper 50^{th} percentile on the AFQT. In the case of the boot camp model, he entered the Marine Corps in fiscal 1989. For the first-term model, he accessed in fiscal 1984.

As expected, because previous studies were heavily relied upon in constructing the models, the attrition behavior revealed through the regressions generally validates existing perceptions of that behavior.

B. REGRESSION RESULTS

1. Boot Camp Attrition Model

This model was estimated for recruits accessing in fiscal years 1988 and 1989, with four year open and ground

contracts, and all five and six year contract types. The sample consisted of 61,060 observations of which 11 percent attrited within the three month period.

Presented below are the results of the boot camp attrition regression model.

LOGISTIC REGRESSION RESULTS
BOOT CAMP ATTRITION MODEL

VARIABLE	BETA	STD. ERROR	CHI-SQUARE	P	R
INTERCEPT	-2.0649	0.0347	3522.89	0.01	
SDIEGO	-0.2446	0.0266	84.02	0.01	-0.044
AFQT3B	0.1005	0.0299	11.27	0.01	0.015
GRND4	-0.1794	0.0299	35.94	0.01	-0.028
GEN5	-0.3316	0.0544	37.07	0.01	-0.029
ALL6	-0.2203	0.0447	24.21	0.01	-0.023
AGE20_21	0.3222	0.0349	85.20	0.01	0.044
AGE22UP	0.5641	0.0434	168.79	0.01	0.063
NONDEP	0.3827	0.0446	73.46	0.01	0.041
BLACK	0.2328	0.0366	40.27	0.01	-0.030
HISP	-0.4418	0.0584	57.13	0.01	-0.036
UNFIT	0.7253	0.0324	500.**	0.01	0.109
CERT	0.5927	0.0496	142.43	0.01	0.058
FY88	-0.0722	0.0262	7.55	0.01	-0.011

All variables in this model were significant at the one percent level. The model chi-square was 1370.97 with 13 degrees of freedom and is 84.4 percent correct in its predictive ability.

The model revealed that although failure to meet height/weight standards was the strongest single influence on attrition probability, the theory that boot camp attrition generally increases with age and lack of educational accomplishment appears valid. While lack of participation in the DEP also contributes to the probability of attriting, having a contract guarantee rather than an open contract tends to reduce the probability. The relative effects of these variables will be discussed later in this chapter.

The classification table that appears below was generated to demonstrate the predictive power of the boot camp model. Using a cut-off value of .18, the table assesses the model in four categories:

- Sensitivity is the percentage of individuals who attrited that were predicted to attrite,
- Specificity is the percentage of individuals who stayed that were predicted to stay,
- False positive rate reflects the percentage of individuals predicted to attrite who actually stayed,
- False negative rate reflects the percentage of individuals predicted to stay that actually attrited.

The combined effects of these four categories yield an overall prediction rating for the model. This model is correct 84.4 percent of the time.

CLASSIFICATION TABLE
BOOT CAMP MODEL

		PREDICTED STAY	PREDICTED ATTRITE	TOTAL
TRUE	STAY	50364	3982	54346
	ATTRITE	5524	1190	6714
	TOTAL	55888	5172	61060

SENSITIVITY: 17.7% SPECIFICITY: 92.7% CORRECT: 84.4%
FALSE POSITIVE RATE: 77.0% FALSE NEGATIVE RATE: 9.9%

2. First Term Attrition Model

This model consisted of recruits with four year contracts (ground, air, and open) who entered the Marine Corps between fiscal years 1981 and 1984. The sample contained 94,159 observations of which 24.3 percent attrited with less than 45 months of service.

Presented below are the results of the first-term attrition regression.

