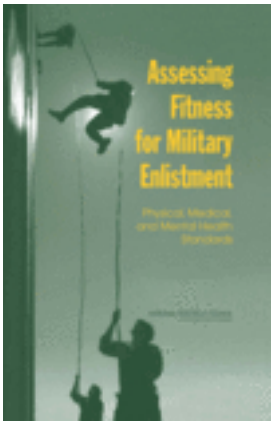

Assessing Fitness for Military Enlistment: Physical, Medical, and Mental Health Standards

Committee on Youth Population and Military Recruitment: Physical, Medical, and Mental Health Standards, National Research Council

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Assessing Fitness for Military Enlistment

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Committee on the Youth Population and Military Recruitment:
Physical, Medical, and Mental Health Standards

Paul R. Sackett and Anne S. Mavor, *Editors*

Board on Behavioral, Cognitive, and Sensory Sciences

Division of Behavioral and Social Sciences and Education

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This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report: Wm. Cameron Chumlea, Departments of Community Health and Pediatrics, Wright State University Boonshoft School of Medicine, Dayton, OH; G. Bruce Copley, Consultant, Flemington, NJ; Matthew J. Friedman, National Center for Post Traumatic Stress Disorders, White River Junction, VT; Robert R. McMeekin, Consultant, Bethesda, MD; Ann Quigley, Transportation Security Administration, Department of Homeland Security; Manmohan Ranadive, U.S. Army Medical Research Institute of Infectious Diseases, Department of the Army, Ft. Detrick, MD; Hendrick W. Ruck, Human Effectiveness Directorate, Air Force Research Laboratory; Brian J. Sharkey, Technology and Development Center, USDA Forest Service, Missoula, MT; and Martin F. Wiskoff, Northrop Grumman Mission Systems, Monterey, CA.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by Johanna Dwyer, Office of Dietary Supplements, National Institutes of Health. Appointed by the National Research Council, she was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Paul R. Sackett, *Chair*
Anne S. Mavor, *Study Director*

Contents

Executive Summary

The Department of Defense (DoD) is the largest employer in the United States, with a current active-duty enlisted military force of 1.15 million. The goal for new active-duty recruits in 2005 is approximately 169,000. The central concern in force management is ensuring that there are sufficient numbers of mentally qualified, healthy, and physically fit personnel to meet current and projected mission requirements. The ability of the Services to meet the enlisted recruiting challenge has varied over time as a function of the size of the recruiting goal, the state of the economy, and the nature of the mission. Even under the most favorable circumstances, recruiting is a difficult job.

The pool of eligible recruits is defined by a set of entrance standards that has been developed by the DoD and the Services to guide the selection of the most qualified and able personnel. When recruiting becomes difficult, as it has in 2005, questions arise concerning the validity of the standards and the consequences of changing them on the size and readiness of the force. In this context, the Committee on Youth Population and Military Recruitment: Physical, Medical, and Mental Health Standards was established to examine the health and fitness of American youth as they relate to current screening enlistment standards and to assess the validity of these standards for predicting attrition and injury in training and on the job.

The charge to the committee consists of four related tasks designed to provide the DoD with guidance on physical, medical, and mental health standards for use in selecting members of the enlisted force. The population of interest for the project, as directed by the committee's sponsor, is

18-24-year-olds and their service during the first term of active-duty military enlistment. Individuals attending the military academies or participating in the Reserve Officers' Training Corps (ROTC), Reserve, and National Guard units are outside the sponsor's purview.

The committee's findings are presented in terms of each task.

FINDINGS

Profile of American Youth

Task 1: Develop a profile of the physical and medical condition of American youth today and in the future.

The committee examined the following health-related factors: physical fitness; body weight and composition; asthma; alcohol, drug, and cigarette use; and mental health. We selected these factors on the basis of their specification in the charge, their frequency of occurrence in the applicant population, the extent to which disqualification for the condition could be overruled or waived by one of the Services, the existence of a military and academic research base, and the extent to which changing the standard could make a difference in the eligibility of a significant number of recruits. There are many disqualifying medical conditions that were not included in the committee's investigation because of strong clinical or scientific evidence concerning their adverse effects on combat performance. These include serious diseases, physiological abnormalities, and physical impairments such as blindness and deafness.

Physical Fitness

Physical fitness is a multidimensional construct consisting of several core components, including cardiorespiratory endurance (aerobic fitness), muscular strength, muscular endurance, flexibility, and body composition. There are only a few studies on trends over time in the cardiorespiratory health of the youth population. Nevertheless, the evidence suggests that cardiorespiratory endurance in young men has declined by approximately 10 percent since 1966, whereas there was no change for young women during the same period. The cardiorespiratory fitness levels of men and woman entering the Army in the 1980s and 1990s were found to be unchanged for men and slightly improved for women. At the present time there are no military enlistment standards for physical fitness; fitness tests are administered at the beginning of, and at different points during, basic training.

Body Composition

Body mass index (BMI, a ratio of body weight to body height) has historically been used by the Services as a screen for enlistment. In fact, each Service has its own criteria for determining acceptable levels of BMI and percentage of body fat. According to the Centers for Disease Prevention and Control (CDC), a BMI over 25 is considered overweight and carries health risks; a BMI over 30 is defined as obese. In the youth population, the prevalence of overweight in children and adolescents tripled between 1963 and 1999 from approximately 5 to 15 percent. The highest prevalence of overweight or risk for overweight during that period was among Mexican American boys and non-Hispanic black girls. Data from the National Health and Nutrition Examination Survey 1999-2000 showing the distribution of BMI for the general population of people ages 16 to 24 indicate that 40 percent have BMIs over 25, and more than 15 percent have BMIs of 30 and over. Thus, the currently recommended BMI enlistment standard used by DoD and most of the Services of 25 or under for young women could lead to disqualification of 40 percent of them from the pool of eligible recruits, while the currently recommended BMI standard of 27.5 percent for young men could lead to disqualification of approximately 25 percent of them from the pool.

Asthma

Asthma is one of the most common chronic illnesses in the United States. The rate of those who have ever experienced an asthma episode varies between 38 and 43 per 1,000 people in the population. This same rate is evident in individuals ages 15 to 34, but the rate is higher in those under age 15. The rate for non-Hispanic blacks is slightly higher than non-Hispanic whites and Hispanics. CDC data from 1980 to the mid-1990s indicate that women were more than twice as likely as men to be hospitalized for asthma. Historically, asthma has been among the top 10 medical disqualifying conditions for which waivers are requested from the Services. The current military enlistment standard disqualifies any applicant who has experienced asthma symptoms after the 13th birthday. Using asthma as an exclusionary factor is likely to work against the enlistment of minorities and women, as these groups exhibit the highest prevalence of asthma.

Mental Health

Psychological adaptation to military service is critical for successful completion of a tour of duty. Stressors associated with transition from

civilian to military life include changes in living arrangements, geographic locations, peer relationships, support systems, schedules, priorities, and control over one's life, as well as separation from family and friends, difficulties in communication with home, and loss of privacy. Soldiers on wartime missions must deal effectively with the stress and anxiety associated with potential loss of their lives and their fellow soldiers.

About 20 percent of children ages 9-17 in the United States have a diagnosable mental or addictive disorder associated with at least minimum impairment, while 11 percent have a significant functional impairment. Common disorders are anxiety, depression, disruptive behavior disorders, and substance use disorder. Estimates of the prevalence of attention deficit hyperactivity disorder range from 7 to 16 percent of youth, and the rates are two to three times higher for boys than for girls. Recent evidence demonstrates that childhood attention deficit hyperactivity disorder (ADHD) is a predictor for adolescent substance use; stimulant therapy for childhood ADHD has been shown to reduce the risk of subsequent adolescent drug and alcohol use disorders. Growing numbers of youth receive outpatient treatment or are hospitalized for mental health disorders. There has been a substantial increase in the use of psychotropic medications, particularly antidepressants and stimulants, for children and adolescents with psychiatric disorders.

Psychiatric disorders account for 6 percent of the disqualifications at the military entrance processing stations; of these, almost half apply for and receive a waiver from one of the Services. It is important to note that many with mild conditions may be discouraged from applying on the basis of questioning at the beginning of the recruiting process; the medical prescreening tool does not differentiate among minor and major psychiatric conditions, and all require the provision of some medical follow-up information. Data from the medical prescreen are not included in any database.

Substance Abuse

Current enlistment standards reflect the reality that some consumption of alcohol is commonplace among youth, despite the fact that in most states it is illegal to consume any alcoholic beverage under age 21. Occasional or "recreational" use of marijuana is also fairly common among youth, and as a result the military decided during the early 1990s that such use would not be disqualifying under its moral character standards. Supply constraints are therefore more focused on heavy or chronic use of illicit drugs or alcohol, especially when they indicate drug dependence.

Alcohol consumption in the population of high school age youth dropped significantly between 1980 and 1993, from a high of more than 70

percent to a low of about 50 percent. Since then, it has fluctuated only slightly. The percentage of youth who indicated being drunk in the past 30 days changed very little between 1991 and the present, standing at just over 30 percent in 2003. Rates of alcohol use are related to both gender and race and ethnicity, but the gender effects are much smaller. For both young men and young women, whites have the highest rates of alcohol consumption and blacks the lowest. Hispanic youth are in between but are closer to whites than blacks.

Marijuana usage also shows a steep drop between 1978 and 1992, from a maximum of 37 percent to a low of 12 percent. The rate began rising again in the early 1990s and reached a more recent maximum of just under 25 percent in 1997, and it has remained at about that level since that time. The rate of other illicit drug use has remained very close to 10 percent for the past eight years or so. Total illicit drug use among men differs very little by race; however, black women have rates that are consistently 10 points below white women. Approximately 6 percent of applicants are initially disqualified on the basis of a positive test for marijuana during the physical examination at the military entrance processing station.

Tobacco Use

Preservice smoking is of interest because of its demonstrated relationship with early attrition during the first term of military service. Trend data generally show that smoking rates declined during the 1970s, remained fairly flat during the 1980s, and began increasing during the 1990s (when marijuana use also began rising). Cigarette smoking rates reached a peak in 1997 and then began declining. By 2003, smoking rates had reached historic lows of 24 percent for any smoking and 16 percent for daily smoking. With regard to daily cigarette smoking, rates are somewhat higher for young men, but usually by just a few percentage points, while larger differences exist by race and ethnicity. White young men and women are much more likely to smoke than their black or Hispanic counterparts. Black youth have the lowest rates of smoking of all groups. There are no enlistment standards related to preservice smoking.

The Nature of Military Work

Task 2: Examine the changing nature of work generally and the new demands placed on the military in the post–cold war era.

Studies show that technology is increasing the physical demands of some jobs and decreasing the demands of others. This leads to the ques-

tion of whether it is feasible or advisable to set different physical and medical standards for different military occupational specialties (MOSs). With limited exceptions, there is little research detailing the physical requirements of individual MOSs. However, the crucial feature regarding the question of setting lower standards for some MOSs than for others is the DoD policy decision that every uniformed service member must be combat-ready. This implies a common set of requirements for combat tasks, regardless of one's primary MOS.

Part of the charge to the committee was to review evidence on the physical requirements of military jobs, but we found no research detailing the fitness requirements of all of the common military tasks required for combat readiness. Furthermore, there is no documentation that would allow an in-depth examination of the physical demands of each MOS in each Service. The committee therefore accepted the policy that military service itself requires a minimum level of physical fitness for all uniformed Service members. As noted in Department of Defense Instruction 1308.3, "It is DoD policy that physical fitness is essential to combat readiness and is an important part of the general health and well-being for Armed Forces personnel."

Evaluating Standards

Task 3: Review the literature on the predictive validity of medical and physical selection standards for training and job performance in the military and in the civilian population.

Evaluation Methodology

The committee's approach to evaluating existing standards was to assess their effects on attrition and injury during basic training and through the first term of service. Measuring job performance after training, although of considerable interest, was not possible due to the difficulty of obtaining valid and reliable measures of individual performance. Ideally, formal trade-off models, like those applied to assessing enlistment standards for education and aptitude, would be used to validate medical and physical standards. They would be particularly useful for continuous conditions, like weight and strength, for which no disqualifying level can be established clinically, as well as for dichotomous conditions, like the use/nonuse of marijuana or having/not having asthma; the presence of these conditions may reduce effectiveness but is not automatically disqualifying. Such models examine the trade-off between performance effectiveness and the proportion of potentially available recruits who have the necessary characteristics. At this time, the trade-off model-

ing approach has not been used to evaluate standards in the medical and physical domains, in part due to the inaccessibility or unavailability of the required medical data and the difficulty of linking personnel and medical files for research purposes. The committee provides a description of this approach and illustration of its use.

Current Research

Military research organizations have conducted several studies on the relationship between physical and medical factors and injury and attrition for fitness, BMI, asthma, and preservice tobacco use. The committee found one useful study showing that recruits receiving mental health waivers were more likely to leave the military early compared with recruits who were qualified on all physical, medical, and mental health standards. Major contributors to the research base include the Accession Medical Standards Analysis and Research Activity, the U.S. Army Center for Health Promotion and Injury Prevention, the U.S. Army Institute for Environmental Research, the U.S. Army Research Institute for the Behavioral and Social Sciences, and the Human Resources Research Organization.

Fitness

As noted earlier, there are no enlistment standards for physical fitness; however, data are available on the relationship between different levels of physical fitness, as measured in basic training, and injury and attrition. Musculoskeletal injuries resulting from basic and advanced individual training pose the single most significant medical impediment to military readiness. Military research and the committee's own analyses show that both male and female recruits who have low levels of cardiorespiratory fitness are more likely to be injured or leave basic training and military service early (or both) than those with high levels of cardiorespiratory fitness. Women with low fitness are twice as likely as men with low fitness to be injured and to leave military service. This finding may be due in part to the biomechanical differences between men and women and the interaction of these differences with basic training regimens.

Body Composition

Unlike the findings for fitness, the results for BMI show that there are essentially no relationships between BMI and injury and attrition for men and only a slight relationship between BMI and attrition for women. That is, recruits who exceed the current height and weight standard and body fat standard and have received a waiver to enter military service are not

injured or do not leave early with any greater frequency than recruits who meet the enlistment standards.

Asthma

Available data indicate that military personnel who have been admitted to military service with an asthma condition have lower attrition rates than those without asthma, although studies show that their health care costs are higher. Some evidence suggests those with asthma that is discovered after enlistment are more likely to drop out during basic training. Currently, asthma that is present at any level of severity precludes participation in the military. It is likely that individuals without symptoms for a prolonged period of time, or even those with mild and infrequent symptoms, could carry out their service requirements, especially if they received optimal medical therapy and self-management education. However, there are costs associated with ensuring timely access of personnel to needed medical therapies and making self-management education available.

Tobacco Use

Cigarette smoking has periodically surfaced as an issue in the U.S. military. An initial Navy study found that attrition from Navy boot camp was nearly twice as high for smokers (15 percent) than for nonsmokers (8 percent). Additional research found that recruits who required some form of enlistment waiver were approximately 1.5 times more likely than their counterparts without a waiver to have smoked before entering military service. A subsequent Air Force study found preservice smokers were approximately 1.8 times more likely to be discharged during the first year of service than were nonsmokers. A large-scale Army study found that the odds of attrition for soldiers who smoked prior to accession were 1.54 times those of nonsmokers. Finally, recruits who smoke are considerably more likely than nonsmokers to have had behavioral problems before enlistment, including high school misbehavior, criminal offenses, drug use, psychological difficulties, and trouble in dealing with authority.

RECOMMENDATIONS AND POLICY OPTIONS

Task 4: Develop policy options. Consider a full range of personnel options for ensuring that recruits are healthy and fit for military service.

The results of the committee's work led to five broad categories of conclusions and recommendations: reducing injuries and attrition, in-

creasing the pool of eligible youth, developing databases and procedures needed to study the relationship between standards and outcomes, identifying standards that need further investigation, and identifying standards that should be retained. A complete list of conclusions and recommendations is presented in Chapter 8.

Two recommendations concern reducing injury and attrition: (1) develop a standardized fitness test for use in the recruiting process and (2) tailor the demands of basic training to the fitness levels of recruits. Recommendations aimed primarily at reducing attrition involve obtaining better information about recruits' mental health status via the use of a brief self-report of mental symptoms at the military entrance processing station, accompanied by a brief mental status exam by a physician.

Three recommendations concern increasing the proportion of the youth population eligible for entry into military service: (1) do not use BMI as a proxy for fitness, (2) do not use a BMI standard for retention that is more stringent than a BMI standard for entry, and (3) do not require documentation or further medical reviews for self-reported mood and anxiety disorders that occur before the 13th birthday.

Five recommendations concern developing databases and administrative procedures to permit a broader and more probing inquiry into the relationship between standards and outcomes than is possible in light of data available today: (1) maintain data from the medical history form completed by recruits at the recruiting station, (2) develop a common core of physical strength and fitness measures across the Services, (3) collect data permitting the linkage between medical standards and outcomes, (4) increase the specificity of the single mental health item on the medical history prescreen administered at the military entrance processing station, and (5) collect and retain mental health data from recruitment through length of service.

Six recommendations concern substantive research studies needed prior to recommending changes in a current standard or in implementing a new one: (1) analyze the physical requirements of the set of common military tasks across military occupational specialties to obtain a clearer picture of the physical demands of these tasks, (2) study prebasic training fitness interventions to determine whether they are a viable and cost-effective route to reduced injury and attrition, (3) examine the causes of increased injury and attrition in women, (4) compare attrition rates of enlistees with and without mental health conditions existing prior to service, (5) conduct cost-benefit analysis regarding the effects of increasing the stringency of the current marijuana waiver policy, and (6) conduct further research on the relationship between smoking and attrition, with particular attention to the behavioral factors driving the observed relationship.

One recommendation concerns retaining a current standard. Due to the prevalence of asthma, the committee carefully reviewed the literature on the relationship between asthma and outcomes of interest to the Services and concluded that the current standard and waiver process are appropriate.

The committee concluded its earlier study of the role of youth attitudes toward the military and of aptitude and educational standards by noting that recruiting is a complex process, with no single route toward achieving recruiting goals. We end here with the same conclusion. We think, however, that we have been able to highlight a variety of important issues meriting attention as efforts to improve the effectiveness of the recruiting process continue.

1

Introduction

The U.S. Department of Defense (DoD) faces short-term and long-term challenges in selecting and recruiting an enlisted force to meet personnel requirements associated with diverse and changing missions. The DoD has established standards for aptitudes/abilities, medical conditions, and physical fitness to be used in selecting recruits who are most likely to succeed in their jobs and complete the first term of service (generally 36 months). In 1999, the Committee on the Youth Population and Military Recruitment was established by the National Research Council (NRC) in response to a request from the DoD. One focus of the committee's work was to examine trends in the youth population relative to the needs of the military and the standards used to screen applicants to meet these needs.

Mission requirements drive the size and shape of the force, which in turn drive recruiting goals. The ability of the Services to meet recruiting goals is influenced by a number of contextual factors, including the state of the economy and the threats to those who are serving. Although the Services generally meet their goals, there are times when shortfalls occur. When recruiting is difficult, the questions of the current characteristics of youth and the scientific basis for enlistment standards become central. What are the implications for changing the standards in terms of performance, attrition, and cost? If there is a shortfall in recruiting with current standards, can one or more standards be lowered and by how much without compromising readiness?

When the committee began its work in 1999, the Army, the Navy, and the Air Force had recently experienced recruiting shortfalls. By the

early 2000s, all the Services were meeting their goals; however, in the first half of calendar year 2005, both the Army and the Marine Corps experienced recruiting difficulties and, in some months, shortfalls. This was due to a combination of factors, including a decline in unemployment rates, increasing accession demand, and the effect of the ground troop deployments in Afghanistan and Iraq. When recruiting goals are not being met, scientific guidance is needed to inform policy decisions regarding the advisability of lowering standards and the impact of any change on training time and cost, job performance, attrition, and the health of the force.

The first focus of the committee was (1) to examine trends in the attitudes, aptitudes, and aspirations of American youth relative to education and ability standards set by the Services and (2) to explore the competition from other options available to youth after high school, such as jobs in the private sector and higher education. In 2003, the committee produced a report on this topic (National Research Council, 2003). The current focus of the committee is on (1) the health and physical fitness of American youth as they relate to current screening standards and (2) the validity of these standards for predicting attrition, injury, and performance in training and on the job.

Some important questions follow. Is there a scientific basis for existing standards, and should they be modified on the basis of characteristics of today's youth or the new medical treatments available to them? Are there changes to training or health-related support services that should be considered to supplement screening standards? What are the cost implications of modifying physical, medical, and mental health screening standards for recruits?

CHARGE TO THE COMMITTEE

The objective of the current project is to critically examine the current physical, medical, and mental health standards for military enlistment in light of (1) trends in the physical condition of the youth population; (2) medical advances for treating certain conditions, as well as knowledge of the typical course of chronic conditions as young people reach adulthood; (3) the role of basic training in physical conditioning; (4) the physical demands and working conditions of various jobs in today's military services; and (5) the measures that are used by the Services to characterize an individual's physical condition. The focus is on the enlistment of 18- to 24-year-olds and their first term of service. There are five related subtasks geared to DoD's need for guidance on physical, mental, and medical standards for enlistment that form the charge to the committee:

1. Develop a profile of the physical and medical condition of American youth today and in the future. Characterize youth, using scientific literature that offers insight into their anthropometric characteristics, fitness, nutrition, medical, and mental health status. Evaluate demographic trends in light of existing and potential physical and medical standards for military service.

2. Examine the changing nature of work generally and the new demands placed on the military in the post–cold war era, using the work of the NRC's Committee on Techniques for the Enhancement of Human Performance: Occupational Analysis as a point of departure. Review the literature on the physical requirements of military jobs. Consider the implications of current and projected trends in work as they impact approaches to selecting youth with appropriate health status and physical abilities.

3. Review the literature on the predictive validity of medical and physical selection standards for training and job performance in the military and in the civilian population. Gather evidence on the utility of such standards from experimental and observational studies.

4. Develop policy options. Consider a full range of personnel options for ensuring that recruits are healthy and fit for military service, including greater coordination of standards and measurement procedures among the military services, changes in the physical and medical standards applied to recruits, changes to the measures used to implement the standards, methods of validating standards, and changes in training to accommodate recruits selected under new standards.

5. Conduct a workshop on the physical requirements of military service. The workshop should provide a forum for discussions on methodological and substantive issues among committee members, DoD officials, and other experts.

The committee assembled to accomplish the charge is composed of experts in the areas of psychology, military personnel policy, military occupational analysis, military and occupational medicine, military sociology, obesity, physical fitness, chronic diseases, and mental health. Biographical sketches of committee members and staff are provided in Appendix D. In responding to the charge, the committee made a series of assumptions about the scope of the project and the key variables of interest.

The Committee's View of the Project Scope

With regard to scope, three decisions guided the committee's work. First, we decided to focus on American youth ages 18-24 as they relate to

active-duty enlisted personnel through the first tour of duty. Whenever possible, trends in the youth population were examined by race and gender. This decision was guided by the sponsor's interest in recruiting and retention of the first-term enlisted force. The DoD Office of Accession Policy deals primarily with developing recruiting guidelines for selecting these individuals. Individuals attending the military academies or participating in the Reserve Officers' Training Corps (ROTC), Reserve, and National Guard units are outside the sponsor's purview. The military academies and ROTC attract high school students who are interested in obtaining a college education and joining the officer corps.

The second decision regarding scope was to confine the committee's examination of standards to the military's current policy that all enlistees should be deployable—that is, ready for combat. Even though there is a wide variety of jobs in the military that require different skills, different levels of physical conditioning, and different types of medical and mental health, we did not think that it was within our scope or expertise to render an opinion as to whether or not the military should shift from a policy that all enlistees should be deployable to a policy that enlistees should be matched to particular jobs, some not requiring exposure to combat.

The third decision was to include a consideration of modifying basic training in ways that might reduce injury without reducing resulting fitness. The high level of injury in women during basic training was a particular concern. Developing physical fitness programs is clearly within the committee's expertise, and we decided that physical fitness screening and training should be considered in combination.

Key Variables

The committee's charge calls for a critical examination of physical, medical, and mental health issues. In addition, we decided to include drug, alcohol, and tobacco use and related behavioral issues. With regard to selecting medical standards for consideration, the committee was guided by several factors: (1) the frequency of occurrence of various disqualifying conditions in the youth population and in the population of applicants; (2) the extent to which disqualification for a condition could be waived by one of the Services; (3) the existence of military research regarding the effect of the condition on the first-term enlisted force by the Accessions Medical Standards Analysis and Research Activity (AMSARA), the U.S. Army Research Institute of Environmental Medicine (USARIEM), the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), and the U.S. Military Enlistment Processing Command (USMEPCOM); (4) the existence of research and medical advances in the civilian sector that should be evaluated; and (5) standard

TABLE 1-1 Medical Failures and Waivers, May 1, 2003 to April 30, 2005, Active Forces (most frequent medical failures, ranked by frequency; excludes cases with 2+ failures)

Medical Status	Total Applicants			
Name	No Failure	Failure	% Waived	% Occurrence
No failure	359,082			
All other[a]		20,804	36	29.7
Weight		16,312	46	23.3
Marijuana[b]		8,796	20	12.6
Psychiatric		4,303	34	6.1
Lower extremities		4,058	46	5.8
Lungs/chest		3,700	38	5.3
Hearing		3,637	28	5.2
Vision		2,868	41	4.1
Upper extremities		2,840	53	4.1
Skin		2,716	41	3.9
				100.0
Totals	359,082	70,034	38	
Total accessions		239,940		
Total not accessed		189,176		
Total applicants		429,116		

[a]All other medical fail codes with N < 2,000, e.g., blood pressure, abdomen, feet.
[b]Positive test at physical.
SOURCE: Committee analysis based on data provided by USMEPCOM (2005).

changes that could make a difference in the eligibility of significant numbers of potential recruits.

Table 1-1 presents the distribution of failure codes assigned in the medical examination and the waivers assigned in those failure codes by the various Services for applicants between May 2003 and April 2005. The top five disqualifiers are all part of the committee's examination: body mass index (BMI)/weight (23.3 percent), marijuana (12.6 percent), psychiatric/mental health (6.1 percent), lower extremity/musculoskeletal (5.8 percent), and chest and lungs (5.3 percent). Together the top five disqualifiers account for 53 percent of the medical failures.

The committee's evaluation of existing standards includes their effects on attrition and injury. Specifically, attrition was examined in basic training and through the first term of service. Measures relating to injury or illness include days lost, the need for hospitalization, cost, and attrition

resulting from injury and illness. Although of considerable interest, measuring posttraining job performance is problematic because it is difficult to obtain valid and reliable measures of individual performance.

APPROACH AND INFORMATION GATHERING

Framework

Military and civilian research efforts have identified several risk factors associated with injury and attrition. These factors have been divided into three categories. The first includes characteristics of the individual and involves cognitive capabilities, attitudes, motivation, physical fitness, medical status, mental health, age, gender, and race. Each of the characteristics can have some impact on an enlistee's success. The second factor is the physical environment and the job that the individual will be asked to perform. It includes task variables, such as fully loaded marching, lifting, jumping, shooting, and so forth. The third factor is the psychosocial character of the work environment and the attending mental and emotional stressors. Each factor makes an important contribution; however, the interactions among them must also be considered when developing selection standards and fitness training programs for the enlisted force. The committee used these factors and their interactions as a framework for its analysis.

Information Gathering

The committee gathered information on the enlistment process and existing standards from a series of briefings provided by representatives form the U.S. Military Enlistment Processing Command, the U.S. Army Accession Command, and the U.S. Navy Service Training Command. Briefings on research related to the development of screening standards and the relationship among various physical fitness, medical, and mental health conditions and injury and attrition were provided by representatives from the Air Force Research Laboratory (AFRL), USACHPPM, USARIEM, and AMSARA. Some of this material was provided at committee meetings and some at the committee-designed workshop held in January 2005. Other topics presented at the workshop include (1) research on standard setting and testing in the civilian sector, (2) a cost-benefit framework for examining the implications of changes in enlistment standards, and (3) reasons for attrition through various stages in the first term of service based on data from the Army Longitudinal Study using the 1999 cohort. All individuals providing information to the committee are listed in Appendix C.

The committee also used data provided by military organizations in its analysis. Data provided by the Defense Manpower Data Center (DMDC) were used to examine attrition rates for enlistees waived for a variety of medical conditions. Data provided by USACHPPM were used to examine the relationship between BMI levels and injury and attrition and the relationship between physical fitness levels and injury and attrition. These data were based on large research studies conducted at Ft. Jackson. Data provided by USMEPCOM were used to examine medical failure codes and the breakdown (according to the International Classification of Diseases, ICD-9) of those used most frequently. These failure codes are assigned on the basis of medical examinations at the military entrance processing stations (MEPS). The data provided also include the number of individuals in each failure code who received a waiver and was allowed to enter a Service. Other sources of military data were obtained from articles and technical reports identified by MEDLINE, the Defense Technical Information Center, and AMSARA. Most of these reports contain data that were provided to the committee through the briefings noted above. On the civilian side, data from the National Health and Nutrition Examination Survey were analyzed to describe the distribution of BMI and aerobic fitness or maximal oxygen consumption (as measured by VO_{2max}, described in Chapter 4) in the youth population ages 17 to 24. Each of these analyses is discussed in detail in the following chapters.