LOGISTIC REGRESSION RESULTS
FIRST-TERM MODEL

VARIABLE	BETA	STD. ERROR	CHI-SQUARE	P	R
INTERCEPT	-1.1704	0.0220	2826.15	0.01	
SDIEGO	0.0602	0.0157	14.61	0.01	0.011
AFQT3B	0.1834	0.0167	120.21	0.01	0.034
AFQT4	0.2821	0.0363	60.34	0.01	0.024
GRND4	-0.2290	0.0174	172.04	0.01	-0.040
AIR4	-0.5925	0.0230	659.81	0.01	-0.079
AGE20_21	-0.1687	0.0236	50.85	0.01	-0.022
AGE22UP	-0.0866	0.0308	7.90	0.01	-0.008
NONDEP	0.3310	0.0230	205.52	0.01	0.044
BLACK	-0.0018	0.0216	0.01	0.93	0.000
HISP	-0.3427	0.0440	60.57	0.01	-0.024
UNFIT	0.4097	0.0249	269.70	0.01	0.051
CERT	0.5104	0.0246	429.14	0.01	0.064
NHSG	0.9534	0.0246	1498.80	0.01	0.120
FY81	-0.1194	0.0219	29.66	0.01	-0.016
FY82	-0.1487	0.0220	45.46	0.01	-0.020
FY83	-0.1476	0.0215	47.15	0.01	-0.021

The only insignificant variable in this model was the race variable **BLACK**. The variable **AGE22UP** was significant at the 10 percent level and all other variables were significant at the one percent level. The model chi-square was 4041.80 with 16 degrees of freedom and its predictive ability is 71.7 percent correct.

The model evaluated attrition behavior from the completion of boot camp to the end of the first enlistment term. As indicated in the last chapter, the model surveys four accession years, fiscal 1981-1984.

In this model, **NHSG** displaced **UNFIT** as the most significant contributor to attrition probability. In fact, although still highly significant, **UNFIT** ranked below **NHSG**, **AIR4**, and **CERT** in terms of its contribution to first-term attrition probability.

The coefficient for **SDIEGO** was positive, a departure from the boot camp model. All accession years generated negative parameter coefficients. The age variables **AGE20_21** and **AGE22UP** also change signs from the boot camp model. This would seem to indicate that while boot camp might be a greater obstacle to older recruits, their maturity apparently contributes to post-boot camp success, in terms of completing the first term of enlistment.

Beyond the differences noted above, the results of the model were as anticipated. As with boot camp attrition, the probability of attriting during the first enlistment term is increased by lower mental group classification, lack of academic achievement, the failure to meet height/weight standards, and not participating in the DEP.

As with the boot camp model, a classification table was produced for the first-term model to evaluate its predictive power. This table used a cut-off value of .30 to assess the sensitivity, specificity, false positive rate, and false negative rate. The results of the classification appear below. This model is 71.1 percent accurate in its predictions.

CLASSIFICATION TABLE
FIRST-TERM MODEL

		PREDICTED STAY	PREDICTED ATTRITE	TOTAL
TRUE	STAY	60241	10828	71249
	ATTRITE	15786	7124	22910
	TOTAL	76207	17952	94159

SENSITIVITY: 31.0% SPECIFICITY: 84.4% CORRECT: 71.7%
FALSE POSITIVE RATE: 60.3% FALSE NEGATIVE RATE: 20.7%

3. Base Case Analysis Results

As indicated at the beginning of this chapter, the partial effects of the explanatory variables were calculated relative to a base case, to determine their influence on attrition probability. Listed below are the results of these computations for the boot camp model, which had a base case attrition probability of .8875.

Variable	Delta
PI	------
SDIEGO	-.0269
AFQT I-IIIA	------
AFQT3B	+.0097
OPEN4	------
GRND4	-.0192
GEN5	-.0377
ALL6	-.0239
AGE17_19	------
AGE20_21	+.0284
AGE22UP	+.0453
DEP	------
NONDEP	+.0329
WHITE	------
BLACK	-.0254
HISP	-.0522
FIT	------
UNFIT	+.0547
HSDG	------
CERT	+.0470
FY88	-.0074
FY89	------

The "Delta" values represent changes to the base case probability resulting from the influence of each variable. Base case variables are those indicating no change in probability, such as PI, AFQT I-IIIA, OPEN4, and the like. The greatest contributor to boot camp attrition probability in

this model is the variable UNFIT, increased the probability by 5.5 percent.