Data on trends in the youth population were obtained through a review of the professional literature. Major topics in this review include body composition and body fat, asthma, physical fitness, the biomechanics of musculoskeletal injury, various categories of mental health, and drug, alcohol, and cigarette use. Whenever possible, these reviews include breakdowns by gender and race. Finally, methodological topics dealing with the development and use of the recruiting cost model and the application of validity tests in research on selection were reviewed.

DIVERSITY IN THE ENLISTED FORCE

Men and women from all racial and ethnic groups have equal opportunity to seek a military career, provided they meet basic entry requirements. Throughout this report, various terms are used to describe racial and ethnic populations, including African American/black; Caucasian/white; Hispanic/Mexican; Native American/Alaskan Native; Asian American/Pacific Islander, and multiracial. These terms reflect the history of racial discourse in American society.

Comparisons between the civilian population and the military population ages 18 to 44 indicate that blacks are overrepresented in the Services (21.8 versus 12.6 percent) and Hispanics are underrepresented (10

versus 13.9 percent). Although women represent a substantial proportion of the force (17.3 percent), the proportion is significantly less than their representation in society of slightly over 50 percent.

In fiscal year (FY) 2002, approximately 381,000 individuals applied to the Services in the active enlisted military force. Not all applicants are eligible to enlist, and thus not all applicants join the Services. In all, 78 percent of the applicants were male, of whom 66 percent were white, 16 percent black, 12 percent Hispanic, and 7 percent other. For female applicants, approximately 54 percent were white, 26 percent black, 13 percent Hispanic, and 8 percent other (U.S. Department of Defense, Under Secretary of Defense Personnel and Readiness, 2004).

The growth of racial and ethnic minority populations in the civilian population and their significant engagement in the armed forces requires special attention to health and fitness factors that may influence their eligibility for military service. Throughout this report, data are presented to illuminate the differential impact of medical, physical, and mental health status on the military service eligibility of racial and ethnic minority populations.

As data in the following chapters demonstrate, the medical, physical, and mental health status of the youth population may diminish the pool of applicants eligible for military service. In addition, the documented disproportionate burden of risk factors for chronic disease affecting racial and ethnic minority populations may slow or reverse historic positive trends in military service for these groups. Any change in eligibility standards must take into consideration the impact on recruitment of racial and ethnic minority populations.

THE STATE OF MILITARY REQUIREMENTS

All the Services have policies that require every member, regardless of his or her job classification, to be fit for deployment. Soldiers in the Army are expected, among other things, to be able to react to combat situations, to move through the battlefield, to employ hand-to-hand techniques, and to control and evacuate crowds. All these tasks are physically demanding, and many will be performed under extreme environmental conditions of heat or cold, dampness or dryness, at high altitudes, and so forth. Both officers and enlisted personnel must be prepared to use force as required and must be ready to put themselves in harm's way. The military assumes that its personnel will sacrifice their lives as part of their jobs.

In order to meet the physical requirements, the Services have made some assumptions about what fitness level is needed and how this level of fitness should be maintained. In addition, the U.S. Department of De-

fense and the Services have developed guidelines specifying the desired medical and mental health condition of members of the enlisted force. These guidelines are used as screening standards—some are based on strong clinical and scientific evidence about the links between a health condition and the ability to perform in combat (e.g., blindness, deafness), and others are based on assumptions about this relationship (e.g., body composition, certain mental health conditions).

Currently there is little or no screening for physical fitness at the MEPS. For some Services, there are conditioning programs for the recruits while they are waiting in the delayed entry program (DEP) to be shipped to basic training. Recruits may remain in the DEP for up to one year. For the most part, however, physical fitness tests administered at the beginning and throughout basic training are the selection screens. Basic training is intense and physically demanding. Those who do not pass the fitness tests at the end of training will not be able to remain in the Services. This test generally consists of sit-ups or crunches, push-ups or pull-ups, and a run of 1.5 to 3 miles. Maintaining fitness is also a concern. Each Service has its own set of tests and testing schedules to measure physical fitness at various points in the first term.

Medical and mental health standards for screening are contained in the recently revised DoD Instruction 6130.4 (Appendix A—<http://www.dtic.mil/whs/directives/corres/html/61304.htm>). This instruction specifies all medical conditions for which an applicant can be disqualified. As noted earlier, some of these have a clear basis, while others may be interpreted more broadly, depending on the individual case and the need of a particular Service. Thus, some conditions cannot be allowed under any circumstances while disqualification for others can be waived by a Service. Conditions that are frequently waived are of particular interest to the committee.

REPORT ORGANIZATION

This report is organized into eight chapters. Chapter 2 provides an overview of enlistment processing procedures and standards and includes a description of the medical processing at MEPS. Chapter 3 discusses the methodology for linking standards to outcomes, provides an example of how the accession quality cost trade-off model can be applied, and examines the characteristics of current databases and the needs for the future. The next four chapters focus on analyses of particular standards. Each includes (1) a discussion of trends in the youth population as well as in the military enlisted force, (2) an examination of the available data on the relationship between a selected condition and injury or attrition, and (3) an analysis of various interventions found effective in the civilian sector.

Chapter 4 covers physical fitness considerations in selection, preconditioning, and training. Chapter 5 covers body composition and asthma, two medical factors that lead to a substantial number of disqualifications and subsequent waivers. Chapter 6 includes mental health concerns. Chapter 7 discusses substance abuse and smoking. Chapter 8 presents a summary of findings and the committee's conclusions and recommendations.

2

Procedures, Requirements, and Standards

This chapter provides a context for the committee's review and analysis of physical, medical, and mental health standards. It presents information on the existing medical processing system, military policies regarding personnel readiness, and the current status of fitness standards and testing.

The U.S. Department of Defense (DoD) is the nation's largest employer. In fiscal year (FY) 2005 alone, DoD planned to recruit 168,861 people to active duty and succeeded in recruiting 163,259 people (Office of the Deputy Under Secretary of Defense/Military Personnel Policy/Accession Policy, October 10, 2005). That number is somewhat lower than in recent years,[1] primarily because the Air Force is dramatically reducing recruiting in FY 2005 as part of a force-shaping initiative, while the Army fell 6,627 recruits short of its goal. Still, few organizations have annual requirements that even approach these numbers. In addition to the magnitude of these personnel requirements, the military services also confront a complex system of legal and policy constraints that exclude a substantial proportion of potential recruits from enlisting (see Appendix 2-A for an overview of recruiting practices and conditions). Those constraints include mental and physical minimum standards, educational and moral requirements, age limits, and security clearance issues. Our focus here is on the physical, medical, and mental health standards for military service.

[1]Since 1995, annual goals have ranged from 168,010 in 1995 to 192,597 in 2000.

TABLE 2-1 Race/Ethnicity and Gender of Active-Component First-Time Applicants, by Service, FY 2002 (percentage)

	Army	Navy	Marine Corps	Air Force	DoD
Men					
White	65.2	60.6	79.5	74.4	68.1
Black	12.4	22.7	9.7	15.9	14.9
Other/Unknown	22.4	16.7	10.8	9.7	17.0
Hispanic	12.3	16.1	17.4	10.3	13.9
Women					
White	54.6	52.2	71.3	65.8	57.6
Black	22.5	30.2	16.0	22.5	23.9
Other/Unknown	22.9	17.6	12.7	11.7	18.5
Hispanic	14.8	18.0	19.6	12.9	15.5
Totals					
Men	78.5	79.6	91.2	72.4	79.8
Women	21.5	20.4	8.8	27.6	20.2

NOTE: Columns will not add to 100% because Hispanics can be included in multiple races.
SOURCE: Office of the Assistant Secretary of Defense (2002).

The military services' personnel requirements are further complicated by a desire to have the racial and ethnic characteristics of the force reasonably representative of society as well as by legal and policy constraints that prevent the assignment of women to some direct-combat military occupational specialties. These concerns are important because medical and physical fitness requirements for service are likely to have differential impacts by race and sex.

As shown in the Tables 2-1 through 2-4, the military services have been extremely successful maintaining a racial and ethnic mix. Among applicants for military service (Table 2-1) and among new recruits (Table 2-2), blacks are slightly overrepresented compared with the population ages 18 to 24, while Hispanics are slightly underrepresented. Compared with the population ages 18 to 24, blacks are substantially overrepresented among all active-duty military personnel and Hispanics are somewhat underrepresented (Table 2-3). Although women make up a substantial proportion of the force, that proportion is far less than their representation in society (Table 2-4).

TABLE 2-2 Race/Ethnicity and Gender of Active-Component First-Time Accessions, by Service, and Civilians Ages 18-24, FY 2002 (percentage)

	Army	Navy	Marine Corps	Air Force	DoD
Men					
White	75.0	65.9	82.0	78.5	74.9
Black	12.1	18.8	8.0	13.3	13.0
Other/Unknown	12.9	15.3	10.0	8.2	12.1
Hispanic	12.1	14.7	15.8	9.1	12.8
Women					
White	61.2	58.5	75.2	70.6	64.0
Black	24.4	24.4	12.4	19.3	22.2
Other/Unknown	14.4	17.1	12.4	10.1	13.8
Hispanic	15.0	17.3	19.4	11.2	14.8
Total					
Men	82.4	83.3	92.9	77.6	83.5
Women	17.6	16.7	7.1	22.4	16.5
White	72.5	64.7	81.6	76.7	73.1
Black	14.2	19.7	8.3	14.6	14.5
Other/Unknown	13.3	15.6	10.1	8.7	12.4
Hispanic	12.6	15.1	16.1	9.5	13.2

Noninstitutionalized Civilians Ages 18-24					
White	Black	Other	Hispanic	Male	Female
78.5	14.0	7.5	17.7	50.4	49.6

NOTE: Columns will not add to 100% because Hispanics can be included in multiple races.
SOURCE: Civilian data from Bureau of Labor Statistics Current Population Survey File, October 2001-September 2002, Office of the Assistant Secretary of Defense (2002).

MEDICAL AND PHYSICAL FITNESS

Medical Standards and Screening

DoD's medical enlistment standards are contained in DoD Instruction 6130.4 (Box 2-1 provides a listing of the areas covered). This instruction was updated in 2004 on the basis of a review by the Accessions Medical Standards Working Group (AMSWG), which was guided in part by research findings provided by the Accessions Medical Standards Analysis and Research Activity (AMSARA). DoD Instruction 6130.4 forms the basis for screening recruits for all accessions. The new standard clearly emphasizes the importance of correct coding of all health events related

TABLE 2-3 Race/Ethnicity of Active-Component Enlisted Members, by Service, and Civilian Labor Force, Ages 18-44, FY 2002 (percentage)

Race/ Ethnicity	Army	Navy	Marine Corps	Air Force	DoD	Civilians Ages 18 to 44
White	63.5	64.5	70.8	72.6	67.1	80.1
Black	25.1	21.5	13.0	17.3	20.6	12.6
Other/Unknown	11.4	14.0	16.2	10.1	12.3	7.3
Hispanic	11.3	9.2	14.6	6.0	9.8	16.4

NOTE: Columns will not add to 100% because Hispanics can be included in multiple races.
SOURCE: Civilian data from Bureau of Labor Statistics Current Population Survey File, September 2002, Office of the Assistant Secretary of Defense (2002).

TABLE 2-4 Gender of Active-Component Enlisted Members, by Service, and Civilian Labor Force, Ages 18-44, FY 2002 (percentage)

Gender	Army	Navy	Marine Corps	Air Force	DoD	Civilians Ages 18 to 44
Men	85.4	85.6	93.9	80.1	85.2	54.2
Women	14.6	14.4	6.1	19.9	14.8	45.8
Total	100.0	100.0	100.0	100.0	100.0	100.0

SOURCE: Civilian data from Bureau of Labor Statistics Current Population Survey File, September 2002, Office of the Assistant Secretary of Defense (2002).

to the accession process and provides definitions for use by examining physicians.

In addition to this instruction, each Service has its own guidance and regulations for entrance and job assignment. There are several points in the enlistment process at which screening takes place: (1) at the recruiting station, (2) at the military entrance processing station (MEPS)/U.S. Military Entrance Processing Command, and (3) in waiver authorities in each Service.

Recruiting Stations

The enlistment screening process begins at the recruiting stations, where each applicant completes the medical prescreen using DoD Form 2807-2 (see Appendix 2-B). The medical prescreen includes a series of questions based on standards put forth in DoD Instruction 6130.4. If a disqualifying condition is indicated, the applicant is required to provide

BOX 2-1
Physical Standards Categories (6130.4)

Head
Eyes
Vision
Ears
Hearing
Nose, sinuses, and larynx
Dental
Neck
Lungs, chest wall, pleura, and mediastinum
Heart
Abdominal organs and gastrointestinal system
Genitalia (male)
Genitalia (female)
Urinary system
Spine and sacroiliac joints
Upper extremities
Lower extremities
Miscellaneous conditions of the extremities
Vascular system
Skin and cellular tissues
Blood and blood forming tissue diseases
Systemic
Endocrine and metabolic disorders
Neurological disorders
Learning, psychiatric, and behavior
Tumors and malignant diseases
Miscellaneous

an explanation and, in some cases, the recruiter may assist the applicant in obtaining all relevant medical records. Also, each applicant's body mass index (BMI) is estimated at the recruiting station to ensure that it meets the standard of the Service to which the applicant is applying (there is some variation among the Services; see Chapter 5 for a full discussion). An applicant will be temporarily disqualified at the MEPS if he or she does not meet the BMI or body fat standards.

If a recruiter has a concern about a particular medical condition, he or she can call a MEPS medical technician through the Dial-A-Medic Program to ask questions regarding an applicant's medical eligibility. Medical prescreening forms and associated documentation are forwarded to the local MEPS for further processing; this paperwork precedes the applicant's visit to the MEPS. Applicant transportation to the MEPS is

provided at the expense of the military. If a recruiter determines that an applicant is unlikely to meet medical standards because of a condition that is either not eligible for a waiver or unlikely to be granted a waiver, the processing of that applicant stops and the applicant's Form 2807-2 is filed for a limited time in the recruiting office.

Military Entrance Processing Stations

MEPS are responsible for screening all applicants in accordance with DoD Instruction 6130.4. MEPS are staffed with chief medical officers. These medical officers go through a training regimen and attend an annual chief medical officer's conference. They are responsible for profiling applicants for medical fitness to enter the military, making medical decisions, and ensuring that all medical documents are examined and appropriately routed. In addition to the chief medical officer, MEPS are staffed by military medical specialists, noncommissioned officers in charge, medical technicians, fee-basis practitioners, and consultants (medical specialists). Fee-basis practitioners also conduct medical examinations; however, prior to practicing at the MEPS, they must complete a training program and be approved by a credentialing committee. Table 2-5 shows the number and distribution of medical personnel in the current MEPS system. The procedures for medical personnel and medical examinations are contained in U.S. Military Entrance Processing Command (USMEPCOM) Regulation 40-1.

Standards are used by the MEPS to determine whether an applicant is medically and mentally qualified for military service. If an applicant is disqualified, he or she has the option of applying, through the recruiter, to the chosen Service for a waiver of the disqualification; the granting of these waivers can be used to control the flow of enlistees. Each Service has its own policy on waivers; an examination of these policies was outside the scope of the committee's charge.

Medical Processing The medical processing at a MEPS is shown in Figure 2-1. It includes (1) vision and hearing tests, (2) an individual examination and medical history specifying past or existing medical conditions taken by a physician (according to the guidance in DoD Instruction 6130.4) and recorded on Form 2807-1, (3) HIV and drug testing, (4) height and weight (BMI) measurement (in accordance with Service standards), (5) body fat if BMI is exceeded, and (6) an orthopedic/neurological examination intended to identify abnormalities that must be further investigated by the examining practitioner (see Box 2-2 for factors considered in the orthopedic/neurological test). The outcome of the medical evaluation process is a profile that contains document reviews, recommendations for

TABLE 2-5 Medical Personnel

		Physicians	Staff
Military Enlistment Processing Command HQ		3	9
Sector (eastern and western)		2	4
Chief medical officers		65	
Assistant chief medical officers		3	
MEPS support staff			
Medical noncommissioned officer			65
Civilian health technicians			405
Military medical specialists			207
Fee-basis practitioner network	419		
In-house consultants network	48		
Out-of-house consultants	± 305		
Total	817		

SOURCE: Committee briefing by USMEPCOM.

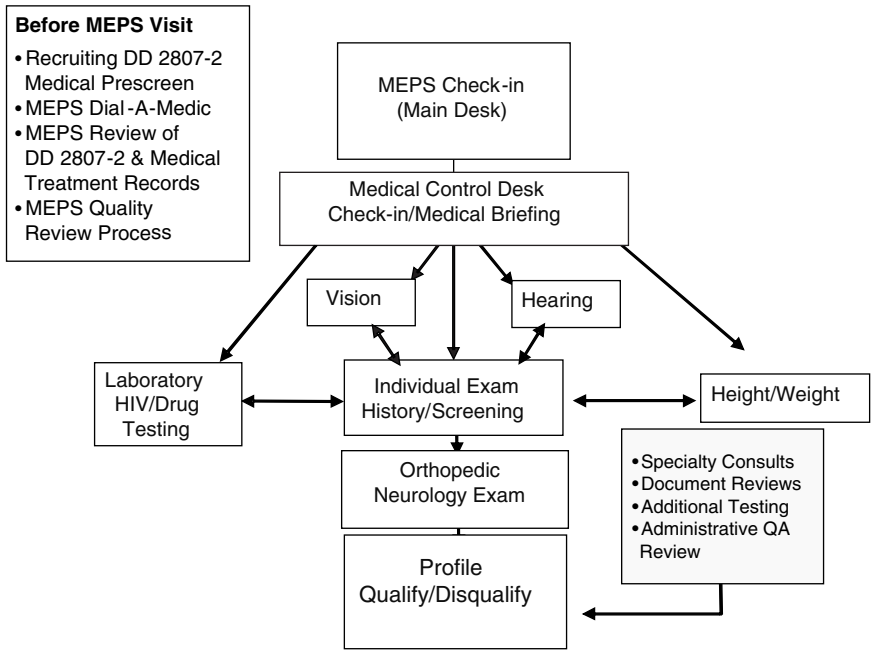

FIGURE 2-1 Medical evaluation process.
SOURCE: Committee briefing by USMEPCOM.

BOX 2-2
Orthopedic/Neurological Screening Examination

Goal:

Identify orthopedic/neurological abnormalities that must be further investigated by appropriate medical personnel.

Ask applicants:

1. Do they have a current or recent injury?
2. Do they have cardiovascular problems?
3. Have they had a recent surgery?

Observe:

1. Abnormalities in posture, habitus, and gait.
2. Deformation, particularly of extremities.
3. Limitations of motion and joints.
4. Muscle absence or atrophy.
5. Lack of muscle strength.
6. Incoordination.
7. Missing digits.
8. Skin eruptions and other skin abnormalities.
9. Apprehension, reluctance, or inability to perform in a prescribed manner due to fear of pain or joint dislocation.
10. Clinically significant scars, including skin grafts.
11. Other abnormalities.

Testing:

Each test movement is demonstrated by a technician—posture, arm, and leg extensions and flexions, etc.

additional testing and consultations, weight reduction programs, etc. This profile determines whether the applicant in medically qualified to enlist, has a medical or physical condition that is likely to be considered for a waiver by the Services, or has a permanently disqualifying condition. For some conditions, further testing or consultation with a specialist is recommended.

As noted above, each service applies its own BMI and body fat standards. Applicants who exceed the weight standard and the body fat standard (used only for those who exceed the BMI standard) are advised

to bring their weight to the standard and return to the MEPS for reevaluation. The date the applicant may return is based on the amount of weight loss required. According to USMEPCOM Regulation 40-1, this date is set based on a waiting period of four days for every pound to be lost. If the applicant loses the required weight, it is not necessary to reevaluate body fat.

Figure 2-2 provides an overview of applicant medical outcomes. The MEPS perform approximately 380,000 medical examinations a year at a cost of $183 per examination (based on 1998 data). Applicants who receive a medical disqualification at the MEPS may apply to their respective Services for a waiver. Each Service has its own waiver authority. Those listed below are for active-duty service.

- Army waivers are granted by the U.S. Army Recruiting Command.
- Navy waivers are reviewed by the Bureau of Medicine and Surgery with recommendations forwarded to the chief, Naval Recruiting Command.
- Air Force waivers are granted by the Air Education and Training Command surgeon general.
- Marine Corps waivers are reviewed by the Bureau of Medicine and Surgery with recommendations forwarded to the commandant of the U.S. Marine Corps for a decision.

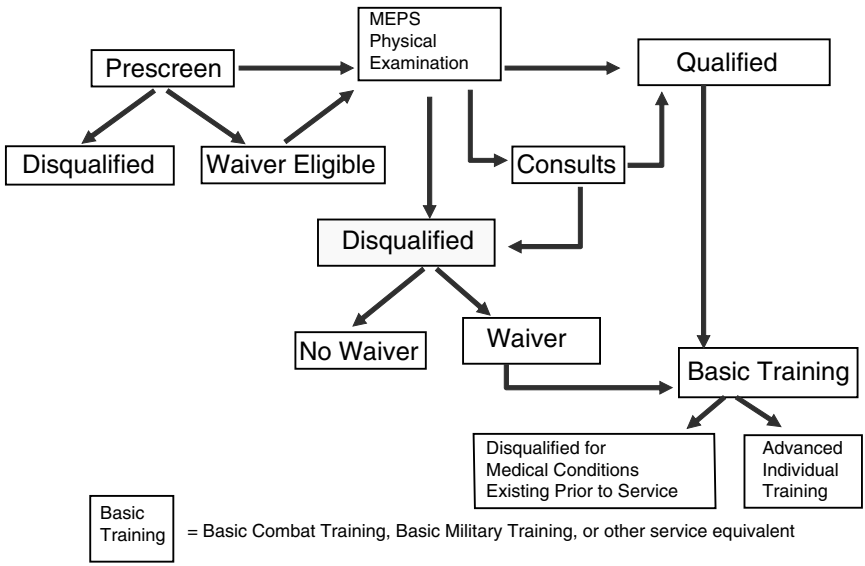

FIGURE 2-2 Applicant medical outcomes.
SOURCE: USMEPCOM (2004).

Data on each applicant are entered into the MEPCOM Integrated Resource System (MIRS). These data include biographical information, medical profile, disqualification coding by parts of the body, and waiver approvals. They can be used to describe the distribution of recruits across medical disqualification codes and corresponding International Classification of Diseases (ICD-9) codes. In addition, the percentage of applicants receiving waivers in each disqualification code can be obtained. However, there is no easy or routine mechanism for linking these data to injury and attrition in training or in the first term of service. In addition, as noted above, there is no information available about applicants who are turned away at the recruiting station without having been seen at the MEPS.

Physical Profile Serial System The military services have developed a medical profile system to relate body systems to military jobs. This system, dubbed PULHES, constitutes the minimum medical standards for military jobs. PULHES evaluates jobs in terms of the following six body systems:

1. P—Physical capacity or stamina. This factor, general physical capacity, normally includes conditions of the heart; respiratory system; gastrointestinal system; genitourinary system; nervous system; allergic, endocrine, metabolic, and nutritional diseases; diseases of the blood and blood forming tissues; dental conditions; diseases of the breast; and other organic defects and diseases that do not fall under other specific factors of the system.
2. U—Upper extremities. This factor concerns the hands, arms, shoulder girdle, and upper spine (cervical, thoracic, and upper lumbar) with regard to strength, range of motion, and general efficiency.
3. L—Lower extremities. This factor concerns the feet, legs, pelvic girdle, lower back musculature, and lower spine (lower lumbar and sacral) with regard to strength, range of motion, and general efficiency.
4. H—Hearing and ears. This factor concerns auditory acuity and disease and defects of the ear.
5. E—Eyes. This factor concerns visual acuity and diseases and defects of the eye.
6. S—Psychiatric. This factor concerns personality, emotional stability, and psychiatric diseases.

Numbers 1 through 4 are used to reflect levels of functional capacity. The basic purpose of the physical profile is to provide an index to overall functional capacity; that is, the functional capacity of a particular organ or system of the body is evaluated in determining the numerical designation

1, 2, 3, or 4. Specifically, 1 indicates a high level of medical fitness for the system being rated, 2 indicates some medical condition or physical defect that may require some activity limitations, 3 signifies one or more medical conditions or physical defects that may require significant limitations, and 4 signifies one or more medical conditions or physical defects of such severity that performance of military duty must be drastically limited. There are few military jobs that permit a 3 or 4. Thus, for those applying for military service, a 3 or 4 on any factor usually means a medical disqualification. Specific definitions of each number for each system can be found in Army Regulation 40-501, February 1, 2005.

Physical Fitness Testing The only physical fitness test currently given at the MEPS is the Air Force Strength Test. Recently AMSARA initiated an experiment to test recruit motivation and strength using the five-minute step test, the number of push-ups performed in one minute, and the Air Force Strength Test. This battery is called the Assessment of Recruit Motivation and Strength (ARMS). The hypotheses are that these tests will (1) identify those with undisclosed medical conditions or low motivation and (2) predict injury and attrition in basic training and advanced individual training. This experiment is currently being conducted at seven MEPS with Army applicants. Its intended use is to screen in applicants who were disqualified on body fat percentage or other fitness measures.

Delayed Entry Program

For most new recruits, there is a gap between the time when they sign their enlistment contract and the time when they actually travel to basic training. This gap—which can last up to one year in the case of a high school senior—is referred to as the delayed entry program (DEP)—(see Appendix 2-A for further detail). Some physical fitness testing and training is provided in the DEP. The Army is experimenting with the 1 1 1 test (1 mile run, 1 minute of push-ups, and 1 minute of sit-ups). There are criteria values the recruit is expected to reach before shipping to basic training. The Marine Corps also has an active program of physical fitness in the DEP, and the Air Force and the Navy provide information designed to encourage those in the DEP to maintain or improve their physical conditioning.

Current Physical Fitness Standards and Testing

Physical Fitness Standards

Technology may be reducing the physical demands of some civilian and military jobs. However, the DoD and the Services direct that every

member must maintain some minimal level of physical fitness (DoD Directive 1308.1). The philosophy that every member of a uniformed Service—regardless of job assignment—is a warrior is emphasized in all the Services. The demands expected to be placed on Service members in the future reinforce this notion. For example, Sager, Russell, Campbell, and Ford (2003) identified Army-wide common tasks for the future force that include numerous physically demanding tasks—such as react to combat situations, move through the battlefield, employ hand-to-hand techniques, control or evacuate crowds—that all soldiers will be required to perform.

While military service is now and is expected to remain a physically demanding occupation, there is little objective documentation of the level of fitness necessary to perform in most military occupational specialties (MOSs).[2] With the exception of the Air Force's Strength Aptitude Test (SAT)—and certain specialties with extreme physical fitness requirements, such as Navy SEALS, Army Special Forces, and Air Force Pararescue/Recovery team members—the Services do not attempt to match the existing (or potential) physical fitness of recruits (or of Service members in general) with their MOSs. Rather, a collateral purpose of the military's training system is to function as a screening system. The Air Force's SAT—which includes no measures of aerobic fitness, endurance, or flexibility—sets a minimum standard for each Air Force specialty, based on actual measurement of physical job demands (weight lifted, pushed, pulled, etc.) in the specialty (Air Force Manual 36-2108, October 2003). The weight/force of each task is converted into equivalent performance on the SAT; the conversions are based on regression equations. Strength standards range from less than 40 up to 110 lbs. on the SAT for various Air Force jobs.

Documentation does not exist that would allow the committee to conduct an in-depth examination of the physical demands of each MOS in each Service (literally hundreds of distinct military jobs). On the surface, it is obvious that these jobs vary widely in the physical demands they place on incumbents as they go about their routine job tasks. For example, the daily tasks performed by an infantry soldier are far more physically demanding than the tasks performed by a personnel or accounting specialist. At the same time, the Services expect that all uniformed Service

[2]The Services vary in the terminology used to characterize specific jobs or job series. MOS is used by the Army and the Marine Corps, and we adopt it here. The Air Force generally refers to Air Force specialties (AFS) or Air Force specialty code (AFSC), and the Navy refers to Navy ratings.

TABLE 2-6 Military Service Physical Fitness Test Components

	Army	Navy	Air Force	Marine Corps
Aerobic capacity	2-mile run	1.5-mile run	1.5-mile run	3-mile run
Upper body muscular fitness	Push-ups (2 minutes)	Push-ups (2 minutes)	Push-ups (1 minute)	Pull-ups (men) Flexed arm hang (women)
Abdominal muscular fitness	Sit-ups (2 minutes)	Curl-ups (2 minutes)	Crunches (1 minute)	Crunches (2 minutes)

SOURCE: Adapted from Singer, Palmer, Rogers, and Smith (2002).

members will be able to perform numerous tasks that lie outside their "job" tasks. As noted in DoD Instruction 1308.3: "It is DoD policy that physical fitness is essential to combat readiness and is an important part of the general health and well-being for Armed Forces personnel." Thus, the committee accepted the policy that military service itself requires a minimum level of physical fitness of all uniformed Service members. Accepting that assumption nonetheless requires some specification of what level of fitness is required. A reasonable starting point is an examination of the Services' policies with regard to physical fitness, its maintenance, and its measurement.

Physical Fitness Testing

All Services have some form of routine physical fitness testing for all members. Consequences of failure to pass this test vary but may include involuntary discharge from the Service. The components included in these tests vary considerably by Service. Table 2-6 presents the components of the tests by Service. In addition, the standards for passing these tests also vary by Service (Table 2-7). Although the Services use different measures in their physical fitness tests, they all include components measuring aerobic capacity, upper body muscle strength, and abdominal muscle strength.