Variables influencing the probability of attriting change somewhat in the first-term model. Listed below are the results of the partial effects calculations for that model. The base case probability of attriting for the first-term model is .7632.

Variable	Delta
PI	------
SDIEGO	+.0107
AFQT I-IIIA	+.0315
AFQT4	+.0472
OPEN4	------
GRND4	-.0439
AIR4	-.1226
AGE17_19	------
AGE20_21	-.0318
AGE22UP	-.0160
DEP	------
NONDEP	+.0546
WHITE	------
BLACK	-.0003
HISP	-.0673
FIT	------
UNFIT	+.0660
HSDG	------
CERT	+.0798
NHSG	+.1300
FY81	-.0222
FY82	-.0279
FY83	-.0277
FY84	------

The education variable, NHSG, is the strongest contributor to attrition probability in this model, raising the probability by 13 percent. The variable UNFIT, the greatest contributor in the boot camp model, drops in terms of

increasing attrition probability in this model to fourth among the variables.

4. Explanatory Variables

a. SDIEGO

This variable was significant at the one percent level in both models but had a negative coefficient in the boot camp model and was had a positive coefficient in the first-term model. The effect of the variable relative to the base case of Parris Island, was to decrease the probability of attrition by 2.7 percent in the boot camp model and to increase the probability by one percent in the first-term model.

b. AFQT3B

This variable was significant in both models at the one percent level. It had a positive coefficient in both models which resulted in a one percent increase in the probability of attriting in the boot camp model and a 3.2 percent increase in the probability in the first-term model, relative to the base case of AFQT categories I-IIIA.

c. AFQT4

This variable was used only in the first term model and was significant at the one percent level. The effect of the variable in the first-term model, relative to the base

case of AFQT categories I-IIIA, was to increase the probability of attriting by 4.7 percent.

d. GRND4

This variable was significant at the one percent level in both models. The coefficient was negative for both indicating a decrease in the probability of attriting of 1.9 percent and 4.4 percent respectively for the boot camp and first-term models, relative to the base case of a four year open contract.

e. AIR4

This variable appeared only in the first-term model. It was significant at the one percent level and had a negative coefficient. The effect of the variable was to reduce the probability of attriting by 12.3 percent relative to the base case of a four-year open contract.

f. GEN5

This variable appeared only in the boot camp attrition model. It was significant at the one percent level and had a negative coefficient. The effect of the variable was to reduce the probability of attriting by 3.8 percent relative to the base case of a four-year open contract.

g. ALL6

This variable was used only in the boot camp model. It was significant at the one percent level and had a negative coefficient. Relative to the base case of a four year open

contract, it reduced the probability of attrition by 2.4 percent.

h. AGE20_21

This variable was significant at the one percent level in both models. It had a positive coefficient in the boot camp model and had a negative coefficient in the first-term model. As such, relative to a base case individual 17-19 years of age, the variable increased the probability of attriting in the boot camp model by 2.8 percent and decreased the probability by 3.2 percent in the first-term model.

i. AGE22UP

This variable was significant at the one percent level in both models. As with the age variable AGE20_21, it was had a positive coefficient in the first model and a negative coefficient in the second model, resulting in a 4.5 percent increase in the probability of attriting during boot camp and a 1.6 percent decrease in the probability during the first term, relative to the base case of a 17-19 year old individual.

j. NONDEP

This variable was significant at the one percent level and had positive coefficients in both models. It increased the probability of attriting by 3.3 percent in the boot camp model and 5.5 percent in the first-term model, relative to the base case of a DEP participant.