PHYSICAL ABILITY TESTING FOR CIVILIAN JOBS

It is useful to compare the civilian workplace with the military work setting in terms of the role and treatment of physical ability. The two differ in at least two dramatic ways. The first is that while physical performance is relevant for 100 percent of military jobs (since basic military

TABLE 2-7 Selected Minimum Standards on Service Physical Fitness Tests

	Army			Navy			Marine Corps		
Aerobic	2-mile run			1.5-mile run			3-mile run		
	Age	Men	Women	Age	Men	Women	Age	Men	Women
	17-21	15:54	18:54	17-19	12:30	15:00	17-26	28:00	31:00
Upper	Push-ups			Push-ups			Pull-ups/Flexed Arm		
	Age	Men	Women	Age	Men	Women	Age	Men	Women
	17-21	42	19	17-19	42	19	17-26	3	15 sec
Abdominal	Sit-ups			Curl-ups			Crunches		
	Age	Men	Women	Age	Men	Women	Age	Men	Women
	17-21	53	53	17-19	50	50	17-26	50	50

NOTE: Air Force minimum standards are based on a weighted combination of scores from the physical fitness test components plus a waist circumference measurement.
SOURCE: Extracted from Singer, Palmer, Rogers, and Smith (2002).

training is a requirement for all), it is a factor in only a relatively limited set of civilian jobs.

The second is that while the military at present adopts a strategy of training to develop physical ability, rather than selecting for physical ability, civilian employers generally use a strategy of selecting for physical ability. Perhaps the prototypic civilian job with high physical demands is that of firefighter; physical ability testing is typically a part of the firefighter selection process (e.g., Biddle and Sill, 1999; Hogan and Quigley, 1994; Truxillo, Donahue, and Sulzer, 1996; Sharkey, 2000). While interests in increasing the number of women qualified for firefighter jobs may lead employers to encourage or even sponsor physical training programs, such programs are designed to prepare a potential applicant to take a preemployment physical test, in contrast to the postenlistment training done in the military setting. Consistent with the earlier observation of limited relevance of physical ability for civilian jobs, surveys of test use show that fewer than 10 percent of employers make use of physical ability measures (Salgado, Viswesvaran, and Ones, 2001).

A handbook chapter by Hogan (1991) remains the best compendium of research on the validity of physical ability measures in the civilian workplace. Hogan notes the use of two approaches to physical testing in the workplace, which use two very different types of tests. The first focuses on simulating the performance of a job-specific physical task (e.g., a firefighter dragging a hose, climbing a ladder). This approach relies on the fidelity with which the test matches exact job conditions as the basis for establishing the content validity of the test. In other words, the basis for the inference that the test is job-relevant is established on logical grounds due to the similarity of test content and job content. The second focuses on measurement of more fundamental physical constructs (e.g., muscular endurance, cardiovascular endurance). This approach uses job analysis to identify physical constructs that appear to be relevant to effective job performance and then examines empirical relationships between individuals' scores on tests of those constructs and measures of criteria of interest (e.g., job performance).

Hogan provides tables with about 100 validity coefficients relating physical test scores to various criteria. The general finding is that physical tests chosen on the basis of job analysis as relevant for the criterion of interest do prove to be predictive of performance on the criterion of interest. Examining gender differences, she found consistent and large mean differences on measures involving strength and cardiovascular endurance. These test differences correspond to differences on the criteria of interest, leading Hogan to conclude that gender differences on the test are not a function of bias in the test. The focus is exclusively on gender and not on race. Legal challenges to the use of physical tests are not uncom-

mon; reviews of such litigation are found in Hogan and Quigley (1986) and Terpstra, Mohamed, and Kethley (1999).

Thus the civilian literature does document that individuals' standing on physical ability measures relevant to the job setting is correlated with subsequent job performance. Because measures of individual job performance are generally not available in military settings, this civilian research reinforces the importance of attending to physical ability and fitness as a determinant of performance. One example of military research accomplished in this regard is a study of Marine Corps physical fitness testing and the relationship of the tests to performance of rifleman tasks in arduous environments (Davis, Dotson, and Sharkey, 1986). The researchers developed a taxonomy of combat tasks, created simulated combat missions, and identified a set of criterion tasks. The ability to perform effectively was predicted by various parts of the Marine Corps physical fitness test. This work was accomplished with using subjects and tasks from one military occupational specialty.

CONCLUSIONS AND RECOMMENDATIONS

To adequately assess the impact of medical standards on applicant flow and disqualification rates, information about screening that takes place before the MEPS physical is required.

> **Recommendation 2-1:** The Services should develop a procedure for maintaining data from the DD Form 2807-2 (Medical Prescreening of Medical History Report) in an automated form for all applicants, including those who are disqualified at the recruiting station.

In order to understand the fitness requirements needed to perform the set of common military tasks in each service, an analysis of the requirements of each task is needed. While the requirements of a few tasks (e.g., carrying a loaded pack) have been studied, there is no systematic analysis of the entire set of common tasks within each service.

> **Recommendation 2-2:** We recommend that research be undertaken to determine the fitness requirements (based on defining the functional requirements) of the common tasks cutting across military occupational specialties in each Service, with the goal of using this research to set fitness standards.

We note that the use of different fitness measures by the Services makes it difficult to assess fitness across the Services. While acknowledging that each Service may have reason to set standards differently from the others and may have reason to implement additional Service-specific

measures, the use of a common set of basic fitness measures would aid understanding of fitness across the Services.

Recommendation 2-3: We recommend that an inter-Service panel develop a common core set of uniformly administered fitness measures for use across the Services in research studies on physical fitness and its policy implications for military service. This does not preclude the use of additional Service-specific measures or the setting of differing standards by each Service.

APPENDIX 2-A: THE RECRUITING PROCESS[3]

Initial contacts between military recruiters and youth interested in military service are exploratory. In most cases, youth seek information from recruiters in more than one Service. In addition to providing information to the prospective enlistee, recruiters determine an applicant's initial eligibility for military service. They ask questions regarding age, citizenship, education, involvement with the law, use of drugs, and physical and medical conditions that could preclude enlistment. Most prospects take an aptitude screening test at a recruiting office. Estimates are that 10 to 20 percent of prospects do not continue beyond this point (Waters, Laurence, and Camara, 1987:12).

Armed Services Vocational Aptitude Battery

Prospects who meet initial qualifications take the Armed Services Vocational Aptitude Battery (ASVAB), the first formal step in the process of applying to enlist in the Armed Forces. The ASVAB is a battery of tests used by DoD to determine enlistment eligibility and qualifications for military occupations. It consists of 10 tests (11 if the applicant takes the computer-adaptive test at a MEPS), four of which comprise the Armed Forces Qualification Test (AFQT): arithmetic reasoning, mathematics knowledge, word knowledge, and paragraph comprehension. The AFQT, a general measure of trainability and predictor of on-the-job performance, is the primary index of recruit aptitude.

AFQT scores, expressed on a percentile scale, reflect an applicant's standing relative to the national population of men and women ages 18 to

[3]Adapted from the web version of *Population Representation in the Military Services, FY2002* (<http://www.dod.mil/prhome/poprep2002/>).

TABLE 2-A-1 Armed Forces Qualification Test (AFQT) Categories and Corresponding Percentile Score Ranges

AFQT Category	Percentile Score Range
I	93-99
II	65-92
IIIA	50-64
IIIB	31-49
IV	10-30
V	1-9

23.[4] The scores are grouped into five categories based on the percentile score ranges shown in Table 2-A-1. Persons who score in Categories I and II tend to be above average in trainability; those in Category III, average; those in Category IV, below average; and those in Category V, markedly below average. By law, Category V applicants and those in Category IV who have not graduated from high school are not eligible for enlistment. Over and above these legal restrictions, each Service prescribes its own aptitude and education criteria for eligibility. Each Service uses combinations of ASVAB test scores to determine an applicant's aptitude and eligibility for different military occupations.

Education Credentials

DoD implemented a three-tier classification of education credentials in 1987, as follows:

- Tier 1—Regular high school graduates, adult diploma holders, and nongraduates with at least 15 hours of college credit.
- Tier 2—Alternative credential holders, including those with a General Education Development (GED) certificate of high school equivalency.
- Tier 3—Those with no education credential.

The system was developed after research indicated a strong relationship between education credentials and successful completion of the first

[4]The score scale is based on a 1997 study conducted by DoD in cooperation with the U.S. Department of Labor. Participants were drawn from a nationally representative sample of young men and women.

term of military service (Flyer, 1959; Elster and Flyer, 1981). Research shows that educational attainment of youth predicts first-term military attrition (U.S. Department of Defense, 1996; Laurence, 1997). In consultation with the National Research Council/National Academy of Sciences, DoD developed a mathematical model that links recruit quality and recruiting resources to job performance (U.S. Department of Defense, 2000). The model was then used to establish the recruit quality benchmarks now in effect. Service programs are required to ensure that a minimum of 90 percent of first-time recruits are high school diploma graduates. At least 60 percent of recruits must be drawn from AFQT Categories I–IIIA; no more than 4 percent of the recruits can come from Category IV. This DoD policy does not prohibit the Services from setting their own targets above these benchmarks. These benchmarks were set by examining the relationship between costs associated with recruiting, training, attrition, and retention using as a standard the performance level obtained by the reference cohort of 1990, the cohort that served in Operation Desert Shield and Operation Desert Storm. Thus, these benchmarks reflect the recruit quality levels necessary to minimize personnel and training costs while maintaining Desert Shield/Desert Storm cohort performance (Sellman, 1998).

The Services have different standards for individuals in each tier. Generally, Tier 3 applicants must have higher AFQT test scores than Tier 2 applicants, who must have higher test scores than Tier 1 individuals.

Physical Examinations

If an applicant achieves qualifying ASVAB scores and wants to continue the application process, he or she is scheduled for a physical examination and background review at one of the MEPS. The examination assesses medical fitness for military service. It includes measurement of blood pressure, pulse, visual acuity, and hearing; blood testing and urinalysis; drug and HIV testing; and medical history. Some Services also require tests of strength and endurance. If a correctable or temporary medical problem is detected, the applicant may be required to get treatment before proceeding. Other applicants may require a Service waiver of some disqualifying medical conditions before being allowed to enlist.

Moral Character Standards

Each applicant must meet rigorous moral character standards. In addition to the initial screening by the recruiter, an interview covering each applicant's background is conducted at the MEPS. For some individuals,

a financial credit check or a computerized search for a criminal record is conducted. Some types of criminal activity are clearly disqualifying; other cases require a waiver, wherein the Service examines the applicant's circumstances and makes an individual determination of qualification. Moreover, applicants with existing financial problems are not likely to overcome those difficulties on junior enlisted pay. Consequently, credit histories may be considered as part of the enlistment decision.

Occupational Area Counseling

If the applicant's ASVAB scores, education credentials, physical fitness, and moral character qualify for entry, he or she meets with a Service classification counselor at the MEPS to discuss options for enlistment. Up to this point, the applicant has made no commitment. The counselor has the record of the applicant's qualifications as well as computerized information on available Service training or skill openings, schedules, and enlistment incentives.

A recruit can sign up for a specific skill or for a broad occupational area (such as the mechanical or electronics areas). In the Army, most recruits (95 percent) entered for specific skill training; the others were placed in a military occupational specialty during basic training. In the Air Force, approximately 70 percent of recruits entered for a specific skill, while the rest signed up for an occupational area and were classified into a specific skill while in basic training. In the Navy, approximately 77 percent of recruits enlisted for a specific skill, while the rest went directly to the fleet after basic training, 20 percent classified in airman, fireman, or seaman programs and 3 percent entered school 12 to 18 months later. Approximately 97 percent of Marine Corps enlistees entered with a guaranteed occupational area and were assigned a specific skill in that area after recruit training; the rest enlisted with either a specific job guarantee or assignment to a job after recruit training.

Normally, an applicant will be shown a number of occupations. In general, the higher the individual's test scores, the more choices he or she will have. While the process differs by Service, specific skills and occupational groupings are arranged similarly to an airline reservation system, with the training "seat" and time of travel (to recruit training) based either on the school or the field unit position openings. The counselor discusses the applicant's interests and explains what the Service has to offer. The counselor may suggest incentives to encourage the applicant to choose hard-to-fill occupational specialties. The applicant, however, is free to accept or reject the offer. Some applicants do not decide immediately but take time to discuss options with family and friends; others decide not to enlist.

The Delayed Entry Program

When the applicant accepts an offer, he or she signs an enlistment contract. Only a small proportion of new enlistees is sent to a recruit training center from the MEPS within a month of enlistment. Most enter the DEP, which allows up to a year before the individual reports for duty, with up to a 365-day extension upon approval by the respective Service secretary (10 U.S.C. 513, as amended October 1999). The DEP controls recruit flow into training seats at technical schools. The Services also use the DEP to prepare enlistees for basic training, providing them with supervised exercise programs, if needed. The DEP acclimates recruits to the military and enhances training performance, which decreases attrition (Gilmore, 2001). Average time in the DEP is between three and five months.

Qualified high school students may enlist in the DEP with a reporting date after graduation; their enlistment contract is contingent upon successfully completing high school. Not all DEP enlistees actually enter active duty. By Service, an average of 13 to 21 percent of individuals in the DEP changed their minds and asked to be released from their enlistment contracts in FY 2002. The Services consider enlistment in the DEP a serious commitment, but they do not require youth to enter military service against their will.

APPENDIX 2-B: MEDICAL PRESCREEN
(pp. 42-46)

INSTRUCTIONS FOR DD FORM 2807-2,
MEDICAL PRESCREEN OF MEDICAL HISTORY REPORT

1. This form is to be completed by each individual who requires medical processing in accordance with Army Regulation 40-501 Chapter 2 standards, or Department of Defense Directive 6130.3, "Physical Standards for Appointment, enlistment, or Induction." The form should be completed by the applicant with the assistance of the recruiter, parent(s), or guardian, as needed (see page 2).

2. This form replaces the existing medical prescreening form (DD Form 2246). The revisions are designed to ensure that medical prescreening questions "used by recruiters and by Military Entrance Processing Commands are specific, unambiguous and tied directly to the types of medical separations most common for recruits during basic training and follow-on training" (per P.L. 105-85, Div. A, Title V, S 532).

3. Use of this form will also facilitate efficient, timely, and accurate medical processing of individuals applying for service in the United States Armed Forces or Coast Guard. The form is designed to assist recruiters in the medical pre-screening of applicants.

EXPLANATION OF CODES.

Items are followed by numbers that refer to the following:

(1) If the applicant has been seen by a physician and/or has been hospitalized for the condition, obtain medical documentation with a medical release form and submit records to the MEPS Medical Section. After the MEPS Medical Officer reviews the provided information, the appropriate recruiting service member will be informed of the examinee's processing status, or if additional record review or specialty consultation may be required for further processing or qualification determination.

a. If the applicant was evaluated and/or treated on an out-patient basis, obtain a copy of actual treatment records of the private medical doctor (PMD) or health care provided (HCP), to include (if any):
- office or clinic assessment and progress notes, including the initial assessment documents, subsequent evaluation and treatment documents, and record and date when released from doctor's care to full, unrestricted activity;
- emergency room (ER) report;
- study reports (e.g., x-ray report(s), magnetic resonance imaging (MRI) report(s), or Computerized Tomography (CT) scan report(s), etc.);
- procedure reports (e.g., arthroscopy, electroencephalogram (EEG; brain wave test), echocardiogram (ultrasound of the heart), etc.);
- pathology reports (e.g., if tissue specimens taken from the body and sent to lab for microscopic diagnosis, etc.);
- specialty consultation records (e.g., neurologist, cardiologist, OB/Gynecologist, gastroenterologist, orthopedic surgeon, pulmonologist, allergist, etc.).

b. If the applicant was hospitalized, then obtain a copy of the hospital record, to include (if any): ER report, admission history and physical, study reports, procedure reports, operative report (especially necessary for surgery to bone or joint), pathology report, specialty consultation reports, and discharge summary.

(2) If an applicant has been diagnosed or treated since age 12 for any attention disorder (Attention Deficit Disorder (ADD) or Attention Deficit Hyperactivity Disorder (ADHD), etc.), academic skills or perceptual defect, or has had an Individual Education Plan (IEP), call the MEPS for additional instructions.

(3) Condition to be discussed with the examining Medical Officer at time of the medical examination.

(4) Call MEPS Medical Section to discuss examinee's medical history BEFORE sending the individual in for physical examination.

(5) Send medical reports to MEPS for review before sending applicant for physical ("papers only" medical review), and MEPS Medical Section will advise regarding further medical processing. Records pertaining to non-psychiatric diagnoses may be sent to the Medical Section of the processing MEPS, with the envelope stating: "CONFIDENTIAL: MEPS MEDICAL SECTION."

(6) Send all documentation relating to ANY past or present evaluation, treatment or consultation with a psychiatrist, psychologist, counselor or therapist, on an inpatient or out-patient basis for any reason, including but not limited to counseling or treatment for adjustment or mood disorder, family or marriage problem, depression, treatment or rehabilitation for alcohol, drug or other substance abuse, directly from the treating clinician and/or hospital to the MEPS Chief Medical Officer. The envelope must bear the following statement: "CONFIDENTIAL: FOR EYES OF THE MEDICAL OFFICER ONLY."

(7) May require an orthopedic consult, scheduling to be coordinated by the MEPS CMO and Medical Section.

DD FORM 2807-2, AUG 2000 Page 1 of 5 Pages

MEDICAL PRESCREEN OF MEDICAL HISTORY REPORT
(Chapter #2 Physicals Only)

Form Approved
OMB No. 0704-0413
Expires Aug 31, 2003

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS. RETURN COMPLETED FORM AS INDICATED ON PAGE 2.

PRIVACY ACT STATEMENT

AUTHORITY: 10 USC 504, 505, 507, 532, 978, 1201, 1202, and 4346; and E.O. 9397.
PRINCIPAL PURPOSE(S): To obtain medical data for determination of medical fitness for enlistment, induction, appointment and retention for applicants and members of the Armed Forces. The information will also be used for medical boards and separation of Service members from the Armed Forces.
ROUTINE USE(S): None.
DISCLOSURE: Voluntary; however, failure by an applicant to provide the information may result in delay or possible rejection of the individual's application to enter the Armed Forces. For an Armed Forces member, failure to provide the information may result in the individual being placed in a non-deployable status.

WARNING: The information you have given constitutes an official statement. Federal law provides severe penalties (up to 5 years confinement or a $10,000 fine or both), to anyone making a false statement. If you are selected for enlistment, commission, or entrance into a commissioning program based on a false statement, you can be tried by military courts-martial or meet an administrative board for discharge and could receive a less than honorable discharge that would affect your future.

1. APPLICANT

a. LAST NAME - FIRST NAME - MIDDLE INITIAL (SUFFIX)	b. DATE OF BIRTH *(YYYYMMDD)*	c. SOCIAL SECURITY NUMBER

2. Mark each item "YES" or "NO". Every item marked "YES" must be fully explained in Item 2b.

a. HAVE YOU EVER HAD OR DO YOU NOW HAVE:	YES	NO		YES	NO
(1) Asthma, wheezing, or inhaler use (4)			(27) Ulcer *(stomach, duodenum or other part of intestine)* (4)		
(2) Dislocated joint, including knee, hip, shoulder, elbow, ankle or other joint (1)(7)			(28) Received disability compensation for an injury or other medical condition (4)		
(3) Epilepsy, fits, seizures, or convulsions (4)			(29) Hepatitis *(liver infection or inflammation)* (4)		
(4) Sleepwalking (4)			(30) Intestinal obstruction *(locked bowels)*, or any other chronic or recurrent intestinal problem, including small intestine or colon problems, such as Crohn's disease or colitis (4)		
(5) Recurrent neck or back pain (4)(1)(7)					
(6) Rheumatic fever (4)					
(7) Foot pain (3)			(31) Detached retina or surgery for a detached retina (4)		
(8) A swollen, painful, or dislocated joint or fluid in a joint *(knee, shoulder, wrist, elbow, etc.)* (1)(7)			(32) Surgery to remove a portion of the intestine *(other than the appendix)* (4)		
(9) Double vision (4)			(33) Any other eye condition, injury or surgery (4)		
(10) Periods of unconsciousness (4)			(34) Are you over 40? *(If so, call the MEPS for information on special requirements for over-40 physicals)* (4)		
(11) Frequent or severe headaches causing loss of time from work or school or taking medication to prevent frequent or severe headaches (4)					
(12) Wear contact lenses *(If so, bring your contact lens kit and solution so you can remove your contact when we test your vision at the MEPS; also, if you have a pair of eyeglasses, bring them with you no matter how old they are.)*			(35) Gall bladder trouble or gall stones (4)		
			(36) Jaundice (4)		
			(37) Missing a kidney (4)		
			(38) Allergy to common food *(milk, bread, eggs, meat, fish or other common food)* (4)		
(13) Fainting spells or passing out (4)					
(14) Head injury, including skull fracture, resulting in concussion, loss of consciousness, headaches, etc. (4)			(39) *(Males only)* Missing a testicle, testicular implant, or undescended testicle (4)		
(15) Back surgery (4)			(40) Broken bone requiring surgery to repair *(with or without pins, plates, screws or other metal fixation devices used in repair)*		
(16) Seen a psychiatrist, psychologist, counselor or other professional for any reason *(inpatient or outpatient)* including counseling or treatment for school, adjustment, family, marriage or any other problem, to include depression, or treatment for alcohol, drug or substance abuse (6)(2)			(41) Ruptured or bulging disk in your back or surgery for a ruptured or bulging disk (4)		
(17) Any of the following skin diseases:			(42) Thyroid condition or take medication for your thyroid (4)		
(a) Eczema (5)			(43) Limitation of motion of any joint, including knee, shoulder, wrist, elbow, hip or other joint (4)(1)(7)		
(b) Psoriasis (5)					
(c) Atopic dermatitis (5)			(44) Drug or alcohol rehab (4)		
(18) Irregular heartbeat, including abnormally rapid or slow heart rates (4)			(45) Kidney, urinary tract or bladder problems, surgery, stones or other urinary tract problems (4)		
(19) Allergic to bee, wasp, or other insect stings *(itching/swelling all over and/or get short of breath)* (4)			(46) Sugar, protein or blood in urine (4)		
			(47) Surgery on a bone or joint *(knee, shoulder, elbow, wrist, etc.)* including Arthroscopy with normal findings		
(20) Heart murmur, valve problem or mitral valve prolapse (4)					
(21) Allergic to wool (4)			(48) Taking any medications *(If so, list reason in Item 2b.)*		
(22) Heart surgery (4)			(49) Pain or swelling at the site of an old fracture (4)(1)(7)		
(23) Been rejected for military service *(temporary or permanent)* for medical or other reasons (4)			(50) Perforated ear drum or tubes in ear drum(s)(4)		
			(51) Anemia (4)		
(24) Any other heart problems (4)			(52) Ear surgery, to include mastoidectomy or repair of perforated ear drum (4)		
(25) High blood pressure (4)					
(26) Discharged from military service for medical reasons (4)			(53) Night blindness (4)		

MEDICAL PRESCREEN

LAST NAME - FIRST NAME - MIDDLE INITIAL (SUFFIX)	SOCIAL SECURITY NUMBER

2a. *(Continued)* HAVE YOU EVER HAD OR DO YOU NOW HAVE:	YES	NO		YES	NO
(54) Arthritis (4)			(66) Cataracts or surgery for cataracts (4)		
(55) Absence or disturbance of the sense of smell (4)			(67) Eye surgery, including radial keratotomy, lens implant or other eye surgery to improve your vision (4)		
(56) Absence or removal of the spleen, or rupture or tear of the spleen without removal (4)			(68) Collapsed lung or other lung condition (4)		
(57) Anorexia or other eating disorder (4)			(69) Bed wetting since age 12 (4)		
(58) Recent fracture(s) (4)			(70) Been a sleepwalker (4)		
(59) Bursitis (4)			(71) Taken medication, drugs, or any substance to improve attention, behavior, or physical performance (2)(1)(6)		
(60) Braces *(If you wear or are planning on obtaining braces for your teeth, have the orthodontist submit a letter stating that braces will be removed before active duty date; release form and sample format can be found in the Recruiter's Medical Guide.)*			(72) Do you smoke? *(If yes:)* (a) Type ☐ Cigarettes ☐ Cigars ☐ Smokeless tobacco; (b) How many per day?; (c) Date last used		
(61) Loss of finger, toe or part thereof (4)			(73) Have you used illegal drugs or abused prescription drugs? *(If yes:)*		
(62) Loss of the ability to fully flex *(bend)* or fully extend a finger, toe or other joint (4)(1)(7)			(a) Name(s) of drug(s); (b) Frequency of use; (c) Date last used		
(63) Shoulder, knee, or elbow problem *(out of place)* (4)(1)(7)					
(64) Locking of the knee or other joint (4)(1)(7)					
(65) Giving way of knee or other joint (4)(1)(7)			(74) Any illnesses, surgery, or hospitalization not listed above		

b. **EXPLAIN ALL "YES" ANSWERS TO QUESTIONS (1) - (74) ABOVE**. *(Describe answer(s), give date(s) of problems, name doctor(s), clinic(s), hospital(s), treatment given and current medical status. Attach additional sheet(s) if necessary.)*

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MEDICAL PRESCREEN

LAST NAME - FIRST NAME - MIDDLE INITIAL (SUFFIX)	SOCIAL SECURITY NUMBER

b. EXPLAIN ALL "YES" ANSWERS TO QUESTIONS (1) - (74) ABOVE. *(Continued)*

3. CURRENT PRIMARY CARE PHYSICIAN(S)

a. NAME(S)	b. ADDRESS *(Include ZIP Code)*	c. TELEPHONE *(Include Area Code)*

4. PREVIOUS PRIMARY CARE PHYSICIAN(S)

a. NAME(S)	b. ADDRESS *(Include ZIP Code)*	c. TELEPHONE *(Include Area Code)*

5. CURRENT INSURANCE PROVIDER

a. NAME	b. ADDRESS *(Include ZIP Code)*	c. INSURANCE ID NUMBER

6. PREVIOUS INSURANCE PROVIDER(S)

a. NAME(S)	b. ADDRESS *(Include ZIP Code)*	c. INSURANCE ID NUMBER

7. APPLICANT.

I certify the information on this form is true and complete to the best of my knowledge and belief, and no person has advised me to conceal or falsify any information about my physical and mental history.

I further understand that I may be requested to provide medical documentation regarding issues within my medical history. I authorize any of the doctors, hospitals, clinics or insurance company(ies) to furnish the Department of Defense medical authority a complete transcript of my medical record for purposes of processing my application for military service.

I completely and honestly disclosed all involvement with illegal drugs.		YES		NO

a. SIGNATURE	b. DATE SIGNED *(YYYYMMDD)*

8. PARENT OR GUARDIAN SIGNATURE FOR MINOR *(Mandatory)* **OR PARENT ASSISTING TO COMPLETE FORM** *(Voluntary)*

a. SIGNATURE	b. DATE SIGNED *(YYYYMMDD)*

9. RECRUITING REPRESENTATIVE: I certify all information is complete and true to the best of my knowledge. I have conducted the medical prescreening requirements as directed by service regulations.

a. NAME *(If representative was used)* *(Last, First, Middle Initial)*	b. PAY GRADE	c. SIGNATURE	d. DATE SIGNED *(YYYYMMDD)*

MEDICAL PRESCREEN

LAST NAME - FIRST NAME - MIDDLE INITIAL (SUFFIX)	SOCIAL SECURITY NUMBER

10. PHYSICIAN'S SUMMARY AND ELABORATION OF ALL PERTINENT DATA *(Physician shall comment on all positive answers in questions (1) - (74). Physician may develop by interview any additional medical history deemed important, and record any significant findings here.)*

a. COMMENTS

11. MEDICAL OFFICER'S PRESCREENING COMMENTS: Based on information provided, further processing is:

a. ON PRESCREEN:

☐ (1) AUTHORIZED

☐ (2) NOT JUSTIFIED *(Permanent Disqualification (PDQ))*:
- ☐ (a) Profile Serial _____ ICD _____
- ☐ (b) Process for Waiver *(CMO initials)* _____

☐ (3) DEFERRED *(See Comments above)*:
- ☐ (a) Pending review of additional documentation
- ☐ (b) RJ Date *(If applicable)* _____ *(CMO initials)* ____

b. ON EXAM:

☐ (1) APPROVED

☐ (2) DEFERRED:/
☐ (3) NOT JUSTIFIED:
- ☐ (a) Additional information needed *(See DD Form 2808)*
- ☐ (b) Information different than on prescreen
- ☐ (c) Form not prescribed by MEPS

(4) MEPS USE:
- ☐ (a) AE ☐ (c) PRI
- ☐ (b) RE ☐ (d) N/A

c. TYPED OR PRINTED NAME OF EXAMINER *(Last, First, Middle Initial)*	d. SIGNATURE	e. DATE SIGNED *(YYYYMMDD)*	9. NUMBER OF ATTACHED SHEETS

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3

Framework for Evaluating Medical and Physical Standards

This chapter discusses and develops a framework for evaluating and setting medical and physical standards. The first section describes some general considerations for validating standards by linking them to specific outcomes, the second section describes a cost trade-off approach that has been used successfully to validate education and aptitude standards, and the third section discusses some of the health databases that might be needed to develop successful validation procedures. Some of the material in this chapter is technical and is intended primarily for policy analysts and others who formulate and evaluate enlistment standards. The function of this chapter is to describe the methodological approach and data needed to evaluate medical and physical enlistment standards in terms of such outcomes as injury, lost time, and attrition.

The setting of military enlistment standards does not follow a single, strict procedure. There are multiple reasons for setting particular standards and, accordingly, there are varying approaches for determining standards. As mentioned in Chapter 2, physical and medical standards are generally set to increase the likelihood that recruits will be able to meet the rigorous requirements of military jobs and missions. Unlike physical and medical standards, the standards for both education and aptitude characteristics are set by fairly formal procedures for validating standards against specific outcomes, such as attrition or job performance.

LINKING STANDARDS TO OUTCOMES

To some extent, the methods used to set enlistment standards have been influenced by the type of characteristic under consideration. Many medical and physical standards are determined by the presence of disqualifying conditions that are justified on prima facie grounds: examples are serious diseases, physiological abnormalities, and such physical impairments as blindness or deafness. For these types of serious medical or physical conditions, a formal validation methodology is usually unnecessary.

More formal, quantitative methods have been developed for validating education and mental aptitudes for two reasons (National Research Council, 1988). First, a characteristic like aptitude is a continuum rather than a present/absent dichotomy; one therefore has to develop cutoff scores to determine eligibility. Second, while education can be considered a dichotomous characteristic (high school graduate versus nongraduate), being a nongraduate is not disqualifying on its face in the same way that blindness might be. Rather, nongraduates (and lower aptitude recruits) can reduce military effectiveness in various ways, such as having high attrition rates or poor performance with respect to certain military duties. Thus, there is a trade-off between effectiveness or performance and the proportion of recruits with these characteristics.

Although formal trade-off models have not been applied to the validation of medical and physical standards, they may be useful when medical or physical attributes are similar to education and aptitude. For example, they could be applied to continuous conditions, such as weight and strength, for which no disqualifying level can be established clinically, or to dichotomous conditions, such as marijuana use or asthma, the presence of which may reduce effectiveness but is not automatically disqualifying.

Elements of a Formal Model

Generally, in order to develop a formal trade-off model, there must be a correlation between a selection characteristic and some desired or necessary outcome. If there is no correlation, then the validation process basically ends with no need for a selection standard, since the characteristic is not related to a valued outcome. At the other extreme, if every person with a certain characteristic at entry has an undesired outcome, then there is no need for a trade-off analysis, since everyone with that characteristic should be disqualified. In effect, for those medical and physical conditions that lead to automatic disqualification, it is assumed that all recruits with those characteristics are unable to perform any military specialty at a

satisfactory level. Of course, for any particular medical or physical condition, this assumption could be subjected to closer scrutiny.

If there is a correlation between the selection criterion and an important outcome, then specific standards can be set based on some type of utility or cost trade-off analysis. The Department of Defense has developed cost trade-off models to set standards for education levels and cognitive aptitudes (National Research Council, 1994). We describe how these models could be adapted for use with appropriate medical and physical standards.

In summary, the process of establishing a standard for an appropriate physical or medical condition consists of several steps. The first step is to determine a valued outcome that corresponds to some aspect of military effectiveness. The second step is to establish an empirical correlation between the condition and the valued outcome. The third step is to determine a specific standard or a cutoff value in the case of continuous conditions, such as body mass index (BMI), using a cost trade-off analysis of some type.

Selecting Outcomes

The outcome used to evaluate an enlistment condition is usually a goal or condition related to military objectives or requirements, such as completion of training, on-the-job performance, or combat effectiveness. The evaluation of education standards, for example, uses the outcome of first-term attrition. The justification is that enlistees who leave before the end of their first term increase training costs, since more recruits must be trained to fill unit manpower requirements. Thus, an enlisted force with 20 percent attrition has to train 125 recruits to fill 100 manpower unit slots, while a force with 40 percent attrition has to train 167 recruits to fill the same unit requirement. This increased recruiting burden represents an increase in training costs of about 40 percent.

Another example is the evaluation of aptitude requirements. In this case, job performance has been the preferred outcome because it is well established that cognitive abilities are good predictors of actual job performance in virtually all military specialties (Armor and Roll, 1994). As the proportion of persons with low cognitive aptitudes increases in a unit, there is a corresponding reduction of combat effectiveness. The concern of recruiting sufficient numbers of people with good cognitive skills has been heightened by the growing technological requirements of many military occupations and activities. Unlike attrition, the assessment of military job performance is an arduous and complex undertaking.

In the case of physical and medical standards, a range of outcomes can be considered. And for some of them, the use of attrition appears warranted. Recruits with certain physical conditions, such as obesity or a very low level of physical fitness, may not be able to complete basic training or may not be able to adapt to difficult combat environments. Attrition might therefore be a reasonable outcome for evaluating specific standards for these conditions. The same might be said for such medical conditions as asthma, orthopedic disorders, and so forth.

Physical conditions such as obesity and fitness and medical conditions like orthopedic disorders can also be evaluated using performance outcomes of various types. For example, many military jobs may involve tasks that require minimum levels of strength, agility, or endurance. The advantage of using these types of performance outcomes is that screening devices might be designed that offer good predictive validity of the outcomes, such as the Assessment of Recruit Motivation and Strength test being tested by the Accessions Medical Standards Analysis and Research Activity (AMSARA).

Finally, another outcome that can be used for many physical and medical conditions is lost time on the job and the medical costs of injuries and sickness (including disability expenditures) arising from these conditions. The outcomes of lost time and medical costs may be especially appropriate for such physical conditions as obesity and fitness or such medical conditions as orthopedic disorders.

Establishing a Correlation

Given the selection of an appropriate outcome, the second step in a validity study is to establish a correlation or association between the physical or medical condition and the outcome. This usually requires an empirical study of some sort. The study may use existing military data, particularly when attrition rates are the outcome of interest. In other cases, an original prospective data collection effort may be required. The latter is usually necessary if the outcome is some type of job performance outcome that is not captured by military records.

Before discussing how a correlation is established empirically, it may be helpful to discuss the nature of this correlation and to understand approaches to validity assessments in various fields. In medical and some behavioral science research, the validity of a screening test is established by its effectiveness in detecting certain conditions (e.g., disease, impairment). Effectiveness of the screen is evaluated by several statistics, including sensitivity and specificity. These are illustrated using a two-by-two table (Table 3-1).

TABLE 3-1 Hypothetical Validity Relationship

		Condition (C)	
		Absent = 0	Present = 1
Screen (S)	Neg = 0	a	b
	Pos = 1	c	d

Sensitivity is defined as the proportion of persons with the condition (C = 1) who are flagged positive by the screen, or

$$Pr[S = 1 \mid C = 1] = d/(b + d) = p_d$$

(the conditional probability having a positive screen if the condition is present). Specificity is defined as the proportion of persons without the condition who are negative on the screen, or

$$Pr[S = 0 \mid C = 0] = a/(a + c) = p_a = 1 - p_{c.}$$

Generally, the most effective screening tests are those with high sensitivity and specificity (e.g., .9 or so).

These two statistics are actually components of a summary measure of association derived by regressing the screen on the condition (scored as dummy variables). The regression coefficient can be calculated in this case as

$$b_s = p_d - p_c = p_d + p_a - 1$$

or the sum of sensitivity and specificity minus one. In the case of high sensitivity and specificity measures, which are desirable for most screening tests, the regression coefficient would be quite high; for example, the regression coefficient would be .8 if both sensitivity and specificity were .9.

In the case of military enlistment standards, validity has a somewhat different meaning and therefore validity studies have taken a somewhat different approach. In the military standards context, validity means the extent to which a screen predicts a future outcome rather than an existing condition. Even a fairly weak relationship (e.g., a modest regression coefficient) between a screen and a future outcome could justify a particular standard, depending on the cost of that outcome.

For example, Table 3-2 illustrates the approximate relationship between high school education and 24-month attrition. The specificity is fairly high at .8, but the sensitivity is quite low at .4, and the overall

TABLE 3-2 Approximate Relationship Between Education and Attrition

		High School Dropout	
		No (0)	Yes (1)
24-month attrition	No (0)	0.8	0.6
	Yes (1)	0.2	0.4

regression coefficient is only .2. The relationship nevertheless justifies an enlistment standard that restricts nongraduates because of the costs of replacing and retraining recruits who leave military service within one or two years. This cost trade-off approach is discussed further in the next section.

Continuing with the examples of education and aptitude standards, the validity of education standards has been established by correlating education levels with first-term attrition rates, as in Table 3-2. The validation of aptitude standards with on-the-job performance outcomes required a massive original data collection effort that took place over a period of nearly 10 years (National Research Council, 1991).

Even assuming that attrition rates are being used as the outcome for a particular standard, reliable entry data cannot be assumed in the case of many medical conditions, which rely on self-report by military applicants. Moreover, some medical conditions observable during the physical exam may be missed. So the availability and reliability of physical and medical conditions at entry cannot be assumed, and obtaining good data may require special prospective studies and data collection such as that being carried out at AMSARA. Of particular interest here are special longitudinal studies being conducted by the Services, such as the Army Research Institute study of the 1999 cohort (McCloy and Putka, 2004).

Special job performance assessment may be appropriate for certain physical conditions such as obesity and fitness. For example, it may be possible to track BMI measurements or fitness test performance as enlistees move through the first term to determine whether entry condition predicts later levels of BMI and fitness. It also may be possible to collect data on the unit commander's evaluation of an enlistee's physical fitness or related characteristics.

Special prospective studies would be necessary to evaluate changing a standard that now causes automatic disqualification. Of course, this depends on whether there are any conditions at the present time that experts feel should not be disqualifying.

Finally, it may be possible to examine various medical outcomes, such as injuries, illnesses, or hospitalizations during the first term that could be related to initial medical or physical conditions, some of which might be subject to disqualification waivers. This type of analysis would involve merging files of the U.S. Military Entrance Processing Command (MEPCOM) with medical record files, which may require special approvals but should be technically possible.

Determining the Standard

The final step, assuming that a physical or medical condition is reliably correlated with an acceptable outcome, is to determine a specific standard for that condition. There are at least two scenarios. On one hand, if the physical or medical condition is a simple binary "present" or "absent," then, as mentioned earlier, the standard may simply be a decision to disqualify a potential recruit if the condition is present (which assumes that a person with that condition cannot perform military duties). If, on the other hand, the condition has a continuous underlying metric, such as BMI, a score on a fitness test, or blood pressure, then a specific cutoff value is required.

The process of determining a specific cutoff value ranges from simple to complex, depending on the way in which utility is assessed. In the simplest case, military experts may be able to use a qualitative procedure based on experience that determines a value above or below which a recruit is highly unlikely to meet the requirement in question.

In the more complex case, particularly when there is no expert opinion about acceptable levels of the condition (or even sometimes when there is an expert opinion), a cost-performance trade-off model can be applied. For example, if BMI or some type of substance abuse is correlated with attrition or some performance outcome, one can compare the cost of disqualifying persons above certain values (based on supply information about the cost of recruits) with the cost of various performance or attrition levels (e.g., training costs associated with different rates of attrition).

COST-PERFORMANCE TRADE-OFF MODELS

In this section, we discuss an example of the type of cost-performance trade-off model that has been applied to aptitudes and education. The full model is a computer-based optimization model that evaluates enlistment standards along two dimensions: high school graduation status and aptitudes. We present a much simplified version of this model and illustrate it with high school graduation status, a characteristic not unlike such medical conditions as asthma or drug use. We use this model later for those

medical and physical standards for which a trade-off analysis might be useful.

High school graduate status is associated with attrition. Recruits with a high school diploma are valued because years of research and experience show that those with a high school diploma are more likely to complete their initial three years of service, as shown in Table 3-2.

The better retention associated with those who complete high school saves money. According to an estimate by the U.S. General Accounting Office (1997, 1998) the cost of first-year attrition is in the range of $15,000-$35,000. In our examples, we use an estimate of $20,000 as the cost of first year attrition. On one hand, this argues for recruitment of those who are most likely to adjust to the rigors of military life and stay the course. The high school diploma is a reliable indicator of "adaptability" and "perseverance." On the other hand, if all nongraduates are excluded from the enlistment pool, it forces recruiters to draw from the pool of graduates, and these individuals may be more expensive to recruit because they may have more opportunities for jobs elsewhere. This problem is compounded if one adds aptitudes to the mix and wants to exclude (or minimize) those with low aptitude scores.

The objective of a cost-performance trade-off optimization model is to choose an enlistment cohort that minimizes the cost of recruiting, training, and compensating the cohort, subject to meeting staffing goals by occupation over the first term of service. The complexity of this formulation may exceed what is necessary for setting most medical or physical standards, but the basic concept can be applied to setting any standard.

The intuition underlying the model is relatively straightforward. Since high school graduates leave the military prematurely at lower rates, they generate more staff years per recruit and lower training cost. However, the additional cost of recruiting high school graduates is greater than that of nongraduates, at the mix typically recruited. The optimization model implicitly makes trade-offs between the higher staff years and lower training costs of the high school graduate recruits and the lower recruiting cost, but also lower staff years and greater attrition, of nongraduate recruits. The graduate/nongraduate mix of recruits the model chooses is that which meets staffing goals most efficiently.[1]

[1]For a more detailed exposition of the model, see *Modeling Cost and Performance for Military Enlistment: Report of a Workshop* (National Research Council, 1994), Part III: The Cost/Performance Trade-off Model (pp. 101-158).

TABLE 3-3 Example of Cost-Performance Trade-off Analysis ($ millions)

Standard	High School Graduates (percentage)	Nongraduates (percentage)	Recruiting Cost	Training/ Comp Costs	Total Costs
Old	90	10	$504	$7,814	$8,318
New	100	0	$941	$7,559	$8,500

Illustration Using the Army Education Standard

To illustrate how the model provides an "optimal" (i.e., cost-minimizing) enlistment standard, consider a hypothetical (but realistic) Army example. We first let the model choose a cost-minimizing high school diploma graduate mix of graduate and nongraduate recruits that meets a given staffing requirement at the lowest cost. For a given set of staffing goals, economic conditions, and other factors, the model solves for an optimal mix of recruits consisting of 89.6 percent high school diploma and 10.4 percent nongraduates. Hence, an enlistment standard that set the high school diploma graduate goal at about 90 percent would be close to optimal.[2]

Now, let us assume that standards are arbitrarily changed, so applicants without a high school diploma are no longer eligible to enlist. The standard under this constraint is 100 percent high school diploma graduates and 0 percent nongraduates.

Which set of standards is best? The new standard results in lower training and compensation costs because, with nongraduates ineligible to enlist, there is lower attrition. However, the new standard results in significantly higher recruiting costs. Table 3-3 compares the two sets of standards.

The higher standards implied by screening out all nongraduates does indeed reduce training and compensation costs relative to the old standard, which includes about 10 percent nongraduates. This is because attrition is lower, so fewer recruits must be trained to achieve a given staffing level. However, the new standard in this example goes too far. By making all nongraduates ineligible, recruiting costs are raised significantly, as recruiters must replace nongraduates with the more difficult to recruit (at the margin) graduates. The increase in recruiting costs more

[2]In fact, 90 percent is the current DoD standard for the percentage of high school diploma graduates recruited.

than outweighs the savings in reduced attrition-related costs, resulting in higher total costs.[3]

A Simple Model for Evaluating Medical or Physical Standards

This type of trade-off and balance may exist for many physical and medical entry standards. For example, in principle, the weight standard as measured by BMI is a trade-off between lower attrition-related costs associated with a higher standard and increased recruiting costs, resulting from disqualifying a portion of the recruiting market due to higher standards. The right balance, then, and the optimal weight standard is one that minimizes cost by balancing the higher recruiting costs associated with a more stringent standard with the savings in attrition costs.

Of course, there will not be an optimization model for all physical and medical standards. However, we can use this trade-off framework to help determine the correct direction of change in standards. If a particular medical or physical condition is correlated with attrition and various standards are set that raise or lower the proportion of recruits with this condition, then what is the effect on cost? For a given cost of attrition, this will provide an estimate of the change in attrition costs. If the proportion of the relevant recruit population that is made ineligible by the modest increase in the standard can be determined, then the recruiting cost function can be used to estimate the change in recruiting costs.

In some of the chapters in this report, we apply a simple cost-performance analysis that uses a number of parameters defined below. In the notation, the subscript 1 refers to the value of the parameter under existing or current standards, while the subscript 2 refers to the value of the parameter after changing standards (i.e., reducing the number of or disqualifying persons who have a given medical or physical characteristic):

- the probability of attrition for those with or without a given characteristic, a_w and a_{wo} (the cost model here assumes a 12-month attrition rate).
- the difference in attrition rates for those with and without the characteristic, $d = a_{wo} - a_w$ (normally, $a_{wo} < a_w$).
- the cohort 12-month attrition rates before and after changing standards, a_1 and a_2.
- the unit cost of attrition (cost of training through 12 months), C.

[3]To those familiar with the mathematics of optimization, this is a predictable result. A more constrained cost minimization problem (e.g., no nongraduates) cannot be less costly than the outcome of an optimization that does not have the constraint. This is an implication of Le Chatelier's principle.

- the proportion of recruits with the characteristic before and after changing the standard, p_1 and p_2 (before changing standards, p_1 is assumed to be the same for the recruit population and the larger youth population).
- the size of the eligible youth population before and after changing standards, POP_1 and POP_2.
- the size of the force needed at 12 months (posttraining), F.
- the number of recruits needed before and after changing standards, N_1 and N_2, in order to attain a given force size F (N_2 will be less than N_1).
- recruiting costs as a function of the number recruited and the recruit-eligible population, which we denote by the function $R(N,POP)$ with $dR/dN > 0$ and $dR/d\ POP < 0$.

The enlistment standard, in this analysis, is used to screen out populations that have higher expected attrition rates in the first year of service than the general population. The benefit associated with screening out a population is that attrition will be lower. The cost is that, because some in the population will no longer be able to enlist, recruiting costs may be higher.

Because there are lower attrition rates, the number of recruits leaving prior to completing a year will be lower. Let a_1 be the average attrition rate before the standard is in place and let a_2 be the average attrition rate after the standard is in place. Then, if N_1 is the number recruited and C is the unit cost of attrition, then $N_1*(a_1 - a_2)*C$ is, to a first-order approximation, the savings in attrition costs. However, because attrition rates are lower, fewer individuals must be recruited in the first place to fill a given number of spaces at the end of the year. Let the number of spaces to be filled equal F. Then, N_1, the number originally recruited, is equal to $F/(1 - a_1)$. If expected average attrition were to fall to a_2 with the enlistment standard in effect, the number of recruits needed would be N_2, equal to $F/(1 - a_2)$. Hence, a more precise estimate of the savings in attrition costs is calculated as the difference in costs before and after the enlistment standard is introduced:

$$AttritionCostSavings = C * \frac{F}{(1-a1)} - C * \frac{F}{(1-a2)} = C * F * \left[\frac{1}{1-a1} - \frac{1}{1-a2} \right]$$

Now, we ask, how does a_1, the average attrition rate prior to the introduction of the enlistment standard, differ from a_2, the average attrition rate after the introduction of the enlistment standard? Let the expected attrition rate (probability of attrition) for those without the characteristic to be subject to the enlistment standard be denoted a_{wo} and the expected

attrition rate (probability of attrition) for those with the characteristic be denoted a_w. Then, let the proportion of the recruits with the characteristic, before the standard is in place, be equal to p_1. The average attrition rate before introducing the enlistment standard, is

$$a_1 = (1 - p_1) * a_{wo} + p_1 a_w = a_{wo} - p_1 a_w = a_{wo} - p_1 d$$

where d is the difference between the expected attrition rate for those without and those with the characteristic in question. Now, with the enlistment screen, the proportion of recruits with the characteristic falls to p_2. Hence, the average attrition rate after applying the enlistment screen is

$$a_2 = (1 - p_2) * a_{wo} + p_2 a_w = a_{wo} - p_2 d$$

Note that if all are screened out, $p_2 = 0$, and the attrition rate is simply the "without" attrition rate. We can rewrite the equation for the average cost savings as:

$$AttritionCostSavings = C * F * \left[\frac{1}{1 - \left(a_{wo} - p_1 d\right)} - \frac{1}{1 - \left(a_{wo} - p_2 d\right)} \right]$$

In addition to the benefits of lower attrition costs, an enlistment standard that screens out recruits reduces the effective population from which to recruit. This increases recruiting costs, most probably in a nonlinear way. Recruiting costs are a function of the number of recruits, N, and the population available to recruit from, POP.

The additional recruiting costs are given by

$$R\left(N_2, POP_2\right) - R\left(N_1, POP_1\right)$$

where we adopt the assumption that the effect on the relevant recruiting population is proportionate to the effect that the standard has on the number of recruits. Hence,

$$POP_2 = \left(1 - (p_1 - p_2)\right) POP_1$$

The number of recruits required is adjusted downward because attrition is expected to be lower. The number required to recruit to reach a

given goal is reduced, lowering recruiting costs somewhat. However, the population available for recruiting is also reduced, raising recruiting costs.

DATA RELEVANT TO EVALUATING MEDICAL AND PHYSICAL STANDARDS

DoD maintains many databases necessary, if not critical, for evaluating medical and physical standards. One of the factors that complicates carrying out studies of this type is that some of these databases, particularly health databases, are held by separate agencies, making cross-reference and linkage difficult and problematic. Another issue is the validity and reliability of the data in these sources. This section discusses some of the administrative and research issues pertaining to these databases.

Overview of Databases

A simple sort by function reveals four types of databases relevant to evaluating medical and physical standards: health care system management data, health surveillance data, health research data, and personnel data. These databases encompass a personnel and health care system unique in the world for its global scope, the number of personnel, and comprehensive health care. Those eligible for health care include all active-duty personnel, their immediate family members, and Reserve and National Guard personnel assigned to duty with the active force.

Since the population eligible for this health care system in general mirrors the U.S. population from ages 17 to 18 to the beginning of military retirement after 20 years of service, these databases could be a powerful resource not only for DoD but also for the country as a whole, in terms of health demographics, occupational health, and the formulation of health policy. Access to information in DoD health databases, however, is tightly controlled.

The primary purposes of the health databases are to protect and preserve the health of the fighting force in the field and to enhance health care delivery to beneficiaries. All those seeking information from these databases, whether DoD agencies or their contractors, other federal government agencies, or individuals or organizations outside DoD, must show in their request some benefit to the health of the fighting force or some benefit to delivery of health care to beneficiaries (S. Jenkins, privacy officer, Health Affairs, Office of the Assistant Secretary of Defense, personal communication, June 13, 2005 [http://tricare.osd.mil/tmaprivacy]).

The health databases are by definition those operated by the Army, Navy, and Air Force medical departments and by the Health Affairs component of the Office of the Secretary of Defense (OSD/HA). Databases

maintained outside the medical departments and OSD/HA contain considerable health information, including some identified to specific individuals, but these databases are not subject to the controls cited above. Most importantly for this study, MEPCOM is not a medical command, but rather a recruit processing command. As a consequence, even though MEPCOM performs medical functions, such as physical examinations, the medical records created by these functions do not become subject to medical record controls until each enlistee, carrying his or her medical record, is sworn in as a member of the U.S. armed forces at a military entrance processing station (MEPS) (S. Jenkins, personal communication).

The flow of information from health databases is governed by the Privacy Act of 1974 and by the Health Insurance Portability and Accountability Act of 1996 (HIPAA). Generally, DoD health databases include specific identifiers of individuals associated with health events being reported. For this reason, legitimate requests for information can be complicated by requirements of these federal privacy laws. Security rules in DoD to protect sensitive information also apply. As a consequence, responsiveness to requests for information can be slow. If the request for information requires what is judged to be a research effort, then an institutional review board (IRB) approval is required before any search for data can be undertaken. In addition, searches for information not routinely reported can be undertaken only when the requestor provides funding for the effort.

A listing and brief description of each of the major databases that may be relevant to evaluating medical and physical standards is presented in an appendix to this chapter.

Data Linkage Issues

There clearly exists a wealth of information about individual service members that is gathered, stored, updated, and maintained, beginning with an applicant's first contact with a military recruiter and continuing throughout the service member's career. Much of this information is stored in sophisticated central databases, although some information is maintained only locally and on paper. There have been some successful attempts at integrating—or at least connecting—these databases. For example, the MEPCOM Integrated Resource System (MIRS) is the source for building the initial personnel records maintained by the Defense Manpower Data Center, some of whose record data are provided to the Total Army Injury and Health Outcomes Database.

General connectivity between medical and personnel databases does not exist, however. There are serious privacy issues associated with the

maintenance and availability of medical databases and the maintenance costs can be high. At the same time, the ability to link personnel and medical databases, including individual-level information, is a central requirement for doing the kinds of longitudinal studies and analyses needed to support decision making in the area of physical, medical, and mental health standards for enlistment; these questions cannot be adequately addressed by data collected on a study-by-study basis. In particular, the linking of databases has the potential to permit multivariate analyses of a variety of phenomena. Analyses of the joint and interactive effects of physical, medical, and mental health variables on outcomes of interest would be of great value.

CONCLUSIONS AND RECOMMENDATIONS

Some standards are justified on prima facie grounds, based on an incontrovertible link between the standard and fitness for service (e.g., blindness, deafness, paralysis). Many, however, are based on a presumed link between the standard and an outcome of interest. The evaluation framework linking standards to outcomes outlined in this chapter is applicable to all physical and medical enlistment standards.

Recommendation 3-1: We recommend that data be collected that would allow the study of empirical links between physical and medical characteristics and performance-based outcomes, such as attrition and injury.

Application of a cost trade-off methodology requires valid data on enlistee health and fitness throughout the tour of duty as well as the ability to link health and fitness measures to such outcomes as lost work time and attrition. This requires ready access to and linkage between health and personnel databases.

Recommendation 3-2: We recommend that DoD undertake a project to develop the data and technology necessary for a cost-performance trade-off model that could be applied to setting and evaluating medical and physical standards.

Recommendation 3-3: We recommend that DoD commission a review of the medical databases necessary for evaluating and assessing medical and physical enlistment standards and create a mechanism for integrating or linking the medical databases with existing personnel databases at the Defense Manpower Data Center, subject to all legal requirements.

APPENDIX 3-A
OVERVIEW OF DATABASES

Management Databases

The Office of the Assistant Secretary of Defense for Health Affairs maintains two separate management databases, one for inpatients and one for outpatients. They are global in scope and cover all three military departments. The general purpose of these databases is to match health care assets to patient demands. The Army, Navy, and Air Force each have their own health care management databases for the same general purpose. (The Navy provides health care services for the Marine Corps.)

Surveillance Databases

Defense Medical Surveillance System

DoD's global Defense Medical Surveillance System (DMSS) (accessible on the Internet at http://amsa_army_mil) is assigned organizationally to the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) in Aberdeen Proving Ground, Maryland, and is maintained at the Walter Reed Army Medical Center in Washington, DC. It was established in 1994 in the aftermath of the first Persian Gulf War. It is an operational database serving operational needs and is supported by operational funds, but it has proven to be very useful for conducting research. The database receives information according to a specific reporting protocol on every inpatient and outpatient visit to any DoD health care facility worldwide. Every event is to be documented with the appropriate International Classification of Diseases (ICD-9) code. DMSS publishes monthly reports, both electronically and in print, and performs analyses for medical leadership. DMSS also has a component called the Reportable Medical Events System, which publishes monthly reports on communicable diseases in the military of public health significance, in parallel with the civilian reporting system of the Centers for Disease Control and Prevention. DMSS does not link directly to personnel databases; however, it receives data from the Defense Manpower Data Center and other sources, including demographics and occupational data, to permit population-based routine medical surveillance and to answer basic surveillance questions, such as rates by gender, rates for specific deployments, rates by age, and reportable diseases.

Service Health Surveillance Systems

For many years, each Service has maintained a health surveillance system of its own personnel.

Service Occupational Health Databases

Each Service maintains health databases on personnel with military occupational specialties of importance to their global operations. Examples are the longitudinal health databases on all aviators in the Air Force.

Research Databases

Total Army Injury and Health Outcome Database

The Total Army Injury and Health Outcome Database (TAIHOD) is an administrative electronic database with origins in 1994 as a component of the Women's Health Initiative. Over time the database has grown into its present form. It uses datasets common to DMSS but is structured differently to serve research, in contrast with operational surveillance needs. This database is limited to the Army because injury and disability reporting is not standardized across Services and because safety and accident reporting is also not standardized. The database is maintained at the U.S. Army Research Institute of Environmental Medicine. There is an initiative to broaden this database further. Currently, 25,000 medical records of Army personnel accessed in 1998, 1999, and 2000 are being reviewed and scanned into the database.

Accession Medical Standards Analysis and Research Activity Databases

The Accession Medical Standards Analysis and Research Activity (AMSARA) (available on the Internet at http://amsara.amedd.army.mil) was established in 1996 to support the Accession Medical Standards Steering Committee of the Under Secretary of Defense (Personnel and Readiness). AMSARA is located in the Division of Preventive Medicine at Walter Reed Army Institute of Research, Washington, DC. AMSARA study datasets are structured to answer specific queries from sponsors. Collectively they represent many individual databases rather than a single, multipurpose database. They are constructed by AMSARA researchers who examine individual recruit medical and personnel records and MEPCOM and Service data pertaining to the accession of recruits.

Because of this hands-on process at the individual record level, these databases have high validity. All investigations by AMSARA have institutional review board approval and oversight.

Nonmedical Databases

Army Accessions Command Database

Army Accessions Command is the executive agent for the acting under secretary of defense, military personnel policy, for screening and processing potential recruits. Its database of importance for this study is the one maintained by its subordinate command, MEPCOM.