k. BLACK

This variable was significant at the one percent level and had a negative coefficient in the boot camp model, but proved not to be significant in the first-term model. In the boot camp model, the variable decreased the probability of attriting by 2.5 percent relative to the base case of a white individual.

l. HISP

This variable was significant at the one percent level and had a negative coefficient in both models. It reduced the probability of attriting in the boot camp model by 5.2 percent and by 6.7 percent in the first-term model, relative to the base case of a white individual.

m. UNFIT

This variable was significant in both models at the one percent level. The positive coefficient in each model reflected an increase in the probability of attriting, relative to a based case of an individual meeting the height/weight standards at accession, of 5.5 percent in the boot camp model and 6.6 percent in the first-term model.

n. CERT

This variable was significant at the one percent level and had positive coefficients in both models. The effect of the variable, relative to a base case of a high school graduate, was to increase the probability of attriting

by 4.7 percent in the boot camp model and eight percent in the first-term model.

*o. **NHSG***

This variable appeared only in the first-term model and was significant at the one percent level. Its positive coefficient reflected a 13 percent increase in the probability of attriting during the first term relative to the base case of a high school graduate.

*p. **FY81***

This variable was used only in the first-term model and proved to be significant at the one percent level. Its coefficient was negative resulting in a 2.2 percent decrease in the probability of attriting relative to the base case year 1984.

*q. **FY82***

This variable was used only in the first-term model and proved to be significant at the one percent level. Its negative coefficient resulted in a 2.8 percent increase in the probability of attriting relative to the base case year 1984.

*r. **FY83***

This variable was used only in the first-term model and proved to be significant at the one percent level. Its negative coefficient resulted in a 2.8 percent decrease in the probability of attriting relative to the base case year 1984.

s. FY88

This variable appeared only in the boot camp model. Significant at the one percent level, its negative coefficient resulted in a 7.4 percent decrease in the probability of attriting relative to the base case year 1989.

C. SUMMARY

The results of logit regressions used in this thesis generally support the findings of other studies. With the exception of the race variable **BLACK** in the first-term model, all variables used in the models were statistically significant. The behavior associated with the characteristics was, for the most part, as expected. The only surprises were the unexpected sign changes for the coefficients of the variables **AGE20_21**, **AGE22UP**, and **SDIEGO** from the boot camp model to the first-term attrition model.

The sign changes for the age variables, though not expected, did make sense. An older individual might be less inclined to accept the discipline and rigors associated with boot camp, thereby increasing his likelihood of attrition. Conversely, however, the increased maturity of an older recruit could benefit him in a post-training work environment.

The change in the coefficient from the boot camp to the first-term model for the **SDIEGO** variable seems to indicate that while attending boot camp in San Diego reduces the probability of attriting during recruit training, all things

being equal, it increases the probability of attriting during the first term. Such behavior might very well support Buddin's hypothesis that policy is interpreted and implemented differently at separate training bases.

A final note of interest is the change in the degree of influence exhibited by the inability to meet height/weight standards between boot camp and the remainder of the first term of service. The single most significant attribute in the boot camp model, it dropped to fourth in importance in the post-boot camp model. Perhaps this is due to a possible boot camp filtering effect on unfit individuals as well as the potential reenforcement of Buddin's assumption that the post-boot camp military lifestyle is less rigorous.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The results of this study generally support the conclusions of prior attrition research. Except as noted in the previous chapter, the signs and significance levels of the variables were as anticipated, namely that lack of academic accomplishment, lower mental category classification, non-participation in the DEP, and failure to meet height/weight standards increase the probability of attrition. Age was also found to contribute to that probability, but only in the boot camp model. The influence of recruit training depot attended is also divided. San Diego graduates have increased probabilities of first-term attrition in spite of having decreased probabilities of attriting from boot camp.