The MEPCOM Integrated Resource System is the database that provided information to the committee for this study. This is an administrative database encompassing many management functions of MEPCOM. It contains all data on each applicant relevant to the accession process, including outcome information on physical examinations, medical failure codes, ICD codes for all failures, and waiver status. Individual applicants are identified by their Social Security numbers. This database does not include health information acquired by recruiters of individual Service recruiting commands from individual applicants.

Defense Manpower Data Center Databases

The Defense Manpower Data Center (DMDC) maintains the largest archive of personnel, manpower, training, and financial data in the Department of Defense. Of the numerous individual databases it maintains, several are routinely used for personnel research, studies, and analyses. For example, the Active Duty Military Personnel File provides an inventory of all individuals on active duty. It is a standardized and centralized database of present and past members of the active-duty force. Historical data back to 1971 are available. This file includes such data elements as the following:

- Personal data, including Social Security numbers, education level, home of record, date of birth, marital status, number of dependents, race, and ethnic group.
- Military data, including Service, pay grade, Armed Forces Qualification Test percentile, military primary duty and secondary occupation, unit identification code, months of service, duty location, estimated termination of service date, basic active-duty service date, date of current rank, pay entry base date, foreign language ability, and major command code.

Similarly, databases such as the Active Duty Military Enlisted Cohort File, the Active Duty Military Personnel Transaction File, and the MEPCOM Examination and Accession File, are often used for research, studies, and analyses.

Validity of Administrative Databases

The issue of the validity of these administrative databases has been addressed in research publications by users of these databases. An example is a recent publication by Hoge et al. (2005) in which the authors found a very high correlation in their results among different administrative data systems. Also cited were publications by Miller et al. (2000) and Bell et al. (2003).

4

Physical Fitness and Musculoskeletal Injury

Military basic training is designed to be an intense program that orients and indoctrinates new recruits to the Service. The selection process for enlisted personnel, as currently designed, does not include any measurement of physical fitness. Thus, the basic training system must be capable of providing effective physical fitness training to individuals who vary widely in the levels of fitness they bring to the system. According to the Army, "Few soldiers enter the Army physically fit for the arduous duties ahead of them" (U.S. Department of the Army, 2005:5). As noted in Chapter 2, all Services routinely test the physical fitness of personnel during basic training, and in order to graduate from basic training, recruits must have demonstrated that they will be capable of passing these routine physical fitness tests.[1] In that respect, basic training performs an expensive screening function for the Services.

Because a key purpose of basic training is to ensure that graduates are able to meet the physical demands of serving as a combat soldier, physical training is a central element of the basic training protocol for all Services. While specific physical training procedures differ across the Services, the demands are substantial in all branches. Since the physical

[1]The actual standard for graduating from basic training can differ from the standard used in operational units. Note that the Army requires 35 push-ups for most men in BCT but requires 42 push-ups for men in the same age group in an operational unit. There are also lower minimum requirements for sit-ups and the 2-mile run during basic training.

fitness of entering recruits is not evaluated in advance of basic training and recruits are not required to meet physical fitness standards prior to their transportation ("shipping") to basic training, the physical training element of basic training is expected to have widely varying effects on recruits. Those who enter basic training with a relatively low level of physical fitness would be expected to find the physical training component of basic training to be more demanding and stressful than those who enter with high physical fitness.

This chapter summarizes the available evidence regarding the relationship between physical fitness and negative outcomes during the first term of military service. Particular focus is given to orthopedic injuries and attrition, both being frequent and very expensive negative outcomes in military recruits. Because military personnel are recruited from the adolescent population, the physical fitness status of contemporary American youth is also reviewed. Our knowledge of the impact of low physical fitness on negative outcomes in military populations is summarized, and the scientific basis of musculoskeletal injuries is briefly presented. Finally, several possible approaches to reducing injuries and attrition in basic trainees are considered. The approaches presented are based on application of the scientific evidence regarding the relationship between physical fitness and injury or attrition in military personnel.

CONCEPTS OF PHYSICAL FITNESS

Definitions of Physical Fitness

Physical fitness has been verbally and operationally defined in numerous ways. Nonetheless, certain common themes are evident in most of the verbal and operational definitions that have come into wide use over the past century. Most verbal definitions of physical fitness allude to a person's ability to perform vigorous physical tasks. For example, Clarke defined physical fitness as "the ability to perform daily tasks with vigor and alertness, without undue fatigue, and with ample energy to enjoy leisure pursuits and to meet unforeseen emergencies" (Clarke, 1967). If Clarke's classic and widely cited definition is applied to first-term military personnel in combat occupational specialties, a soldier who is physically fit would be capable of meeting the considerable physical demands of combat soldiering without experiencing fatigue at a level that unduly limits job performance. In other words, physical fitness is one of the functional capacities of the soldier's job (see the discussion of functional capacity later in this chapter).

Operational definitions of physical fitness have evolved dramatically over previous decades. However, virtually all accepted operational defi-

TABLE 4-1 Definitions of Health-Related Fitness Components

Component of Physical Fitness	Definition[a]	Relationship to Physical Performance and Health[b]
Cardiorespiratory endurance	Ability to sustain moderate intensity, whole-body activity for extended periods	Enhanced physical working capacity Reduced fatigue Reduced risk of coronary heart disease
Muscular strength	Maximum force applied with a single muscle contraction	Enhanced functional capacity (lifting, carrying) Reduced risk of low back pain
Muscular endurance	Ability to perform repeated, high-resistance muscle contractions	Enhanced functional capacity (lifting, carrying) Reduced risk of low back pain
Flexibility	Range of motion in a joint or series of joints	Enhanced functional capacity (bending, twisting) Reduced risk of low back pain
Body composition	Fatness; ratio of fat weight to total body weight	Enhanced functional capacity Reduced risk of chronic disease

[a]From Clarke (1967).
[b]From Pate and Shepard (1989).

nitions present physical fitness as a multidimensional construct. While many earlier operational definitions of physical fitness included numerous motor performance capacities (e.g., coordination, balance, agility), most contemporary definitions view physical fitness as comprised of a small number of core components, each of which is known to determine one's ability to perform certain types of demanding physical tasks. These core components include cardiorespiratory endurance, muscular strength, muscular endurance, flexibility, and body composition. Collectively, these components have sometimes been referred to as "health-related physical fitness" (U.S. Department of Health and Human Services, 1996). Table 4-1 presents definitions of each of these components of physical fitness; the table also provides a brief indication of the relationship of each component to physical performance and to health.

Measurement of Physical Fitness

Because physical fitness has been conceptualized as a multidimensional construct comprised of several independent factors, comprehensive tests of physical fitness typically include multiple test items. Numerous test batteries have been developed for use in laboratory, quasi-

laboratory, and field settings. The laboratory measures of physical fitness typically have been used as criterion measures for development and validation of quasi-laboratory and field measures. For example, maximal aerobic power or maximal oxygen consumption (VO_{2max}) is a laboratory measure of cardiorespiratory endurance that involves performance of exhaustive exercise on an ergometric device (e.g., treadmill, cycle ergometer) while metabolic gases are collected and analyzed. VO_{2max} is the "gold standard" that has been used as the basis for validating quasi-laboratory measures such as the Physical Work Capacity-170 test (McMurray et al., 1998) and field measures, such as distance runs (Kline et al., 1987; Cureton et al., 1995).

Most contemporary field tests of physical fitness developed for use in the civilian population include test items that are designed to measure cardiorespiratory endurance, muscular strength and endurance of the abdominal musculature, muscular strength and endurance of the upper arm musculature, flexibility of the low back or hamstring region, and body composition. An example is FITNESSGRAM, which is the most widely used physical fitness test battery in U.S. schools (Cooper Institute, 2004). Table 4-2 summarizes the alternate test items that are available in the FITNESSGRAM protocol. Each of the items included in FITNESSGRAM has been validated against criterion laboratory measures of fitness. For each item, health-related criterion-referenced standards are available (Cooper Institute, 2004).

TABLE 4-2 FITNESSGRAM Test Battery

Components of Physical Fitness	FITNESSGRAM Test Items[a]
Cardiorespiratory endurance	The PACER, one-mile run, or walk test
Muscular strength and endurance of the abdominal musculature	Curl-up
Muscular strength and endurance of upper arm musculature	90-degree push-up, modified pull-up, pull-up, or flexed arm hang
Flexibility of the low back or hamstring region	Back-saver sit and reach
Body composition	Skinfold measurements or body mass index

[a]From Cooper Institute (2004).

MILITARY FITNESS STANDARDS AND TESTS

Test Protocols

We addressed the issue of physical fitness requirements for military service in Chapter 2. As noted there, each Service routinely tests the physical fitness of its personnel. Administration of these tests is highly decentralized; tests are usually administered at the unit level, wherever in the world that unit happens to be located. The Services have implemented instructions to help ensure that these tests are administered in a standardized fashion regardless of unit or location. For example, the Army notes: "The APFT [Army Physical Fitness Test] consists of push-ups, sit-ups, and a 2-mile run, done in that order on the same day. Soldiers are allowed a minimum of ten minutes and a maximum of twenty minutes rest between events. All three events must be completed within two hours. The test period is defined as the period of time that elapses from the start to the finish of the three events" (U.S. Department of the Army, 2005:5). Table 4-3 displays the components of each Service's physical fitness assessment.

Fitness Standards

The Services take physical fitness seriously. As noted by a joint-Service workshop (Military Operational Medicine Research Program, 1999):

> All military personnel, regardless of occupational specialty, unit assignment, age, or gender should acquire a base level of general physical fitness. This physical fitness promotes a standard of physical readiness

TABLE 4-3 Military Service Physical Fitness Test Components

	Army	Navy	Air Force	Marine Corps
Aerobic capacity	2-mile run	1.5-mile run	1.5-mile run	3-mile run
Upper body muscular fitness	Push-ups (2 minutes)	Push-ups (2 minutes)	Push-ups (1 minute)	Pull-ups (men) Flexed arm hang (women)
Abdominal muscular fitness	Sit-ups (2 minutes)	Curl-ups (2 minutes)	Crunches (1 minute)	Crunches (2 minutes)

SOURCE: Adapted from Singer et al. (2002).

commensurate with the active life style and deployability of the military profession. Such a DoD-wide generalized fitness standard will enhance overall health, physical well-being, military readiness, and appearance. This base level of fitness can then be used as a springboard to train personnel for further physically demanding occupational specialties or unit assignments and deployable combat readiness.

Military personnel who cannot maintain adequate levels of physical fitness are subject to various administrative penalties, up to and including dismissal from military service. As one Army publication notes, "Soldiers without medical profiles, who repeatedly fail the APFT [Army Physical Fitness Test], will be barred from re-enlistment or processed for separation from the service. A repetitive failure occurs when a soldier fails a record test, the soldier is provided adequate time and assistance to improve his or her performance, and failure occurs again" (U.S. Department of the Army, 2003:73).

Table 4-4 displays selected minimum requirements for passing the physical fitness assessments for personnel who have completed their initial entry training.

The rationale for physical fitness assessment components—and for the levels required to pass the assessments—varies by Service. For example, "The APFT [Army Physical Fitness Test] provides a measure of upper and lower body muscular endurance. It is a performance test that indicates a soldier's ability to perform physically and handle his or her own body weight" (U.S. Department of the Army, 2005:5). Constable and Palmer (2000) describe the Services' programs and their history and (to some extent) the rationale behind their programs. Standards to pass these assessments have generally been set on the basis of normative data collected by each Service.

FITNESS IN THE YOUTH POPULATION AND IN MILITARY PERSONNEL

This section presents a comparison of the physical fitness of military personnel (as reported in a variety of published studies) to the physical fitness of contemporary American youth (as assessed by the National Health and Nutrition Examination Survey).

The U.S. Population

The National Health and Nutrition Examination Survey (NHANES) began in 1970. It was designed to monitor the trends in prevalence, awareness, and treatment of selected risk factors and diseases of Americans. The participants in NHANES are civilian, noninstitutionalized residents

TABLE 4-4 Selected Minimum Standards on Service Physical Fitness Tests

	Army			Navy			Marine Corps		
Aerobic	2-mile run			1.5-mile run			3-mile run		
	Age	Men	Women	Age	Men	Women	Age	Men	Women
	17-21	15:54	18:54	17-19	12:30	15:00	17-26	28:00	31:00
Upper	Push-ups			Push-ups			Pull-ups/Flexed Arm		
	Age	Men	Women	Age	Men	Women	Age	Men	Women
	17-21	42	19	17-19	42	19	17-26	3	15 sec
Abdominal	Sit-ups			Curl-ups			Crunches		
	Age	Men	Women	Age	Men	Women	Age	Men	Women
	17-21	53	53	17-19	50	50	17-26	50	50

NOTE: Air Force minimum standards are based on a weighted combination of scores from the physical fitness test components plus a waist circumference measurement. The Army's point system, by contrast, sets minimum scores on each event. All soldiers must attain a score of at least 60 points on each event and an overall score of at least 180 points. The maximum score a soldier can attain on the APFT is 300 points. Soldiers in basic combat training must attain 50 points in each event and an overall score of 150 points.
SOURCE: Extracted from Singer et al. (2002).

and are randomly sampled to be representative of Americans. The examination consists of an in-home interview followed by medical tests in the mobile exam center. Beginning in 1999, NHANES examined the cardiorespiratory fitness of participants, which provides population data on the fitness levels of Americans.

Cardiorespiratory fitness was measured with a submaximal treadmill exercise test. The protocol consisted of a 2-minute warm-up, two 3-minute exercise periods, and a 3-minute recovery period. The grade and speed of the treadmill was dependent on the participant's physical activity readiness code, age, and body mass index (BMI). During the first exercise stage, the participant should attain approximately 55 to 65 percent of their age-predicted maximal heart rate. During the second stage of exercise, the participant should attain approximately 70 to 80 percent of it. VO_{2max} was estimated according to the heart rates achieved at the submaximal work rates. Values that were greater than 75 ml/kg/min were recoded to 75 ml/kg/min.

Datasets were obtained from the web site of the Centers for Disease Control and Prevention (CDC). Both NHANES 1999-2000 and NHANES 2001-2002 were used in the analyses. The downloaded files provided demographic information and estimated VO_{2max}. Percentile ranks of estimated VO_{2max} of 16- to 24-year-olds were calculated. The sample size for VO_{2max} for men and women was 1,115 and 927, respectively. Separate analyses were conducted to assess the association between race and cardiorespiratory fitness. The participants were stratified into three groups: non-Hispanic white, non-Hispanic black, and Mexican American. Due to small numbers in the "other" category, those participants were excluded from the racial analysis (n = 175). All analyses were performed using SUDAAN (a program of analytic procedures designed to analyze complex data sets) to allow for the population weights and sampling design.

Military Personnel

A search of the National Library of Medicine's online MEDLINE database was conducted using the key words: *fitness, weight status, military,* and *recruits.* Articles were included if cardiorespiratory fitness expressed as ml/kg/min or two-mile run time was reported. A total of seven articles were included in the final analysis. All seven of the articles measured Army recruits, and the mean age ranged from 18 to 21.5 years. Three studies (Knapik et al., 2001b; Patton, Daniels, and Vogel, 1980; Sonna et al., 2001) administered a treadmill running protocol using open-circuit indirect calorimetry to determine VO_{2peak}, and one study used the Astrand cycle ergometer test to estimate VO_{2max} (Kowal, Patton, and Vogel, 1978). The remaining three studies measured cardiorespiratory fitness with the

two-mile run (Snoddy and Henderson, 1994; Popovich et al., 2000; Knapik et al., 2003a).

The mean estimated or measured VO_{2max} and standard deviations of military personnel were extracted from seven articles and were plotted against the percentile rank of estimated VO_{2max} of 16- to 24-year-olds from NHANES 1999-2000 and NHANES 2001-2002. Some articles reported cardiorespiratory fitness as two-mile run times. These values were transformed to estimated VO_{2max} in ml/kg/min using regression equations from Mello, Murphy, and Vogel (1988). The correlations between VO_{2max} and two-mile run times were -0.91 for men and -0.89 for women (Mello, Murphy, and Vogel, 1988). The two-mile run times that correspond to VO_{2max} for the percentile ranks are displayed in the figures, which were also transformed using the regression equations from Mello and colleagues (Mello, Murphy, and Vogel, 1988).

The VO_{2max} of male military recruits relative to the U.S. population of 16- to 24-year-olds is presented in Figure 4-1, and the same information is presented in Figure 4-2 for female recruits. For men, the mean VO_{2max} ranged from the 35th to 75th percentiles, and the standard deviations ranged from the 30th to 90th percentiles. Fitness levels of male military personnel were in the upper 70 percent of the distribution, corresponding to a minimum VO_{2max} of 41.2 ml/kg/min or a 2-mile run time of 17 minutes and 28 seconds. For women, the mean VO_{2max} ranged from the 43rd to 77th percentiles, and the standard deviations ranged from the 27th to 99th percentiles. Fitness levels of female military personnel were in the upper 75 percent of the distribution, corresponding to a minimum VO_{2max} of 33.1 ml/kg/min or a 2-mile run time of 22 minutes and 29 seconds. To assess the relationship between fitness and race, maximal oxygen consumption of non-Hispanic whites, non-Hispanic blacks, and Mexican Americans was compared. There were no differences in VO_{2max} among the three races for the men; and for women, non-Hispanic blacks had lower VO_{2max} compared with Mexican Americans ($p = 0.042$).

Secular Trends

In 1954, the Kraus-Weber Test battery found that the fitness levels of American children were much lower than those of European children (Kraus and Hirschland, 1954). These results brought national attention to children's fitness levels, and President Eisenhower responded by creating the President's Council on Youth Fitness (now the President's Council on Physical Fitness and Sports) to promote youth fitness (Corbin and Pangrazi, 1992). This began four decades of field tests to measure components of fitness (U.S. Department of Health and Human Services, 1985, 1987; Reiff et al., 1986). It is difficult to determine secular trends of cardio-

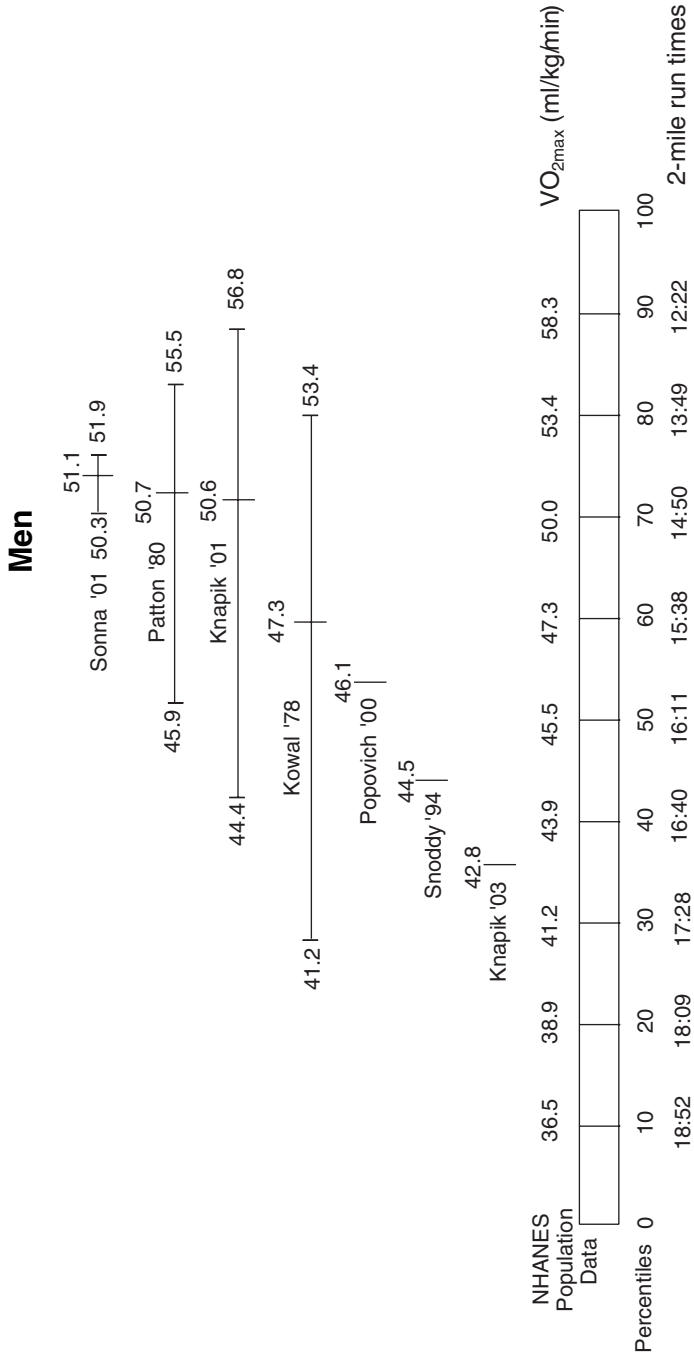


FIGURE 4-1 Measured or estimated VO_{2max} in samples of military personnel (men) relative to the U.S. population (16-24 years, N = 1,115).
SOURCE: NHANES (1999-2002).

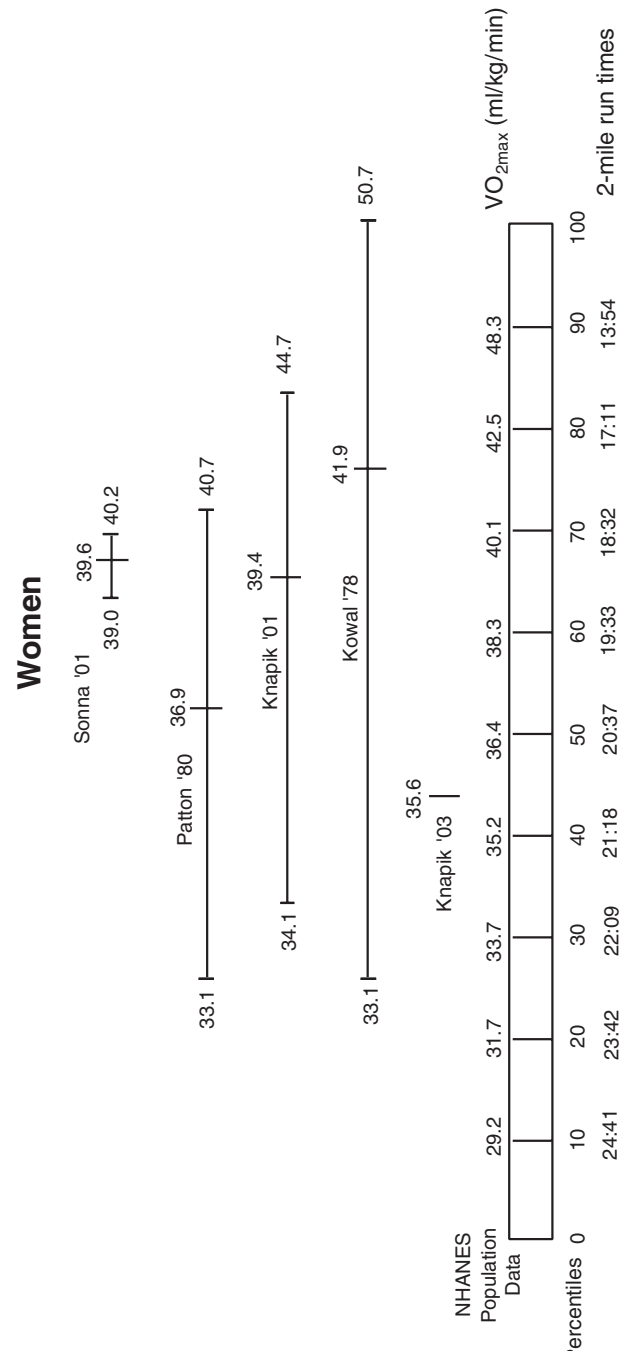


FIGURE 4-2 Measured or estimated VO_{2max} in samples of military personnel (women) relative to the U.S. population (16-24 years, N = 927).
SOURCE: NHANES (1999-2002).

respiratory fitness with these different field tests because the mile run was not included in test batteries until the 1980s (Corbin and Pangrazi, 1992).

Other sources of data to assess secular trends in cardiorespiratory fitness are the Health Examination Survey Cycle III (1966-1970) and the most recent NHANES (1999-2002). The Health Examination Survey included a treadmill exercise test for 12- to 17-year-olds (McDowell, 1989; Gillum, 1989) and NHANES (1999-2002) administered a treadmill exercise test to persons ages 12 to 49. Both protocols had two incremental work stages ranging from 2-3 minutes. The protocols were not identical; therefore, the comparison should be interpreted with caution. For youth ages 12 to 17, the mean VO_{2max} for boys decreased approximately 10 percent during the 35-year period, whereas there was no difference in mean VO_{2max} for girls.

Sharp and colleagues (2002) compared the cardiorespiratory fitness levels of men and women entering the Army over a 20-year period (1978-1998). VO_{2max} was measured using open-circuit indirect calorimetry during a treadmill running protocol. The mean VO_{2max} of men in the 1978 sample was equivalent to the 1998 sample (50.7 ± 4.8 ml/kg/min in 1978 and 50.6 ± 6.2 ml/kg/min in 1998). Among women, the mean VO_{2max} in the 1998 sample was 6 percent higher than the 1978 sample (36.9 ± 3.8 ml/kg/min in 1978 and 39.2 ± 5.1 ml/kg/min in 1998). Thus, the recruits in 1998 had cardiorespiratory fitness levels that were equal to or greater than recruits in 1978.

PHYSICAL FITNESS, MUSCULOSKELETAL INJURY, AND ATTRITION IN MILITARY BASIC TRAINING

This section focuses on the relationship of physical fitness to injury and attrition in basic training. Data are presented demonstrating that low physical fitness is closely associated with diminished performance in basic training (as measured by injury and attrition status).

Prevalence of Musculoskeletal Injuries in the Applicant Population

Even before they are shipped to basic training, some potential recruits arrive at the military entrance processing station (MEPS) with chronic injuries and other musculoskeletal conditions. Some of these conditions preclude military service, while others, following review through the waiver system, are deemed to be admissible. It is also highly probable that there is a group of recruits with musculoskeletal conditions that go undetected at the MEPS.

As a general marker of the prevalence of musculoskeletal conditions in the applicant population, the committee accessed information on reasons for medical disqualifications (or "failures") at the MEPS. These data were provided by the U.S. Military Enlistment Processing Command (USMEPCOM). It should be noted that, in general, recruiters do not send a potential applicant to a MEPS if he or she has a musculoskeletal condition that the recruiter perceives will not be waived. Thus, in terms of providing information about the prevalence of musculoskeletal conditions in the applicant population, these data suffer from a recruiter selection bias common to all MEPS databases.

For the period May 1, 2003, to April 30, 2005, there was a total of approximately 429,116 applicants who underwent the physical/medical screen at the MEPS (this is essentially the number of potential applicants who successfully completed the Armed Services Vocational Aptitude Battery exam). Of these, 239,940 (60 percent) entered a Service. Among the total accessions, there were 26,326 (11 percent) who were "medically disqualified" (i.e., did not pass the screen) at the MEPS and received a waiver. An additional 43,708 applicants were medically failed and either did not apply for a waiver or else were not waived and thus were not accessed. (See tables in Appendix B.)

The most common reasons for medical failure were being overweight (23 percent), self-reported marijuana use (13 percent), and musculoskeletal conditions of the upper or lower extremities (10 percent). The codes used for upper or lower extremity musculoskeletal conditions reflect a great variety of disorders, and many of the codes are unspecific (i.e., "other lower extremity conditions"). To the extent possible, the basic distribution of these codes is described below.

For the lower extremity, knee and patella conditions were the most common category, accounting for 15 percent of lower extremity failures. Within the knee category, repairs to the anterior cruciate ligament accounted for 7 percent of lower extremity failures. However, it should be noted that a history of this repair is widely perceived by the military Services to be a waiverable condition, and thus is probably overrepresented in this data source relative to the general applicant population. Ankle and foot conditions accounted for 4 percent of lower extremity failures, joint pain or stiffness for 8 percent, and presence of an orthopedic device or "complications of medical care" for an additional 5 percent. The remaining conditions (68 percent of all lower extremity failures) represented a wide variety of conditions, no single one of which was larger than 2 percent.

For the upper extremity, shoulder conditions were the most common category, accounting for 12 percent of all upper extremity failures. Within the shoulder category, a variety of types of shoulder dislocation codes

accounted for 8 percent of all upper extremity failures, and rotator cuff conditions accounted for 2 percent. Elbow, forearm, and upper arm conditions accounted for 3 percent, finger and wrist fractures and amputations for 3 percent, and presence of an orthopedic device or complications of medical care for 7 percent. The remaining 75 percent comprised a wide variety of conditions, no single one of which is larger than 2 percent.

There is no systematic linkage of the information from the MEPCOM medical failure database to medical data on incident injury in basic training. There is also no routine linkage of the medical failure database to administrative data on basic training attrition. Because of the lack of linkage to outcomes and the great diversity and lack of specificity of the musculoskeletal conditions reported above, the committee did not make any further use of this data source.