The most significant variable influencing boot camp attrition was failure to meet the height/weight standard. The variable was also highly significant in the first-term model, which evaluated attrition from the completion of boot camp to the end of the first enlistment term. The statistical significance of the variable at the one percent level in both models supports the contention that overweight and normal weight recruits have different attrition behavior.

In the boot camp model, overweight recruits experienced a 5.5 percent greater probability of attriting than did their normal weight counterparts. The probability of attriting, however, was reduced for individuals who underwent recruit training at San Diego. Thus, while a recruit who fails to meet height/weight standards has a greater probability of attriting, attending recruit training at San Diego rather than Parris Island increases his likelihood of success in boot camp.

One of the most dramatic differences in attrition behavior displayed in the two models was the remarkably lower probability of attriting experienced by individuals having aviation guarantees. Relative to those holding open contracts, these individuals experienced a 12.3 percent lesser probability of attriting in the first-term model. Though more moderate, ground contract guarantee holders also had a decreased probability of attrition. In contrast to individuals with aviation guarantees, however, the attrition probability of overweight recruits with ground contracts increased during the first term. Overweight aviation contract holders had a reduced attrition probability, but not as great as that of their normal weight counterparts. Once again, while overweight recruits demonstrate a higher probability of attriting, the likelihood of first-term success is improved if they are members of the aviation community.

Participation in the DEP was shown to decrease the probability of attrition in both the boot camp and first-term models, validating results found in attrition literature. Overweight recruits, however, experience significantly greater attrition probabilities than their do their normal weight counterparts. The influence of the weight variable is more pronounced than the DEP variable in the models. Thus, while DEP participation did not reverse the attrition probability of overweight recruits, it did increase their likelihood of success in both models.

B. IMPLICATIONS

Differences in the attrition behavior patterns of normal and overweight recruits suggest that current male accession weight standards may be too broad. Previous discussions concerning the tradeoffs between bodymass and fitness as well as the economic costs associated with attrition, suggest that existing standards are a potential liability to the Marine Corps in terms of wasted resources and reduced force readiness.

The results of this study also suggest that the success chances of overweight recruits can be improved, even under the current weight standards. This is, to some degree, misleading. While it may be possible to mandate that overweight recruits participate in the DEP, it is unrealistic to universally provide contract guarantees to them simply to

improve their chances of success. Neither is it likely that recruits would be assigned to boot camp solely on the basis of their weight status. It is, however, plausible that other things being equal, these alternatives be used on a case by case basis to enhance the success chances of overweight recruits.

The significance of these findings is not limited to potential policy implications relative to weight standards. They are equally beneficial in terms of the questions that they prompt about unexplained differences in the attrition probabilities between contract types and the possible ramifications associated with changes in effects on boot camp and first-term attrition probabilities relative to boot camp attended.

C. RECOMMENDATIONS FOR FUTURE RESEARCH

It was not possible to assess the effect of incremental increases in body mass on attrition for overweight recruits due to the categorical nature of the data used in this study. Such an evaluation would provide greater insight into the relationship between attrition and the failure to meet weight standards. This information would be necessary to determine a more appropriate set of standards, which would reduce wasted resources while still satisfying the manpower needs of the Marine Corps. Additional research in this area would be very useful.

Another avenue for potential study is in the area of attrition behavior differences exhibited by aviation and ground communities. Though overweight individuals in the aviation community produced lower attrition probabilities in the models, normal weight recruits also demonstrated a significantly lower probability in that population. This indicates that factors other than the physical demands of the environment influence individual success. Identifying those factors could prove beneficial to the Marine Corps in terms of helping to reduce attrition elsewhere in the organization. Lastly, the disparity between attrition trends of the two recruit training depots should be evaluated to see why an individual is more likely to succeed in boot camp at San Diego, but less likely to achieve first-term success if initially trained there. Explaining this behavior could potentially benefit the Marine Corps in terms of reducing both boot camp and first-term attrition.

LIST OF REFERENCES

1. Center for Naval Analysis, Research Memorandum 90-219, "Rankings by Historical Attrition Rates of Potential Marine Corps Recruits," by James North and Adebayo Adedeji, December 1990.

2. Armed Forces & Society, Vol. 12 No. 2, "Are Smart Tankers Better? AFQT and Military Productivity," by Barry L. Scribner et al, Winter 1986.

3. Center for Naval Analysis, CNS 1168-Vol. I, "Enlisted Supply: Past, Present, and Future," by Lawrence Goldberg, September 1982.

4. Center for Naval Analysis, CRC 425, "A New Look At Success Chances of Recruits Entering the Navy (SCREEN)," by Robert F. Lockman and Philip M. Lurie, February 1980.

5. Office of Naval Research, Report AR-002, "Generalized Expectancies, Life Experiences, and Adaptation to Marine Corps Recruit Training," by Thomas M. Cook et al, April 1980.

6. Center for Naval Analysis, CRM 89-314 (Revised), "Identifying Successful Marine Corps Recruits," by Aline O. Quester et al, April 1990.

7. Center for Naval Analysis, CRM 89-168, "Tradeoffs in Using Alternative Height-Weight Standards," by Timothy E. Rupinski, August 1989.

8. Rand Corporation, N-2847-FMP, "Weight Problems and Attrition of High-Quality Recruits," by Richard Buddin, June 1989.

9. Center for Naval Analysis, CRM 89-16, "Using Attrition Rates in Setting Height-Weight Standards," by Timothy E. Rupinski, May 1989.

10. Center for Naval Analysis, CRM 88-190, " Physical Fitness of Marine Corps Recruits," by Timothy E. Rupinski, April 1989.

11. Rand Corporation, R-3539-FMP, "Trends in Attrition of High-Quality, Military Recruits," by Richard Buddin, August 1988.

12. Center for Naval Analysis, CRM 90-62, "Length of Time in the Delayed-Entry Program and Its Effect on Marine Corps First-Term Survival," by James H. North August 1990.

13. Center for Naval Analysis, . Manual 58, "Marine Corps Attrition Interactive (MCAID)," by David L. Reese, October 1989.

APPENDIX
FORTRAN PROGRAM TO MATCH DATA FILES

```
CHARACTER*6 VAR1
CHARACTER*18 VAR2
INTEGER KEYREC,BEGREC,ENDREC,NREC
CALL EXCMS ('FILEDEF 10 CLEAR')
CALL EXCMS ('FILEDEF 11 CLEAR')
CALL EXCMS ('FILEDEF 12 CLEAR')
CALL EXCMS ('FILEDEF 10 DISK F11 KEY T (RECFM F LRECL 18')
CALL EXCMS ('FILEDEF 11 DISK F11 DATA T (RECFM F LRECL 18')
CALL EXCMS ('FILEDEF 12 DISK F11 OUT T (RECFM F LRECL 26')
KEYREC = 257
     DO 10, I=1,KEYREC
        READ (10,100) VAR1,BEGREC,ENDREC
        NREC=(ENDREC-BEGREC)+1
        DO 20, J=1,NREC
           READ (11,110) VAR2
           WRITE (12,120) VAR1,VAR2
20   CONTINUE
10   CONTINUE
100  FORMAT(A6,2I6)
110  FORMAT(A18)
120  FORMAT('89',A6,A18)
     STOP
     END
```

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Technical Information Center Cameron Station Alexandria, Virginia 22304-6145	2
2.	Superintendent Attn: Library, Code 52 Naval Postgraduate School Monterey, California 93943-5000	2
3.	Commandant of the Marine Corps Code TE 06 Headquarters, U.S. Marine Corps Washington, D.C. 20380-0001	1
4.	Captain Kevin A. Jackson 8314 Frosty Court Lorton, Virginia 22079	1
5.	Professor George W. Thomas Code AS/TE Naval Postgraduate School Monterey, California 93943-5000	1