Incidence of Injury and Attrition

Musculoskeletal injuries resulting from basic and advanced individual training pose the single most significant medical impediment to military readiness (Jones and Hansen, 2000). In 1994 and 1995, these types of injuries were the leading cause of disability in all the Services and were the leading cause of hospitalizations for the Army, the Navy, and the Marine Corps (DoD Injury Surveillance and Prevention Work Group, 1999). High incidence rates of musculoskeletal injuries impose enormous consequences on the military, including monetary costs, lost work or training time, and recruit attrition. Depending on the data source and the type of injury, average days lost per injury can range from 2.3 days for strains and sprains to over 100 days for more acute conditions, such as bone fractures (DoD Injury Surveillance and Prevention Work Group, 1999; Knapik et al., 1993; Lauder et al., 2000; Reynolds et al., 1994). Overuse bone injuries such as stress fractures also account for a significant number of lost duty days (averaging 6.2 days per injury) (Reynolds et al., 1994). In addition, studies have shown that musculoskeletal injuries are responsible for a significant number of limited-duty days. Common soft-tissue overuse injuries such as tendonitis and muscle strains have resulted in 3 to 7 limited-duty days per injury (Knapik et al., 1993).

Training injury rates have been estimated from 10 to 15 per 100 recruits per month for male recruits, 10 to 25 per 100 recruits per month for female recruits, and 6 to 12 per 100 recruits per month for infantry (Almeida et al., 1999; Bell et al., 2000; Jones et al., 1993b; Knapik et al., 1993; Kowal, 1980; Reinker and Ozburne, 1979; Riddell, 1990; Shaffer et al., 1999b; Tomlinson, Lednar, and Jackson, 1987). Among these populations, the cumulative incidence of musculoskeletal injuries that required medical attention has been reported to be between 8 and 55 percent for

men and between 17 and 62 percent for women (Almeida et al., 1999; Cowan et al., 1996; Jones et al., 1993a, 1993b; Kaufman et al., 1999; Knapik et al., 1993; Kowal, 1980; Reinker and Ozburne, 1979; Reynolds et al., 1994; Shaffer et al., 1999b). In studies that reported injury rates for both male and female recruits, the injury rate for women was twice as high as the injury rate for men.

A number of previous studies have established a range of risk factors for injury during military training. Recent reviews of risk factors for training-related injuries (Jones and Knapik, 1999; Kaufman, Brodine, and Shaffer, 2000) identified a range of risk factors for injury in the military, including low levels of physical fitness (Shaffer, 1999a; Jones et al., 1993a; Knapik et al., 1993), high and low flexibility (Knapik et al., 1993), anatomical factors (Kaufman et al., 1999), and smoking (Reynolds et al., 1994).

As noted throughout this volume, attrition is a substantial problem among first-term military enlistees. However, the degree to which the problem is attributed directly to musculoskeletal injuries is less clear. A Government Accounting Office report has stated that the Department of Defense lacks consistent and complete information on the causes of attrition (U.S. Senate Committee on Armed Services, Subcommittee on Personnel, 1997). According to this report, a significant portion of first-term attrition occurs during the first six months in the service. For instance, in 1994, 6-month attrition rates were 15.7 percent for the Army, 15.7 percent for the Navy, 12.5 percent for the Marine Corps, and 11.6 percent for the Air Force. This means that, in one year, more than 25,000 new recruits did not remain in the military beyond the training phase.

Poor Physical Fitness as a Risk Factor for Injury and Attrition

Injury

Research on the relationship between physical fitness and training injuries in men and women has been conducted by several researchers (Jones, 1992; Jones et al., 1993a; Westphal et al., 1996). These studies found that individuals with faster performance on a timed run (more aerobically fit) suffered significantly fewer injuries than slow runners. For men, 36 percent of the fast runners and 61 percent of the slow runners reported musculoskeletal injuries (Jones, 1992); for women, 50 percent of the fast runners and 71 percent of the slow runners reported injuries (Westphal et al., 1996). More recent research suggests that the effect of cardiorespiratory fitness may possibly interact with BMI, with leaner, slower recruits tending to have the highest risk of injury (Jones, Darakjy, and Knapik, 2004).

To model the effect of low cardiorespiratory fitness on injury and attrition, the committee used data provided by the U.S. Army Center for

Health Promotion and Preventive Medicine (USACHPPM) from Fort Jackson, South Carolina. Injury data came from a prospective cohort study of six battalions of male (n = 2,945) and female (n = 2,080) Army trainees during nine weeks of the basic combat training at Fort Jackson between 1997 and 2001 (Knapik et al., 2001a; Jones, Darakjy, and Knapik, 2004). Injury data were abstracted from clinic and hospital medical records. Attrition data were taken from the same source for 2000 and from another Fort Jackson study conducted in 2001 (Knapik et al., 2004a) in order to ensure sufficient numbers and a consistent definition of attrition. Attrition was defined as failure to graduate from basic training for any reason, including preexisting medical conditions, failure to adapt to military life, serious injury during basic training, or failure to meet standards on skills. Some of these soldiers go on to repeat basic training and eventually graduate. Height and weight data were taken at the MEPS and performance on the timed run was measured at entry to basic training. Demographic characteristics of the recruits used in the injury analyses are shown in Table 4-5. Although this data source provides information only for Army recruits, comparable data for the other Services were not readily accessible.

To examine injury and attrition risk, USACHPPM initially stratified subjects by quartiles of BMI and run-time performance. Following examination of the data, they combined the middle two quartiles to improve the precision of the estimates of injury attrition risk. Table 4-6 shows the associations of successive levels of run time and BMI with injury, and

TABLE 4-5 Demographic Features of Fort Jackson Study Sample

	Race	Men (n = 2,945)		Women (n = 2,080)	
	White	60.6%		46.2%	
	Black	24.7%		37.6%	
	Other	14.3%		15.7%	
		Mean	SD	Mean	SD
Age (years)		20.2	3.2	20.3	3.7
Height (cm)		176.4	7.1	163.6	6.4
Weight (kg)		74.5	12.8	61.1	9.5
BMI (kg/m^2)		23.9	3.7	22.8	3.0
2-mile run time (min)		17.0	2.6	21.2	2.8

NOTE: SD = standard deviation.
SOURCE: Jones, Darakjy, and Knapik (2004). U.S. Army Center for Health Promotion and Preventive Medicine. Previously unpublished data from samples of male and female trainees at Fort Jackson, South Carolina, 1997-2001.

Table 4-7 shows their association with attrition. Two immediate conclusions can be made from these tables:

- The risk of both injury and attrition is markedly higher for female recruits.
- Physical fitness and BMI both affect the risk of injury and attrition; however, fitness generally appears to be a stronger predictor than BMI.

A further analysis of these data by the commitee, controlling for the confounding effects of gender and BMI, indicate that the risk of injury rises by 13 percent for each 1-quartile drop in performance (increase in run time), averaged across gender and BMI categories (Table 4-8). This analysis assumes an approximately average effect of cardiorespiratory fitness across gender and BMI categories, which is reasonable based on the pattern of risk presented in Tables 4-6 and 4-7.

There are striking differences between men and women in the risk of injury during Army basic training (adjusted risk ratio of 2.26, 95 percent confidence interval, CI: 2.08, 2.45). It has been argued that these gender differentials are largely driven by the lower physical fitness of the female recruit population (Bell et al., 2000). However, we observed that adjustment for cardiorespiratory fitness (in quartiles) had limited impact on the risk ratio for women relative to men, even when we assigned midpoint scores to the cardiorespiratory fitness quartiles (adjusted risk ratio of 2.12, 95 percent CI: 1.95, 2.31)

The committee also projected the effect on injury risk of increases or decreases in the distribution of cardiorespiratory fitness of the recruit population (as measured by the APFT standardized timed 2-mile run test), controlling for BMI within quartiles. Our analysis shows modest but definite gradients in injury risk associated with cardiorespiratory fitness. For men, decreases in the cardiorespiratory fitness of the recruits (e.g., due to decreases in the general youth population) so that all recruits were at currently accepted minimal standards (i.e., almost all in the lowest quartile of fitness) would increase the injury risk from 21.2 percent (95 percent CI: 19.7, 22.7) to 26.2 percent (95 percent CI: 24.7, 27.8). If all female recruits were in the current lowest quartile, the injury risk would increase from 47.8 percent (95 percent CI: 45.7, 50.0) to 54.4 percent (95 percent CI: 52.3, 56.6). Correspondingly, there would be reductions in the injury risk for both men and women if the distribution of cardiorespiratory fitness could be shifted so that recruits had greater physical fitness (e.g., through introducing a standard for cardiorespiratory fitness). Figure 4-3 illustrates the shifts in injury risk that would occur as a result of changes in the distribution of physical fitness.

TABLE 4-6 Risk of Injury by Body Mass Index (BMI) and 2-Minute Run Time

	Fast Run Time (25%)		Medium Run Time (50%)		Slow Run Time (25%)		
	Injury Risk	Risk Ratio (95% CI)	Injury Risk	Risk Ratio (95% CI)	Injury Risk	Risk Ratio (95% CI)	Total
Men							
Low BMI (25%)	16.5%	1.0 (referent)	21.4%	1.3 (0.9, 1.8)	28.7%	1.7 (1.2, 2.6)	20.7%
Medium BMI (50%)	19.6%	1.2 (0.7, 2.1)	19.3%	1.2 (0.9, 1.6)	25.1%	1.5 (1.1, 2.1)	20.5%
High BMI (25%)	20.5%	1.2 (0.7, 2.1)	19.8%	1.2 (0.9, 1.7)	26.5%	1.6 (1.2, 2.2)	22.8%
Total	18.6%		20.0%		26.2%		21.1%
Women							
Low BMI (25%)	45.0%	1.0 (referent)	52.2%	1.2 (1.0, 1.4)	60.8%	1.4 (1.1, 1.7)	50.9%
Medium BMI (50%)	35.7%	0.8 (0.6, 1.0)	47.7%	1.0 (0.8, 1.1)	55.2%	1.2 (1.0, 1.5)	45.7%
High BMI (25%)	38.2%	0.9 (0.6, 1.2)	48.3%	1.1 (0.9, 1.3)	50.8%	1.1 (0.9, 1.4)	47.6%
Total	39.2%		48.9%		54.4%		47.5%

NOTE: BMI = body mass index.
SOURCE: Jones, Darakjy, and Knapik (2004). U.S. Army Center for Health Promotion and Preventive Medicine. Previously unpublished data from samples of male and female trainees at Fort Jackson, South Carolina, 1997-2001. See Figure 4-3 for cutpoints used to define categories.

TABLE 4-7 Risk of Attrition by Body Mass Index (BMI) and 1-Minute Run Time

	Fast Run Time (25%)		Medium Run Time (50%)		Slow Run Time (25%)		
	Attrition Risk	Risk Ratio (95% CI)	Attrition Risk	Risk Ratio (95% CI)	Attrition Risk	Risk Ratio (95% CI)	Total
Men							
Low BMI (25%)	6.0%	1.0 (referent)	10.1%	1.7 (1.0, 2.9)	16.1%	2.7 (1.4, 5.1)	9.5%
Medium BMI (50%)	6.1%	1.0 (0.6, 1.8)	7.0%	1.2 (0.7, 2.0)	16.2%	2.7 (1.6, 4.6)	8.6%
High BMI (25%)	6.6%	1.1 (0.4, 3.2)	6.8%	1.1 (0.6, 2.1)	14.3%	2.4 (1.4, 4.1)	10.2%
Total	6.1%		7.7%		15.4%		9.2%
Women							
Low BMI (25%)	7.2%	1.0 (referent)	15.3%	2.1 (1.1, 4.0)	25.6%	3.5 (1.8, 7.2)	14.4%
Medium BMI (50%)	7.6%	1.0 (0.5, 2.1)	14.1%	2.0 (1.1, 3.6)	30.5%	4.2 (2.3, 7.8)	15.8%
High BMI (25%)	10.3%	1.4 (0.6, 3.5)	15.9%	2.2 (1.1, 4.2)	33.7%	4.7 (2.5, 8.6)	21.8%
Total	7.9%		14.8%		30.8%		16.9%

NOTE: BMI = body mass index.
SOURCE: Jones, Darakjy, and Knapik (2004). U.S. Army Center for Health Promotion and Preventive Medicine. Previously unpublished data from samples of male and female trainees at Fort Jackson, South Carolina, 2001, 2003. See Figure 4-4 for cutpoints used to define categories.

TABLE 4-8 Multivariate Analysis of Risk Factors for Injury during Army Basic Combat Training, Fort Jackson, South Carolina, 1998-2000

	Injury Risk Ratio (95% CI)	
Variable	Unadjusted	Adjusted[a]
Low cardiorespiratory fitness 1 quartile decrease in run time	1.11 (1.07, 1.15)	1.13 (1.09, 1.17)
Body fatness 1 quartile increase in BMI	1.00 (0.96, 1.04)	0.97 (0.93, 1.00)
Gender (female versus male)	2.25 (2.07, 2.45)	2.26 (2.08, 2.45)

NOTE: CI = confidence interval.

[a]Controlling for the other variables listed in this table.

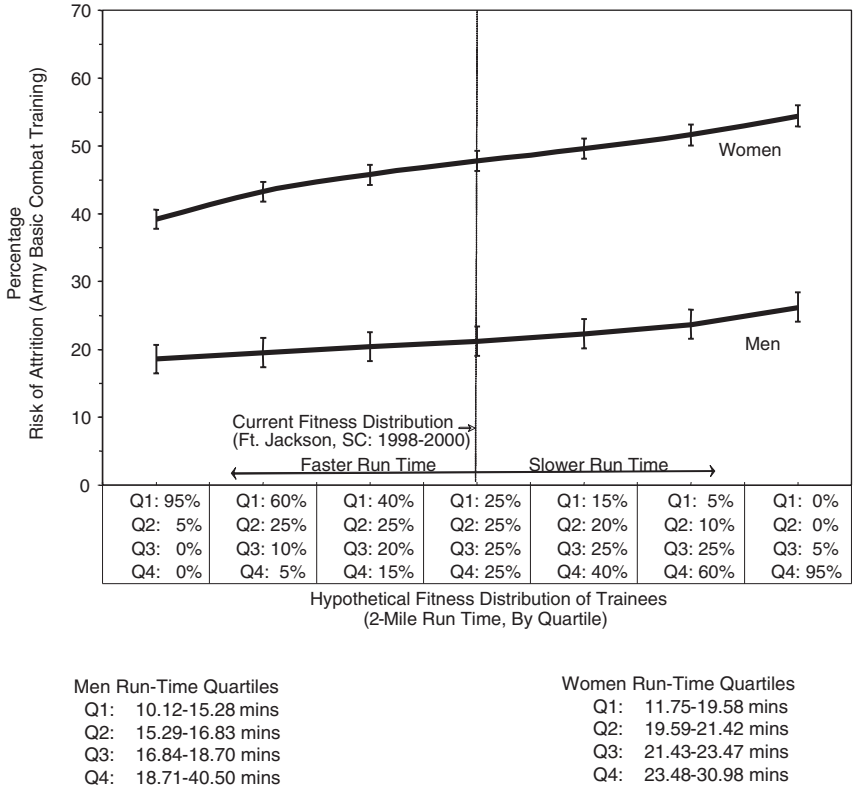
SOURCE: Jones, Darakjy, and Knapik (2004). U.S. Army Center for Health Promotion and Preventive Medicine. Previously unpublished data from samples of male and female trainees at Fort Jackson, South Carolina. See Figure 4-3 for cutpoints used to define categories.

These results underscore the importance of strengthening the role of fitness testing (at least for cardiorespiratory fitness) in current recruitment procedures. Potentially, fitness could be improved by introducing a new standard based on a simple test of physical fitness. The Accessions Medical Standards Analysis and Research Activity has experimented with the introduction of a simple step test into the MEPS (Krauss, 2004).

Attrition

There is clear evidence that preservice fitness is directly related to attrition. In a longitudinal study of Army recruits who entered military service in 1999, the physical fitness levels of recruits when arriving at basic training predicted attrition both during training and years later, in operational units.[2] Specifically, recruits who passed the Army's physical fitness test both very early in training and later in training had an 18.9 percent attrition rate from their operational unit, whereas those who failed the test both early and later in training had a 26 percent attrition rate from

[2]Personal communication from Dan Putka, HumRRO, 2005, based on reanalyses of data collected for the Army Research Institute's Project First Term.



Men Run-Time Quartiles
Q1: 10.12-15.28 mins
Q2: 15.29-16.83 mins
Q3: 16.84-18.70 mins
Q4: 18.71-40.50 mins

Women Run-Time Quartiles
Q1: 11.75-19.58 mins
Q2: 19.59-21.42 mins
Q3: 21.43-23.47 mins
Q4: 23.48-30.98 mins

FIGURE 4-3 Relationship between risk of injury and physical fitness (2-mile run time).
SOURCE: Jones, Darakjy, and Knapik (2004). U.S. Army Center for Health Promotion and Preventive Medicine. Previously unpublished data from samples of male and female trainees at Fort Jackson, South Carolina.

their unit. A recruit's race was not predictive of pass/fail status on either the early or the later fitness tests during basic training; however, women were much more likely to fail, while those who self-rated their fitness level as high were much more likely to pass.

To further analyze the relationship between fitness and attrition, the committee used data provided by USACHPPM (data from two studies conducted at Fort Jackson in 2000 and 2003; see the description in the previous section).

The analysis of the USACHPPM injury data in the previous section identified poor physical fitness as a strong risk factor for injury, and the analysis of the attrition data shows that it is an even stronger risk factor for attrition (Table 4-9). Each 1 quartile decrease in performance on the timed run test was associated with about a 50 percent increase in the risk of attrition (adjusted risk ratio of 1.51, 95 percent CI: 1.40, 1.62). Gender was a strong risk factor for attrition, although less so than it was for injury. When we assigned midpoint scores to the fitness quartiles, the risk ratio for women was reduced to 1.34 (95 percent CI: 1.14, 1.59).

As it did with injury, the committee conducted an analysis that involved shifting the distribution of cardiorespiratory fitness toward the least fit and measuring the effect on the outcome of attrition. For both men and women, improving the cardiorespiratory fitness of the recruit population has considerable potential to reduce the risk of attrition. Figure 4-4 illustrates these effects. For men, decreases in the cardiorespiratory fitness of the recruits so that almost all recruits were in the lowest quartile of fitness would increase the attrition risk from 9.2 percent (95 percent CI: 8.2, 10.3) to 15.4 percent (95 percent CI: 14.1, 16.6). If all female recruits were in the current lowest quartile, the attrition risk would increase from 17.1 percent (95 percent CI: 15.5, 18.3) to 30.8 percent (95 percent CI: 28.8, 32.0). Correspondingly, there would be reductions in the

TABLE 4-9 Multivariate Analysis of Risk Factors for First-Term Attrition During Army Basic Combat Training, Fort Jackson, South Carolina, 2000, 2003

	Attrition Risk Ratio (95% CI)	
Variable	Unadjusted	Adjusted[a]
Low cardiorespiratory fitness		
1 quartile decrease in speed	1.49 (1.39, 1.60)	1.51 (1.40, 1.62)
Body fatness		
1 quartile increase in body weight	1.09 (1.02, 1.16)	0.99 (0.93, 1.06)
Gender (female versus male)	1.84 (1.59, 2.13)	1.87 (1.62, 2.15)

[a]Controlling for the other variables listed in this table.

SOURCE: Jones, Darakjy, and Knapik (2004). U.S. Army Center for Health Promotion and Preventive Medicine. Previously unpublished data from samples of male and female trainees at Fort Jackson, South Carolina. See Figure 4-4 for cutpoints used to define categories.

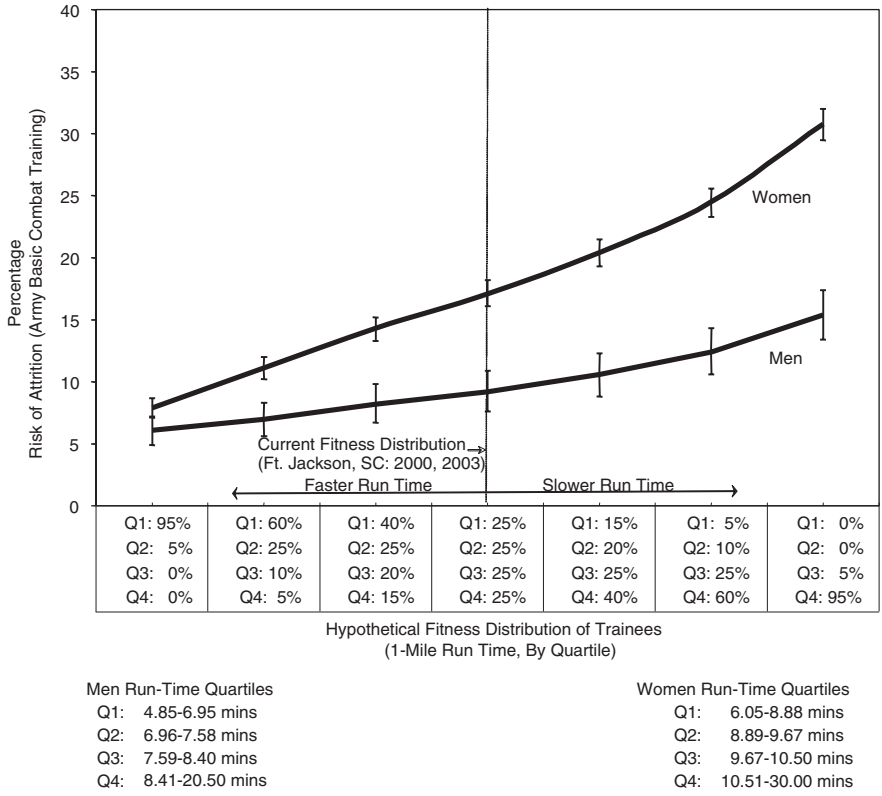


FIGURE 4-4 Relationship between risk of attrition and physical fitness (1-mile run time).
SOURCE: Jones, Darakjy, and Knapik (2004). U.S. Army Center for Health Promotion and Preventive Medicine. Previously unpublished data from samples of male and female trainees at Fort Jackson, South Carolina.

attrition risk for both men and women if the distribution of cardiorespiratory fitness could be shifted towards increasing fitness.

These analyses confirm the importance of low cardiorespiratory fitness as a readible, measurable, and modifible risk factor for injury and attrition in military recruits, and they underscore the potential for current qualifying standards to include some test of physical fitness. At a minimum, such a test would be useful for screening those recruits who would benefit from remedial fitness training. Such programs have been shown to reduce injury and attrition (Knapik et al., 2001a, 2003a, 2004a, 2004c).

Programs that modify the training environment so that the physical challenge is presented in a gradual or incremental fashion for all recruits are also effective (Rice et al., 2001).

SCIENCE OF MUSCULOSKELETAL INJURIES

Multidimensional Nature of Risk

Military and civilian research efforts have identified several risk factors for musculoskeletal injury, categorized as individual characteristics, physical demands, and psychosocial demands. Table 4-10 presents a list of studies that have identified risk factors for overuse and traumatic injury, classified by whether the study addressed individual characteristics, physical demands, or psychosocial demands. Individual characteristics include age, gender, race, physical structure, previous injury, previous physical activity, and physical fitness. Physical demands are physical stressors, such as running, marching, lifting, carrying, and jumping, imposed by the training and work environment. Psychosocial demands include pressure to perform and requirements to conform to a particular social or organizational structure. Because the causal pathways to musculoskeletal injury include a consideration of all these factors, it is important to consider their interactions. That is, the investigation of any one potential risk factor may shed only partial light on how injuries occur and how they might be prevented. The following sections examine the scientific literature characterizing each of these risk factors with the purpose of illuminating its contribution to the occurrence and prevention of injury.

Physical Demands

Load-Tolerance Relationship A fundamental concept in understanding biomechanical risk associated with physical activity involves the concept of the load-tolerance relationship. This concept suggests that for an activity to minimize risk, the activity should be designed so that the load imposed upon a tissue during the execution of the task does not exceed the tolerance of the structure. This concept is illustrated in Figure 4-5. During an activity, a loading pattern is developed on a body structure that is repeated as the activity is repeated. When the magnitude of the load imposed on a structure is less than the tissue tolerance, the task is considered safe and the magnitude of the difference between the load and the tolerance is considered the safety margin. Implicit in this figure is the idea that risk occurs when the imposed load exceeds the tissue tolerance. While tissue tolerance is defined as the ability of the tissue to withstand a

TABLE 4-10 Risk Factors for Developing Overuse and Traumatic Injuries in Military Populations

Risk Category	Risk Factor	Supporting Literature
Physical factors	Greater physical demand levels (including exercise)	Berkowitz et al., 1999; DiBenedetto et al., 2002; Dybel and Seymour, 1997; Feuerstein, Berkowitz, and Peck, 1997; Huang and Feuerstein, 2004; Jones, Cowan, and Knapik, 1994; Lincoln et al., 2002; Potter et al., 2002; Shaffer et al., 1999b; Smith and Cashman, 2002; Tomlinson, Lednar, and Jackson, 1987
Individual factors	Low levels of past physical activity	Almeida et al., 1999; Gardner et al., 1988; Jones et al., 1993a, 1993b; Kowal, 1980; Shaffer et al., 1999a; Winfield et al., 1997
	Low levels of physical fitness	Almeida et al., 1999; Bell et al., 2000; Jones et al., 1993a, 1993b; Knapik et al., 1993; Kowal, 1980; Reynolds et al., 1994; Schneider et al., 2000; Shaffer et al., 1999a; Pope, 2002
	Smoking	Jones et al., 1993a; Lincoln et al., 2002; Reynolds et al., 1994
	Age (older)	Brudvig et al., 1983; Jones et al., 1993a; Lincoln et al., 2002; Pope, 2002
	Age (younger)	Feuerstein, Berkowitz, and Peck, 1997; Knapik et al., 1993; Tomlinson, Lednar, and Jackson, 1987; Winfield et al., 1997

load without structural damage, current research is beginning to expand the concept of tolerance to include not only mechanical tolerance of the tissue but also the point at which the tissue exhibits an inflammatory reaction.

Many activities associated with exercise as well as work tasks involve lighter tissue loads yet have become increasingly repetitive. The conceptual load-tolerance model can also be adjusted to account for this type of risk exposure. Figure 4-6 shows that biomechanics logic can account for this trend by decreasing the tissue tolerance over time. As suggested in this figure, during repetitive activities the load imposed on a tissue remains relatively constant; however, the ability of the tissue to tolerate the load decreases over time. This is believed to be the mechanism of risk during highly repetitive activities or activities that are performed for extended periods of time.

TABLE 4-10 Continued

Risk Category	Risk Factor	Supporting Literature
	Gender (male)	Tomlinson, Lednar, and Jackson, 1987
	Gender (female)	Brudvig et al., 1983; Feuerstein, Berkowitz, and Peck, 1997; Geary et al., 2002; Gemmell, 2002; Kelly and Bradway, 1997; Kowal, 1980; Pester and Smith, 1992; Smith et al., 2000; Snedecor et al., 2000
	Short stature	Jones et al., 1993a
	Race (Caucasian)	Bell et al., 2000; Brudvig et al., 1983; Sulsky et al., 2000
	Lower extremity morphology	Beck et al., 1996; Cowan et al., 1993, 1996; Jones, Cowan, and Knapik, 1994 ; Jones et al., 2000; Kaufman et al., 1999, Winfield et al., 1997
	Previous injury history	Almeida et al., 1999; Jones et al., 1993a; Lincoln et al., 2002; Smith and Cashman, 2002
Psychosocial/ organizational factors	Occupational stress	Feuerstein, Berkowitz, and Peck, 1997; Huang and Feuerstein, 2004; Lincoln et al., 2002
	Job satisfaction	Huang and Feuerstein, 2004; Lincoln et al., 2002
	Low pay grade	Lincoln et al., 2002
	Greater cognitive processing	Huang and Feuerstein, 2004

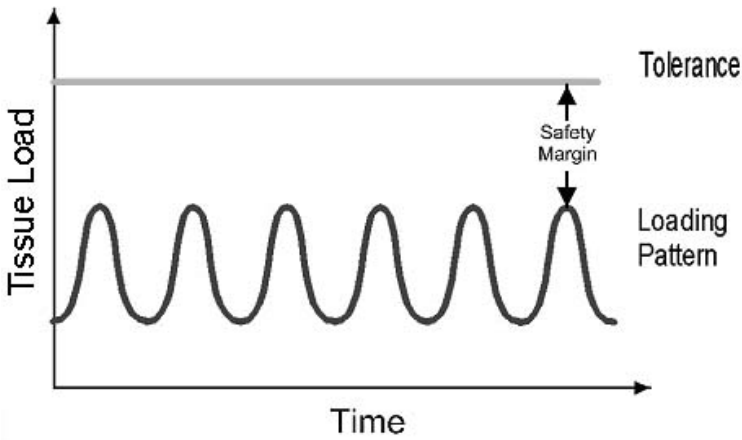


FIGURE 4-5 Traditional load-tolerance relationship between loads imposed upon a tissue and the ability of a tissue to withstand (tolerate) the load.

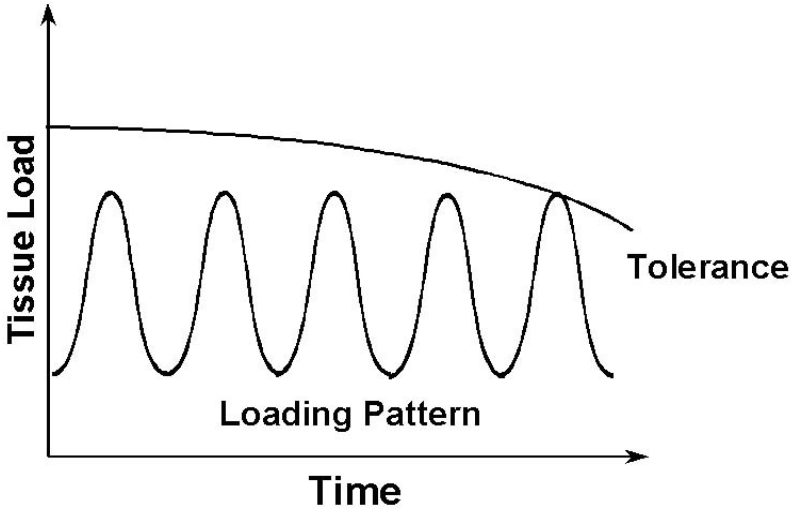


FIGURE 4-6 Load-tolerance relationship during repetitive activities. The load remains relatively constant; however, the tolerance decreases with increasing repetition.

Acute Injuries Versus Cumulative Trauma Two types of trauma can affect the human body and lead to musculoskeletal disorders in occupational settings. Acute trauma can occur when a single application of force is so large that it exceeds the tolerance of the body structure during an occupational task. Acute trauma is associated with large exertions of force that would be expected to occur infrequently, such as when a person falls and creates a large impact on a limb. This situation would result in a peak load that exceeds the load tolerance.

Cumulative trauma refers to the repeated application of force to a structure that tends to wear it down, lowering its tolerance to the point at which the tolerance is exceeded through a reduction of this tolerance limit (Figure 4-6). Cumulative trauma represents wear and tear on the structure. This type of trauma is becoming more common in occupational settings, as more repetitive jobs requiring lower force exertions become more prevalent.

The cumulative trauma process can initiate a response resulting in an inflammatory cycle that is extremely difficult to break. The cumulative trauma process begins by exposure to manual exertions that are either frequent (repetitive) or prolonged. The repetitive application of force can affect either the tendons or the muscles of the body. If the tendons are

affected, these are subject to mechanical irritation as they are repeatedly exposed to high levels of tension. Groups of tendons may undergo friction due to the repetitive activity. The physiological response to this mechanical irritation can result in inflammation and swelling of the tendon. The swelling will stimulate the nociceptors surrounding the structure and signal the central control mechanism (the brain) via pain perception that a problem exists.

In response to this pain, the body attempts to control the problem via two mechanisms. First, the muscles surrounding the irritated area will coactivate in an attempt to stabilize the joint and prevent motion of the tendons. Since motion will further stimulate the nociceptors and result in further pain, motion avoidance is indicative of the start of a cumulative trauma disorder and often indicated when workers shorten their motion cycle and move slower. Second, in an attempt to reduce the friction occurring within the tendon, the body can increase its production of lubricants (synovial fluid) within the tendon sheath. However, given the limited space available between the tendon and the tendon sheath, the increased production of synovial fluid often exacerbates the problem by further expanding the tendon sheath. This action further stimulates the surrounding nociceptors.

This initiates a vicious cycle in which the response of the tendon to the increased friction results in a reaction (inflammation and the increased production of synovial fluid) that exacerbates the problem. Once this cycle is initiated, it is very difficult to stop. Anti-inflammatory agents are often prescribed in order to break this cycle. The process results in chronic joint pain and a series of musculoskeletal reactions, including reduced strength, reduced tendon motion, and reduced mobility. Together, these reactions result in a functional disability.

Cumulative trauma can also affect the muscles. Muscles are overloaded when they become fatigued. Fatigue lowers the tolerance to stress and can result in micro trauma to the muscle fibers. This micro trauma typically means the muscle is partially torn, which causes capillaries to rupture and results in swelling, edema, or inflammation near the site of the tear. The inflammation can stimulate nociceptors and result in pain. Once again, the body reacts by cocontracting the surrounding musculature and minimizing the joint motion. However, since muscles do not rely on synovial fluid for their motion, there is no increased production of synovial fluid. Nevertheless, the end result of this process is the same as that for tendons—reduced strength, reduced tendon motion, and reduced mobility. The ultimate consequence of this process is, once again, a functional disability.

Although the stimulus associated with the cumulative trauma process is somewhat similar for tendons and muscles, there is a significant

difference in the time required to heal the damage to a tendon compared with a muscle. The mechanism of repair for both tendons and muscles is dependent on blood flow. Blood flow provides nutrients for repair as well as dissipates waste materials. However, the blood supply to a tendon is a fraction of that supplied to a muscle (typically about 5 percent in an adult). Thus, given an equivalent strain to a muscle and a tendon, the muscle will heal rapidly (if not reinjured), whereas the tendon could take months to accomplish the same level of repair. For this reason, ergonomists must be particularly vigilant in the assessment of workplaces that could pose a danger to the tendons of the body. In industrial settings, this lengthy repair process becomes the motivation for early reporting of musculoskeletal discomfort. It is common for industry to incorporate ergonomic processes that place a high value on identifying potentially risky jobs before a lost-time incident occurs through such mechanisms as discomfort surveys.

Building Tolerance—Wolff's Law Biological tissue has the ability to adapt to load demands up to a point. Specifically, bone can be considered to be a dynamic tissue and thus can respond to loading conditions. Bone responds to loading through remodeling of the bone structure. The nature of the load defines how the bone will remodel. Typically, bone remodels so that the trabecular network within the bone optimally resists compression and bending.

Bone tissue is capable of changing its shape, size, and structure in response to mechanical loads imposed on the structure over time. This bone change or adaptation in response to tissue load was first described by Wolff in 1892 and is referred to as Wolff's law. Wolff's law states that bone will be deposited where needed and reabsorbed where it is not needed (Chaffin, Andersson, and Martin, 1999:579). Although the general concept of bone remodeling is well known, the precise relationships governing the response have not been described. Conversely, immobilization will result in adaptation of the tissue and a decrease in tolerance. It should be emphasized that adaptation to increase tolerance occurs only up to a certain point. All tissue will fail if loaded sufficiently.

The ability for bone to remodel is also influenced by age and gender. Maximum skeletal bone mass occurs around age 30 and then decreases with increasing age. In addition, large differences in bone mass begin to occur once women reach menopause.

Adaptation also occurs in muscle tissue. Increases in muscle mass can occur if muscle is loaded and then permitted to rest for a sufficient period of time. This concept is well known to body builders, who stress the muscle groups during a training session and then allow the muscle to recover by training the muscle group every other day. In this training

method muscle tissue is stressed and then permitted to recover for approximately 48 hours. This provides time for nutrients to nourish muscle cells, and they respond by growing more muscle mass. However, as with bone remodeling, there are limits to muscle tolerance. Any tissue, when stressed sufficiently through acute or cumulative means, will fail.

Psychosocial Factors and Injuries

Psychosocial factors, such as pressure to perform, the organization of tasks, and the social context may also contribute to musculoskeletal injuries and attrition among military recruits. Few studies have attempted to understand the causal relationship between psychosocial factors and biomechanical loading of the musculoskeletal system.

Marras and colleagues performed controlled biomechanical assessments of spinal loading under diverse psychosocial conditions. Under the low stress psychosocial condition, subjects were asked to perform precisely controlled spine loading tasks while the experimenter provided a supportive (friendly) environment for the subject. Under the high stress psychosocial conditions, the same spine loading tasks were performed, except the psychosocial environment was unsupportive (unfriendly).

The assessments of spine loadings indicated that some subjects responded to the high stress environment with up to a 27 percent increase in spine loading, while other subjects displayed no difference in spine loading between conditions. Further analyses indicated that those subjects that responded with an increase in spine loading ranked higher on certain personality traits (introverts and intuitors). This study also provided insight into the biomechanical mechanism of increased risk. Even though the same physical task was performed under the high and low stress conditions, those subjects whose spine loads increased (introverts and intuitors) amplified their spine loads by increasing muscle coactivation. This increased muscle coactivation resulted in altered patterns of trunk muscle recruitments under the high stress conditions that were not necessary to perform the task but were a result of the stress environment. This increased coactivation caused the agonist and antagonist trunk muscles to oppose each other, thereby increasing spine loads as well as changing the nature (increased shear) of spine loading.

Further studies by Davis and associates demonstrated that the same mechanism of spine loading increases appeared under conditions in which mental demands and pacing were increased. Here again, greater coactivation was observed, thus increasing the loading of the spine.

Collectively, these studies show that there is a strong interaction among physical requirements of the task, the psychosocial environment, and the personality profile of the person. The personality characteristics

of the individual can interact strongly with the psychosocial environment and lead to increased coactivation of the musculoskeletal system. This coactivation typically increases joint loading and may lead to increases in cumulative tissue degeneration and increased risk of musculoskeletal disorders.

Although very few studies in the military have focused on psychosocial factors and how they may impact musculoskeletal injury, the combination of high physical training, preparing for combat, and intense operational tempo is bound to place psychological stress on military recruits. One study involving U.S. Marines found that decision authority and experienced responsibility for work were significant correlates for musculoskeletal pain intensity (Huang and Feuerstein, 2004). This study also found that increased time pressure and greater cognitive processing were also associated with increased musculoskeletal symptom reporting (Huang and Feuerstein, 2004). Other military studies have suggested that occupational stress and low job satisfaction were correlated with increased risk of musculoskeletal pain and disability (Feuerstein, Berkowitz, and Peck, 1997; Lincoln et al., 2002).

Individual Factors

Physical Activity, Physical Fitness, and BMI As described earlier in this chapter, low physical fitness is a major modifiable risk factor for injury and attrition in military training. Poor physical fitness is correlated with low levels of physical activity (American College of Sports Medicine, 1998). Low-level physical fitness at the time of recruitment is a major risk factor for attrition that is not addressed in current recruitment standards, other than through the assessment of BMI, which is a poor surrogate for measuring physical fitness (this is discussed further in Chapter 5). One study has suggested that BMI is not a strong independent risk factor for injury (Bell et al., 2000); however, research is needed to examine how BMI may modify the effect of low physical fitness. Tables 4-6 and 4-7 demonstrate that the highest risk of injury, for both men and women, is in the group with lowest fitness and lowest BMI—the lean but unfit (Jones, Darakjy, and Knapik, 2004). Thus, higher BMI may be possibly protective of injury in low fitness recruits.

Gender As reported in the analysis above and in the literature (see Table 4-10; Kaufman, Brodine, Shaffer, 2000; Institute of Medicine, 1998), injury rates for women are generally substantially higher than for men during basic training. Numerous biomechanical differences between men and women have been reported in the literature, which collectively may help to explain the differences between these musculoskeletal injury rates.

Studies have identified biomechanically relevant differences between genders in the knee,[3] back,[4] shoulder,[5] hip,[6] elbows,[7] and fingers.[8]

While biomechanically related risk is multidimensional, several factors may help to explain the greater risk of musculoskeletal disorders for women. First, differences in muscle mass and the mechanical advantage of the muscles relative to the joint have been reported for the back, with women generally at a biomechanical disadvantage (Janssen et al., 2000; Jorgensen et al., 2001, 2003a; Marras et al., 2001). Differences in muscle line of action are associated with differences in the muscle origin and insertion in women and typically provide less mechanical advantage and greater muscle (and joint) loading (Jorgensen et al., 2001). Similarly, studies of the knee joint muscle mass have also indicated reduced muscle mass and a muscle mechanical advantage in women (Suzuki et al., 1996; Wretenberg et al., 1996; Csintalan et al., 2002; Wojtys et al., 2003).

Second, there are differences in the bone and ligamentous tissue size and response as a function of gender. Within the knee joint, Besier and colleagues (2005) found that the knee contact area of women compared with men was significantly smaller when flexed but similar at full extension. In addition, men have slightly greater cartilage thickness (Eckstein et al., 2001). Similarly, differences in the size and bone density of vertebral bodies have been documented between men and women, with women having reduced size (Gilsanz et al., 1994a, 1994b; Ebbesen et al., 1999; Marras et al., 2001). Ligamentous creep response also appears to differ between men and women, with women exhibiting greater creep (and less stability) especially when the knee is flexed at 35 degrees (Chu et al., 2003).

Significant biomechanical differences in neuromuscular response between genders have also been documented in the literature. Granata and colleagues (2002) have noted reduced stiffness in the quadriceps of equivalently trained women compared with men. This would indicate reduced

[3]See Johnson et al., 1979; Carlson et al., 1996; Wretenberg et al., 1996; Cao et al., 1998; Kerrigan et al., 2000; Eckstein et al., 2001, 2002; Hudelmaier et al., 2001; Kaufman et al., 2001; Wojcik et al., 2001; Csintalan et al., 2002; Granata et al., 2002; Manninen et al., 2002; Chu et al., 2003; Wojtys et al., 2003; Baker et al., 2004; Blackburn et al., 2004; Besier et al., 2005; and Sbriccoli et al., 2005.

[4]See Gilsanz et al., 1994a, 1994b; Ebbesen et al., 1999; Lindbeck and Kjellberg, 2001; Marras et al., 2001; Davis et al., 2002; and Jorgensen et al., 2001, 2003a, 2003b.

[5]See Anders et al., 2004.

[6]See Genda et al., 2001.

[7]See Lin et al., 2005.

[8]See Kujala et al., 1999.

leg stability and partially explain the increased risk for women. Shultz and colleagues (2001) identified differences in the timing of muscular recruitment within the quadriceps between men and women. When ligament loading occurs, women have been noted to experience increased muscle spasms and attenuated muscular function (Sbriccoli et al., 2005). Cao and colleagues (1998) have described the differences in gait response time between men and women. Collectively, these differences have been found to impact running gait due to significantly greater hip adduction, hip internal rotation, and knee abduction angle in women (Ferber et al., 2003). These differences have also resulted in greater risk for women participating in sports as well as a poorer ability to recover from a tripping (Wojcik et al., 2001).

Similar differences in neuromuscular functioning have been noted in the low back. Lindbeck and Kjellberg (2001) documented differences in the use of knee and trunk kinematics as a function of gender. These differences, when combined with the structural differences noted earlier, interact and result in differences in the magnitude and nature of spine loading (Marras et al., 2002, 2003). They may be further exacerbated by differences in personality, which are often gender related (Marras et al., 2000) as well as by the level and type of mental workload (Davis et al., 2002).

Race and Age Increasing age and white race are noted as risk factors for overall injury (Table 4-10), for injury resulting in hospital stays for disability and for discharges from the service as result of disability (Accessions Medical Standards Analysis and Research Activity, 2002). Sulsky and colleagues (2000) studied age as a risk factor for disabling knee injury and noted that the effect of age was very different for men and women. Non-Caucasians had a lower risk of knee injury (relative risk, RR, of 0.70 for men, 0.40 for women). In contrast, Launder studied hospitalizations for sports-related and training-related injuries and found the highest rates among younger age groups and black men.

The Accessions Medical Standards Analysis and Research Activity conducts routine analysis of the available data on first-term attrition. It reports a higher risk of hospital admission within a year of accession for older age groups (> age 30 versus ages 17-20, RR = 1.46, 95 percent CI: 1.34, 1.60). Similar relationships are observed for discharges for conditions "existing prior to service" and for discharge for disability. Relative to whites, blacks were at slightly higher risk of hospital admission within a year of accession (RR = 1.04; 95 percent CI: 1.01, 1.06) but at lower risk for discharges for conditions existing prior to service (RR = 0.76, 95 percent CI: 0.76, 0.80) and for disability discharge (RR = 0.80, 95 percent CI: 0.72, 0.89).

It is unknown to what extent age and race may modify the protective effect of high fitness on injury and attrition. The data used by the committee to analyze the combined effect of fitness and BMI on injury and attrition does not contain sufficient numbers to permit further stratification by categories of race and age. Research is needed to address this topic. Whenever possible, associations should be disaggregated by race to assess the extent to which associations are constant within strata of race.

Smoking A history of smoking prior to the start of basic training is a risk factor for injury; this is addressed in Chapter 7. There are a number of plausible biological mechanisms through which smoking may predispose a recruit to injury from the stresses imposed on the body in basic training, including restricted circulatory flow and degraded ability to maintain high-quality bone health. In addition, smoking may be correlated with behavioral factors that are independent risk factors for injury, such as risk-taking behavior.

Previous Injury History A positive injury history is a risk factor for injury during basic training (Table 4-10), and similar findings are reported in the sports medicine literature for athletic populations (Kucera et al., 2005). The mechanism by which a positive history of previous injury is associated with the incidence of injury is currently not well understood. Like smoking, this may reflect a positive correlation with behavioral factors (such as risk-taking) that are predictive of injury. It may also reflect an anatomical weakness in a particular site in the body, such as chronic ankle instability, increased risk due to low physical fitness and fatigue, or poor rehabilitation of an original injury that may predispose that body site to reinjury.

Evaluating Functional Capacities: A Framework for Reducing Risk

The logic behind assessments of functional capacities is that a person's physical abilities (capacity) can be measured, documented, and evaluated via a standard physical testing procedure and compared with physical exposures that are required to perform a particular task or job. Thus, by matching worker capabilities to task demands in this manner, it is thought that the probability that an individual's capacity is exceeded by the job requirements can be minimized. Furthermore, it is assumed that if task demands are sustained within the limits of the job demands, the risk of a task-related injury is minimized. These assessments have been successfully employed in numerous industrial situations in an attempt to control the cost of musculoskeletal injuries in the workforce (Key, 1999).

Evaluating functional capacity requires a job analysis that involves a quantitative job description documenting the various physical exposures associated with job demands, such as strength, cardiovascular, and postural demands of the job. The applicant's capabilities are compared with these essential job functions. If a capacity insufficiency in the applicant's capabilities is noted relative to the job requirements, he or she may be not be selected for employment, may be placed in a conditioning, strengthening, or body mechanics program, or may be assigned to a less demanding job. For example, Sharkey (2000) reviewed the job demands and the development of a work capacity test for wildland firefighting. The first step was a job analysis of firefighting tasks. Using the *Uniform Guidelines for Employee Selection* (Federal Register, 1979), the job analysis data were used in combination with past field studies to identify potential job-capacity selection tests. Laboratory studies were used to validate the selected tests, followed by a field evaluation. One of the tests, the pack test, was selected as a valid, job-related test to measure work capacity for these wildland firefighters.

This functional capacity evaluation approach may provide a framework to assess the risk of musculoskeletal disorders associated with exposure to such military tasks as basic training. If the physical requirements of basic training can be documented, the abilities of the incoming recruits could be compared with these training demands, and theoretically it should be possible to predict the percentage of recruits who would be expected to suffer task-related injuries. Given this quantifiable structure, it would also be possible to assess how the characteristics of the incoming recruiting class would need to change so that attrition due to musculoskeletal injury would meet a specific target. In this way it might be possible to optimize youth recruitment so that the maximum number of youths could be recruited with the minimum number of attritions.

APPROACHES TO REDUCING INJURIES AND ATTRITION

Assessment of Physical Fitness Prior to Shipping to Basic Training

All branches of the military require active-duty personnel to meet physical fitness standards, and all the branches provide for administration of physical fitness tests during and after basic training. However, currently none of the military branches systematically tests its recruits for low physical fitness prior to their shipping to basic training. This results in some recruits starting basic training with very low physical fitness, and, as mentioned earlier, these recruits are known to be at significantly elevated risk for injury and attrition. These high-risk recruits could be identified prior to their initiation of basic training if procedures

were adopted for the testing of physical fitness at the MEPS or at some point subsequent to being seen at the MEPS but prior to shipping to basic training.

Although physical fitness has not been included in military recruitment protocols in the past, such procedures are widely used in the private sector and the scientific literature on measurement of physical fitness provides many test options that meet acceptable standards for validity and reliability. Accordingly, it should be possible to develop procedures that would be relatively efficient and valid in the hands of military personnel who are involved in the recruitment processes. That said, addition of a physical fitness testing procedure would add costs to the recruitment process. Presumably, these costs would vary depending on the phase at which the testing procedure is incorporated and on the nature of the fitness test. In addition, there would be some modest increase in risk to the recruits who would be required to complete the physical fitness test.

The primary purpose for adding a physical fitness assessment prior to initiation of basic training would be to identify prospective recruits or accessions whose physical fitness is so low as to place them at substantially elevated risk for injury or attrition. Of course, identifying such persons would be useful only if appropriate actions were taken based on their identification as what we call "low fit." There are a number of different actions that could be taken, and any or all of them would be expected to reduce injury and attrition in the population of basic trainees and first-term recruits. If a physical fitness test was administered prior to recruitment, those falling below a specified standard could be excluded at that time, provided with guidance on increasing their fitness, retested later, and reaccepted if they subsequently met the standard. This is essentially equivalent to placing recruits in the delayed entry program (DEP) and providing physical training for them. Alternatively, those found to be low fit prior to accession could be accepted into military service and referred to a mandatory training program, which would be completed prior to shipping to basic training. Another alternative, if basic training protocols were modified to allow it, is that low-fit inductees could initiate basic training without delay but complete training procedures that would be scaled to their lower level of fitness.

Physical Training Programs for Low-Fit Recruits Prior to Basic Training

If testing procedures are adopted that identify some recruits as low fit, they could be referred to physical training programs that would be designed to increase their fitness to acceptable levels prior to initiation of standard basic training. As suggested in the preceding section, this fundamental approach could be applied regardless of the phase of the accession

process at which the fitness screen is applied. However, the nature and setting of the training program is likely to depend on the phase of the process at which it is incorporated. For example, if fitness was assessed at any point prior to arrival at basic training, those found to be low fit could be provided with guidelines for self-management of a physical training program, or they could be referred to community-based programs that meet specified standards or criteria. Alternatively, low-fit recruits could be referred to physical training programs that would be delivered by the military branch and completed prior to initiation of basic training.

The body of knowledge in exercise science and widely accepted professional guidelines provide an extensive and solid basis for the design and delivery of physical fitness programs for healthy adults (American College of Sports Medicine, 1998, 2005). This knowledge base indicates that an individual's physical fitness level is determined by a combination of genetic and environmental factors, with the key environmental factor being recent physical activity participation. The scientific literature on exercise training shows that individuals vary greatly in their adaptations to a particular physical training program; that is, some persons demonstrate pronounced increases in fitness as a result of training, while others show minimal or no change (American College of Sports Medicine, 1998, 2005). However, almost all low-fit persons show some increase in fitness with physical training, and the majority experience substantial increases in fitness with sustained exposure to training. Hence, there is a well-established technology for enhancing physical fitness in healthy young adults, and extensive scientific evidence demonstrates that most young adults can increase their fitness substantially with increased exercise participation (American College of Sports Medicine, 1998, 2005). There seems little question about the efficacy of physical training programs to increase physical fitness in low-fit recruits who would be identified through a fitness test.

As with physical fitness testing procedures, referral of low-fit recruits to exercise training programs would involve additional costs. If the training programs were undertaken prior to induction, these costs could be borne primarily by the individual recruit. However, the costs would be borne by the military branch if recruits are referred to special physical training programs after recruitment but prior to initiation of basic training. Also, exercise training involves some short-term health risks, although these risks are minimal in young, healthy adults.

Modification of Physical Training Procedures in Basic Training

Physical training is a central component of the basic training protocol of all military branches. This component addresses two broad goals. First,

physical training is designed to increase physical fitness so that graduates of basic training are prepared to meet the physical demands of advanced military training and to perform military occupations, including combat specialties. In addition, the physical training component of basic training seemingly contributes to the overall physical and psychological demands of the training process, which are aimed at preparing soldiers for the sometimes extraordinary stresses of military service. Because physical training serves both of these purposes and because of a traditional focus on team-building and unit identification in basic training, physical training protocols in basic training have tended to emphasize group exercise rather than individualized training methods. Typically, all members of a training unit engage in the same types and amounts of exercise without regard to the wide interindividual variability in physical fitness that is seen within units. While this method may serve some important purposes, it represents a violation of one of the most widely accepted tenets of exercise training: exercise intensity and dose should be adjusted in accordance with the initial fitness level of the individual. While it would probably not be practical to provide for total individualization of exercise training programs in basic training, it could be possible to consider the initial fitness status of recruits by grouping trainees for physical training on the basis of their current fitness levels.

Because sustained running is thought to be a problematic activity from the standpoint of increased risk of overuse injury, it would seem to be particularly useful to group trainees on the basis of current fitness for distance running sessions. This idea has been tested and found to be effective in reducing the risk of injury and attrition. Table 4-11 presents a summary of the literature on this topic.

The approaches examined have used modifications to existing training programs, particularly with regard to running, that emphasize grouping individual by fitness levels, matching training levels to individual fitness, and providing a gradual progression in running pace and running distance. In addition, most programs have significantly reduced the number of miles run per week. A complication of these studies is that it is not possible to randomize these programs at the level of the individual, since groups train as a unit; therefore, most studies have used historical cohorts as "controls." Another feature of some programs is testing and assignment to "remedial" physical training protocols, either at the start of (Knapik et al., 2004a) or during (Knapik et al., 2003a, 2003b, 2004c; Rice et al., 2001) standard basic or advanced training. These programs have produced major reductions in the risk of injury without compromising the level of physical fitness at the completion of training (Almeida et al., 1997; Rice et al., 2001; Knapik et al., 2004c). In addition, at least one program has

TABLE 4-11 Modified Training Programs That Have Been Effective in Reducing Injuries in the Military

Intervention Approach	Supporting Literature	Intervention Outcome
Reduction of high-impact training	Scully and Besterman, 1982	73 percent reduction in stress fracture incidence
	Reinker and Ozburne, 1979	11 percent reduction in stress fracture rate
	Pester and Smith, 1992	13 percent reduction in stress fracture rate (16 percent in men, 7 percent in women)
Reduction of running mileage and gradual training progression	Almeida et al., 1997; Jones et al., 2000	50 percent reduction in stress fracture rate without a reduction in aerobic fitness
	Rice et al., 2001	Reduced lost-time injuries by 40 percent and musculoskeletal disorders by 49 percent. Fitness test pass rates slightly higher in intervention group
	Knapik et al., 2004c	Risk of injury in basic training reduced by 33 percent in men and 40 percent in women
Work-hardening training cycle (gradual increase)	Reinker and Ozburne, 1979	11 percent reduction stress fracture rate
Preconditioning and fitness appropriate training	Lee et al., 1997	55 percent lower attrition rates
Multiple intervention approach	Kelly and Bradway, 1997	35 percent reduction in lost training days 83 percent reduction in overall attrition rate for musculoskeletal disorders
	Knapik et al., 2004b (Modified Physical Training, Injury Education, Injury Surveillance)	50 percent reduction in relative risk of a time loss injury

TABLE 4-11 Continued

Intervention Approach	Supporting Literature	Intervention Outcome
Special training units for individuals identified as having low physical fitness based on a fitness test at the start of basic training	Knapik et al., 2004a	Risk of basic training attrition reduced from 25 to 8 percent in men; from 29 to 19 percent in women; cost savings of $14 million annually in the U.S. Army
	Knapik et al., 2004c	No reduction in injury risk
Special training units for individuals identified as having low physical fitness based on a fitness test at the end of basic training	Knapik et al., 2003a, 2003b	Retention in service after one year of 74 percent of men and 63 percent of women who graduated through the special training unit

been subject to a benefit-cost analysis and found to produce annual savings of $14 million in the U.S. Army alone (Knapik et al., 2004a). Pope (2002) studied injury and attrition during training in the Australian army and concluded that introducing a running test to screen out low physical fitness recruits could generate cost savings of over $1 million annually.

Gender-Specific Physical Training Programs

Risk of overuse injuries to the lower extremities is much higher in female than in male basic trainees (Institute of Medicine, 1998), and it is well documented that fitness is consistently lower in female recruits than in their male counterparts (Sharp et al., 2002). Also, it seems very likely that low fitness is causally related to lower extremity injury and injury-related attrition from first-term military service (Jones et al., 2000). Accordingly, the current practice of integrating female and male recruits in the same basic training units and exposing the two gender groups to the same physical training program is a prescription for producing high injury rates in female trainees. It should not be surprising that rates of overuse injury in female trainees are extremely high. To reduce this risk, physical training procedures for female recruits could be adjusted in accordance with the lower average fitness level of women. Gender could be taken into account in the physical training element of basic training, either by creating separate training units for men and women or by grouping within gender-integrated units on the basis of fitness level. If the latter

approach was adopted, the lower fit subgroups would include disproportionately high percentages of women.

In addition to physical fitness, some of the neuromuscular, biomechanical, and anatomical differences between men and women may also play a role in injury causation in basic training. The higher risk of injury observed in women may be due to an independent contribution of these factors; they may also interact with low physical fitness to elevate the risk of injury in women. There is a need for studies that comprehensively compare risk factors for injury in military men and women.

SUMMARY

Research clearly indicates that low levels of physical fitness are closely linked to musculoskeletal injuries, and that musculoskeletal injuries are a significant problem in first-term military enlistees. These injuries impose devastating consequences to the Services in terms of monetary costs, military readiness, and attrition. However, none of the Services systematically assesses individual physical fitness levels prior to the shipping of recruits to basic training. In an effort to minimize the consequences of injury, previous studies have identified several modifiable risk factors that may synergistically affect injury causality. Some of these promising modifiable factors include the physical demands of unit training, individual physical fitness levels prior to the start of basic military training, and psychosocial stress. However, since musculoskeletal injury causality is multifactorial, it is essential to focus on the interactions of multiple factors in order to better understand the process of injury and disorder. In addition, it is clear that female recruits have a high risk of injury in basic training that is due, at least in part, to their lower physical fitness. Fundamental musculoskeletal, biomechanical, and neuromuscular differences in men and women may also play a role. There is currently limited information on how the training environment could be modified to ameliorate the high risk of injury in women (other than accommodating their differential fitness levels). Finally, military interventions aimed at modifying some of these factors have shown some success and provide a positive direction for future prevention and treatment of musculoskeletal injuries in the military.

CONCLUSIONS AND RECOMMENDATIONS

Recruitment

Currently, none of the Services systematically conducts comprehensive standardized physical fitness testing at the time of recruitment.

Standardized physical fitness testing prior to basic training would permit the identification of recruits at higher risk of injury and attrition. Individuals classified as not meeting a designated physical fitness standard could be assigned to remedial physical training prior to basic training (preship intervention), or to a modified basic training regime, or to both. There are a range of options for a physical fitness test (or tests) that would be valid, reliable, feasible to implement, and likely to be cost-effective.

Recommendation 4-1: A standardized physical fitness test should be selected and routinely implemented at some point prior to the initiation of basic military training.

Pretraining

Preship interventions aimed at improved physical fitness merit consideration. There is clear evidence that such programs would increase physical fitness in most recruits with low fitness, but evidence that these programs would reduce the incidence of injury or attrition in basic training is limited.

Recommendation 4-2: Research should be conducted to examine the relationship between physical training programs prior to basic training and the incidence of injury or attrition during basic training, focusing on recruits who would fall below a designated physical fitness standard at the start of basic training.

Training

Although training outcomes are the result of several interrelated factors, preliminary direct evidence suggests that imposing limited physical demands at entry to military training and increasing physical training demands as fitness levels increase could produce comparable levels of physical fitness to current training regimes, with markedly reduced injury rates. This approach should be considered when redesigning basic training.

Recommendation 4-3: Basic training's physical and psychological demands should be tailored to broad categories of an individual's initial fitness level and gradually increased over the duration of the training (in accordance with exercise prescription science and injury prevention principles) so that optimal fitness is achieved with minimal risk of musculoskeletal disorders, traumatic injury, and attrition.

Gender Differences

The literature supports the notion that, due to biomechanical and physical fitness differences, men and women have different risks of musculoskeletal disorders, traumatic injury, and attrition as a function of basic military training. In addition, these differences can impact the path to optimal fitness. Therefore, male and female training protocols should ideally be tailored differently. Female recruits have lower average levels of physical fitness and conditioning, at the initiation of basic training, than male recruits. However, it is currently unclear whether the higher risk of injury during basic training observed in women is entirely a function of their lower (on average) physical fitness, or whether it is also partly driven by the other numerous musculoskeletal, biomechanical, and neuromuscular differences between women and men. It is therefore unknown whether tailoring the demands of basic training to an individual's fitness level (as per Recommendation 4-3) will fully address the problem of the higher risks of injury and attrition observed in female recruits.

Recommendation 4-4: Research should be undertaken to address the causes of the increased risk of injury and attrition in women. This research should address differences between men and women in physical fitness and should also address musculoskeletal, biomechanical, and neuromuscular factors.

5

Medical Factors

There are several medical conditions listed in the U.S. Department of Defense (DoD) Instruction 6130.4 that are disqualifying for military service. Some of these are permanent disqualifiers, whereas others are subject to a waiver of disqualification by one or more of the Services. The top five medical disqualifiers accounted for 53 percent of the total medical disqualifications from May 2003 to April 2005 (data provided by U.S. Military Entrance Processing Command, 2005): excessive body mass index (BMI) and body fat (23.3 percent), use of marijuana (12.6 percent), mental health (6.1 percent), lower extremity injury (5.8 percent), and diseases of the lungs (5.3 percent).

Screening for two of these conditions, excessive BMI and body fat and diseases of the lungs and chest, are discussed in this chapter. (Musculoskeletal injury is discussed in Chapter 4, mental health in Chapter 6, and substance abuse in Chapter 7.) The committee decided not to address orthopedic screening because these conditions are diverse, they lack specificity, and the data are sparse and not linked to outcomes. Most orthopedic screening problems are diagnosed by imaging using an X-ray, CT scan, or MRI. These techniques identify the obvious problems (i.e., a broken pelvis); however, many times, when there is pain, there is no visually identifiable disruption in the system. An example of low sensitivity is in the back; 85 to 90 percent of people with back pain have no identifiable problem via imaging and 10-15 percent of people without back pain have a problem identifiable through imaging. The injury conditions covered in this chapter, such as stress fractures, are easily identifiable by clinical examination or self-report of previous history of problems. Also, as noted

earlier, there is no routine linkage of the medical failure database to administrative data on basic training attrition.

BODY WEIGHT AND COMPOSITION

Prevalence of Overweight in U.S. Population

The percentage of children and adults who are overweight or obese is a growing problem in the United States. Results from the 1999-2002 National Health and Nutrition Examination Survey (NHANES) show that 65 percent of adults are either overweight or obese as defined by BMI.[1] This figure represents an increase of 16 percent over the prevalence for these two categories in 1988-1994 (NHANES III) and an increase of 38 percent over the prevalence found in 1978-1980 (NHANES II). Overweight and obesity in adults are defined by the Centers for Disease Control and Prevention (CDC) as a BMI between 25 and 29.9 for overweight and a BMI of 30 or greater for obesity (http://www.cdc.gov). These definitions have been endorsed by more than 50 scientific and medical organizations and are used as indicators of increased health risks (National Heart, Lung, and Blood Institute, 1998).

Overweight and obesity have a strong impact on heath, disability, and quality of life. Most recently, however, Flegal et al. (2005) compared the relative risk of underweight, overweight, and obese categories with normal, healthy weight using data from NHANES I, II, and III with follow-up through 2000. They found that adults in all age groups classified as overweight (BMI = 25.5-29.9) had a slightly lower mortality rate than adults in the average range of 18.5 to 25.5, while individuals above 29.9 and below 18.5 were shown to be at greater risk for mortality than those in the average group.

In the youth population, the prevalence of overweight in children ages 6 to 11 and adolescents ages 12 to 19 tripled between 1963 and 1999 (U.S. Department of Health and Human Services, 2001). For these age groups, overweight is determined by sex- and age-specific BMIs that are over the 95th percentile on the CDC growth charts. Trend data provided in the *Handbook of Obesity* (Bray, Bouchard, and James, 2004) and taken from NHANES III show increases for both boys and girls in these age groups from 1963 to 2000. The prevalence of overweight in 2000 was 15.5 percent for adolescent boys and girls, 16 percent for boys ages 6 to 11, and 14.5 percent for girls ages 6 to 11.

[1]BMI is calculated as: (weight in pounds ÷ height in inches^2) x 703 or weight in kilograms ÷ height in meters^2.

Recently, Hedley et al. (2004) published a study of the prevalence of overweight and obesity among children, adolescents, and adults in the United States between 1999 and 2002. Over the entire period (1999-2002), the percentage of children and adolescents (ages 6 to 19) at risk for overweight was 31 percent. Table 5-1 shows the breakdown of risk for overweight in children and adolescents by gender and ethnicity for those above the 85th percentile (at risk for overweight) and 95th percentile (overweight) based on the CDC growth charts. For boys ages 6 to 19, 31.8 percent (± 1.4 percent) were at risk for overweight and 16.8 percent (± 0.8 percent) were overweight; the results for girls show that 30.3 percent (± 1.3 percent) were at risk for overweight and 15.1 percent (± 1.1 percent) were overweight. The highest prevalence of overweight was among Mexican American boys ages 6 to 11 (26.5 percent: ± 2.2 percent) and non-Hispanic black girls ages 12 to 19 (23.6 percent ± 1.8 percent). The prevalence of risk for overweight for these two groups was 43.9 percent and 41.9 percent, respectively, compared with 27 percent for white youth of both genders. A graphic representation of the trends in childhood and adolescent obesity by gender and ethnicity is shown in Figure 5-1. It can be seen that the prevalence of obesity is increasing faster for Mexican American and black children than for their white counterparts. Among boys, the greatest rate of increase is among Mexican American youth ages 12 to 19; among girls, the greatest rate of increase is among black youth ages 12 to 19. These data suggest that Mexican American and black youth are more likely than white youth to qualify for military service on the basis of current BMI standards.

Data from NHANES 1999-2000 and NHANES 2001-2002 showing the distribution of BMI for the general population of youth ages 16 to 24 indicate that 40 percent have BMIs of over 25 and more that 15 percent have BMIs of 30 and over. What are the implications of these findings for military recruiting?

Current Military Standards

Standards for BMI and body fat are determined by each Service. In order to develop a picture of the BMI distribution for first-term recruits, the committee plotted the BMI means and standard deviations found in military personnel basic training studies against the BMI distribution in the youth population, ages 16 to 24. Data that characterize the youth population were obtained from NHANES 1999-2000 and NHANES 2001-2002 and included 1,531 men and 1,611 women. The downloaded files consist of demographic and BMI variables. Percentile ranks for each group were calculated using SUDAAN. Separate racial analyses were conducted to assess the association between BMI and race. The participants were

TABLE 5-1 Prevalence of Risk for Overweight and Overweight in Children by Sex, Age, and Racial/Ethnic Group: United States, 1999-2002

		Prevalence (percentage) (standard error in parentheses)			
		At Risk for Overweight and Overweight (BMI for Age ≥ 85th Percentile)			
Sex	Age	All	Non-Hispanic White	Non-Hispanic Black	Mexican American
Both	6-19	31.0 (1.1)	28.2 (1.6)[a,b]	35.4 (0.9)[b,c]	39.9 (1.3)[a,c]
	2-5	22.6 (1.5)	20.8 (2.0)	23.2 (2.3)	26.3 (2.7)
	6-11	31.2 (1.8)	28.6 (2.6)[b]	33.7 (1.6)	38.9 (2.2)[c]
	12-19	30.9 (1.0)	27.9 (1.5)[a,b]	36.8 (1.3)[c]	40.7 (1.6)[c]
Boys	6-19	31.8 (1.4)	29.2 (2.4)[b]	31.0 (1.3)[b]	42.8 (1.6)[a,c]
	2-5	23.0 (2.3)	21.7 (3.2)	20.9 (2.5)	27.6 (3.1)
	6-11	32.5 (2.3)	29.3 (3.8)[b]	29.7 (2.2)[b]	43.9 (3.0)[a,c]
	12-19	31.2 (1.5)	29.2 (2.3)[b]	32.1 (2.1)[b]	41.9 (1.8)[a,c]
Girls	6-19	30.3 (1.3)	27.0 (1.7)[a,b]	40.1 (1.4)[c]	36.6 (1.8)[c]
	2-5	22.3 (1.8)	20.0 (2.3)	25.6 (3.0)	25.0 (3.8)
	6-11	29.9 (2.1)	27.7 (2.8)	37.9 (2.8)	33.8 (2.6)
	12-19	30.5 (1.3)	26.5 (2.0)[a,b]	41.9 (1.7)[c]	39.3 (2.3)[c]

NOTE: BMI = body mass index, calculated as weight in kilograms divided by square of height in meters. BMI was rounded to the nearest tenth. Pregnant girls were excluded. All racial/ethnic groups included in each category are not shown separately.

stratified into three groups: non-Hispanic white, non-Hispanic black, and Mexican American. Due to small numbers in the "other" category, those participants were excluded from the racial analysis (n = 274). Nine studies report BMI measures for male recruits, and eight studies report BMI measures for female recruits.

The BMIs of male military recruits relative to the U.S. population of youth ages 16 to 24 are presented in Figure 5-2; the BMIs of female recruits are presented in Figure 5-3. The mean BMI for men ranged from the 45th to 65th percentiles, and the standard deviations ranged from the 10th to 80th percentiles. Thus, the BMI of male military recruits were in the lower 80 percent of the distribution, which corresponds to a BMI of 29.2 kg/m^2 or less. For women, the mean BMI ranged from the 20th to 55th percentiles and the standard deviations ranged from the 10th to 65th percentiles. Therefore, female military recruits were in the lower 65 percent of the distribution, which corresponds to a BMI of 26.2 kg/m^2 or less. There were no differences in BMI among the three races for men; for

Overweight (BMI for Age ≥ 95th Percentile)

All	Non-Hispanic White	Non-Hispanic Black	Mexican American
16.0 (0.8)	13.6 (1.1)[a,b]	20.5 (0.8)[c]	22.2 (1.1)[c]
10.3 (1.2)	8.6 (1.5)	8.8 (1.5)	13.1 (2.0)
15.8 (1.1)	13.5 (1.5)[a,b]	19.8 (1.4)[c]	21.8 (1.7)[c]
16.1 (0.8)	13.7 (1.1)[a,b]	21.1 (1.2)[c]	22.5 (1.3)[c]
16.8 (0.8)	14.3 (1.1)[b]	17.9 (1.0)[b]	25.5 (1.3)[a]
9.9 (1.6)	8.2 (1.9)	8.0 (1.8)	14.1 (2.1)
16.9 (1.3)	14.0 (1.5)[b]	17.0 (1.5)[b]	26.5 (2.2)[a,c]
16.7 (0.9)	14.6 (1.3)[b]	18.7 (1.7)	24.7 (1.9)[c]
15.1 (1.1)	12.9 (1.6)[a,b]	23.2 (1.1)[c]	18.5 (1.4)[c]
10.7 (1.5)	9.1 (2.0)	9.6 (1.8)	12.2 (3.4)
14.7 (1.6)	13.1 (2.3)[a]	22.8 (2.5)[c]	17.1 (2.0)
15.4 (1.2)	12.7 (1.8)[a]	23.6 (1.8)[c]	19.9 (1.9)

[a]Significantly different from non-Hispanic blacks at $P < .05$, with Bonferroni adjustment.
[b]Significantly different from Mexican Americans at $P < .05$, with Bonferroni adjustment.
[c]Significantly different from non-Hispanic whites at $P < .05$, with Bonferroni adjustment
SOURCE: Hedley et al. (2004).

women, all racial groups differed. Non-Hispanic white women had a lower mean BMI (24.9 kg/m^2) compared with non-Hispanic black women (27.7 kg/m^2; p = 0.0001) and Mexican American women (26.5 kg/m^2; p = 0.004). Non-Hispanic black women had a higher mean BMI than Mexican Americans (p = 0.04).

Body composition screening in the military is a two-stage process. In the first stage, BMI is used. If the recruit is within the acceptable range, than no further screening for body composition is required. If the recruit is above the standard, then a body fat measurement is applied. The current DoD BMI screening standard ranges between 25 and 27.5; a BMI of 25 is the most stringent screen, and a BMI of 27.5 is the least stringent screen recommended for use by the Services. These standards have been justified on the basis of public health data provided by CDC. If a BMI of 25 is used, approximately 40 percent of both men and women ages 16 to 24 could be at risk of disqualification from military service. It is important to note that youth are not significantly affected by the diseases linked to

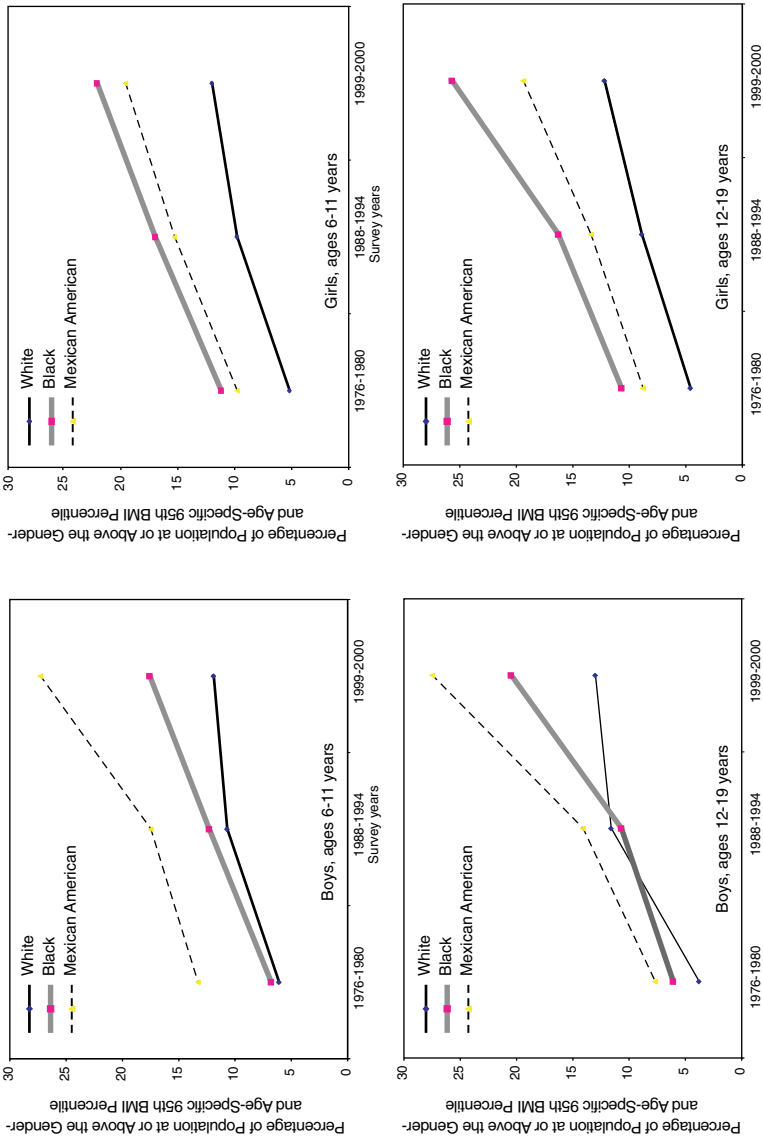


FIGURE 5-1 Trend in obesity prevalence for non-Hispanic white, non-Hispanic black, and Mexican American boys and girls.
SOURCE: Institute of Medicine (2003).

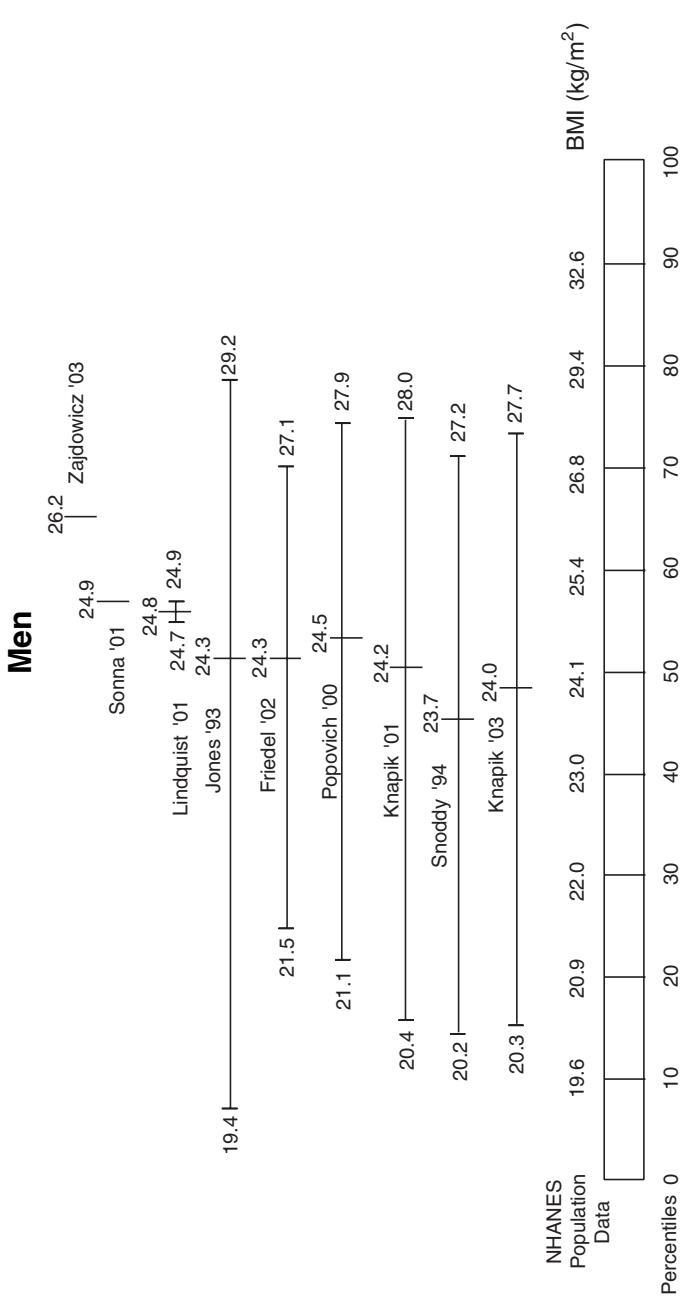


FIGURE 5-2 Body mass index (BMI) in samples of male military personnel relative to the U.S. population.
SOURCE: NHANES (1999-2002).

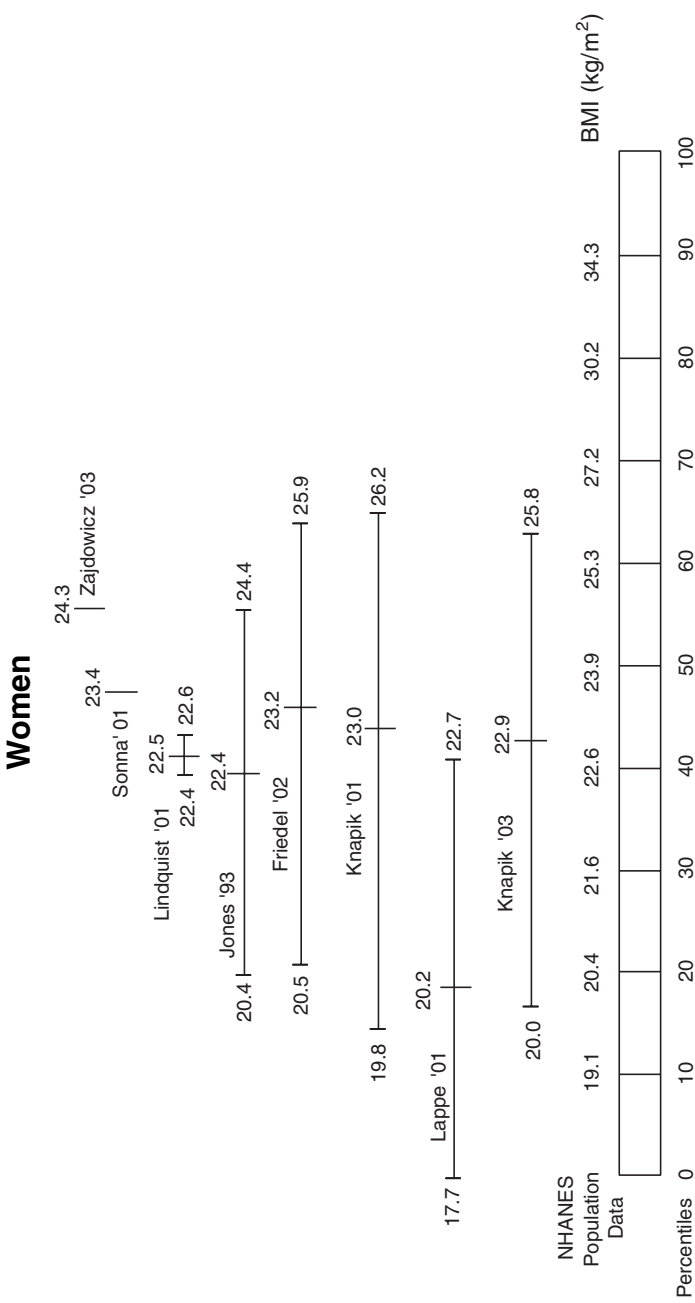


FIGURE 5-3 Body mass index (BMI) in samples of female military personnel relative to the U.S. population.
SOURCE: NHANES (1999-2002).

TABLE 5-2 Maximum Body Mass Index (BMI) for New Recruits and After Entry

		Men		Women	
Service	Age	New Recruit	After Entry	New Recruit	After Entry
Air Force	All ages	27.4-27.5	27.4-27.5	27.5	27.4-27.5
Army	17-20	27.1	25.8	23.5	22.8
	21-27	27.5	26.5	24.1	23.5
Marine Corps	16-20	30.7	27.5	23.6	25.0
	21-24	31.8	27.5	24.1	25.0
	25-30	31.8	27.5		25.0
Navy	All ages	27.5-27.8	27.5	26.6	26.6
DoD		27.5		27.7	

SOURCE: http://www.military.com/Recruiting/Content/0,13898,rec_step07_hw,,00.html (accessed June 2005).

overweight and obesity in adults. One exception is the incidence of type 2 diabetes in certain Native American Tribes. In general, type 2 diabetes, which appears to be on the rise, is found in less than 1 percent of the youth population. However, there have been no definitive studies to date of the U.S. population (American Diabetes Association, 2000).

Each Service has developed its own height and weight tables. The standards currently in use by each Service for new recruits and for retention after entry are shown in Table 5-2. It can be seen that for men, the Marine Corps has the most liberal screen, whereas the other three Services are at or close to the 27.5 recommended by DoD. Both the Army and the Marine Corps have a more liberal standard for male recruits than for retention after entry. Standards for female recruits are the most stringent in the Army and the Marine Corps. Retention standards for women are more stringent than new recruit standards in the Army, whereas retention standards for female Marines are more liberal than they are for new recruits. There is no rationale given for this variability.

As noted above, if a recruit exceeds the BMI screening standard, body fat measures may be taken. There are DoD-recommended body fat measures for men and women that are calculated by formulas that use height and body circumference (DoD Instruction 1308.3, "DoD Physical Fitness and Body Fat Programs Procedures"). For men, body circumference is determined by subtracting the circumference of the neck from the circumference of the abdomen; for women, the body circumference is deter-

mined by adding the waist and hip circumferences and subtracting the neck circumference. The formulas are as follows:

Men: % body fat = $86.010 \times \log_{10}$ (abdomen II – neck) – $70.041 \times \log_{10}$ (height) + 36.76

Women: % body fat = $163.205 \times \log_{10}$ (waist + hip – neck) – $97.684 \times \log_{10}$ (height) – 78.387

Table 5-3 shows the criteria for maximum body fat percentage of men for each Service. As noted in the table, the Navy and the Marine Corps use the DoD procedure described above; however, the Army uses different formulas and, for women, different measurements. The Air Force is currently using only waist circumference. The DoD-recommended standard for men is 26 percent body fat; the Services range from 18 percent (Marines) to 28 percent (Army, ages 25 to 30). For women, the DoD standard is 36 percent body fat; the Services range from 26 percent (Marines) to 33 percent (Navy).

The DoD formulas are based on those developed for the Navy by James Hodgdon in the early 1980s (Hodgdon and Friedl, 1999). As reported by these authors, these equations have been cross-validated in several research studies. Specifically, they were validated against a four-compartment model that included measures of bone mineral content (DXA) and total body water using bioelectric impedance analysis. The results of the cross-validation for men resulted in a correlation coefficient

TABLE 5-3 Criteria for Maximum Body Fat Percentage

		Age		
Service	Formula	17-20	21-24	25-30
DoD	% body fat = $86.010 \times \log_{10}$ (abdomenII circumference – neck circumference) – $70.041 \times \log_{10}$ (height) + 36.76	26%	26%	26%
Navy	Same as DoD	22%	22%	22%
Marine Corps	Same as DoD	18%	18%	18%
Army	% body fat = 76.46 × log (abdomen circumference – neck circumference) – 68.68 × log(height) + 46.89	24%	26%	28%
Air Force	Waist circumference	—	—	—

of r = .88 and a standard error of measurement of 3.15 percent body fat; for women the correlation coefficient was r = .89 and the standard error of measurement was 3.12 percent body fat. It should be noted that the most important predictors are abdomen circumference in men and waist circumference in women. More recently, Leu and Friedl (2002) examined the relationship between the DoD equations and the Army equations. The correlation between the two equations for men was r = .99, for women r = .86. For women, the DoD equation reduced the percentage of Service members classified as overweight or overfat from 17 percent (using the Army equation) to 12 percent. This result is in line with the prevalence for men of 11 percent.

Body Composition, Injury, and Attrition

It is reasonable to consider that body composition may influence military performance. Studies by Pate and colleagues have examined the relationship between fitness and body composition. In one study, correlations were found between cardiorespiratory fitness and body composition (measured by skinfold) on the order of .32 in boys ages 15 and 16 and .26 in girls in the same age group (Pate and Shepard, 1989); in a second large-scale study, an inverse relationship was demonstrated between running speed and body composition in children ages 6 to 18 ranging from –.179 to –.253 for boys and .156 to –.273 for girls (Pate, Slentz, and Katz, 1989).

Higher weight (and fatness) negatively impact endurance performance in two ways: (1) weight appears in the denominator of the VO_2 expression—greater weight is associated with lower weight-relative VO_{2max}; and (2) greater weight increases the energy cost (and required VO_2) associated with any level of activity. Therefore, the percentage of VO_{2max} required by any level of activity is higher in heavier (and fatter) individuals because energy cost is increased and weight-relative VO_{2max} is reduced. Since a measure of endurance fitness is reflective of both physiological fitness and weight status, BMI adds little to a model for predicting injury that includes fitness.

According to studies conducted at Fort Jackson and Fort Leonard Wood in the 1980s and 1990s (Jones et al., 1993b; Jones, 1992), there are no systematic relationships between injury and BMI or injury and body fat in military recruits. In one study, the highest percentage of injuries was found in the low and high BMI quartiles; in another study there was only slight variability across quartiles; and in a third study the injury rates in the top three quartiles were not significantly different from one another (38 to 42 percent). These patterns were similar for men and women, although the injury rates for women were double the rates for men.

To model the effect of changes in the distribution of body mass index on injury and attrition, the committee obtained data on medically attended injuries and first-time attrition from the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). These data were used to make projections about potential future changes in injury and attrition, assuming a variety of hypothetical scenarios for the BMI distribution of the recruit class in years ahead, either as a result of a continuation of the current shift toward higher BMI in the youth population, or as a result of possible changes in the recruitment standards for height and weight.

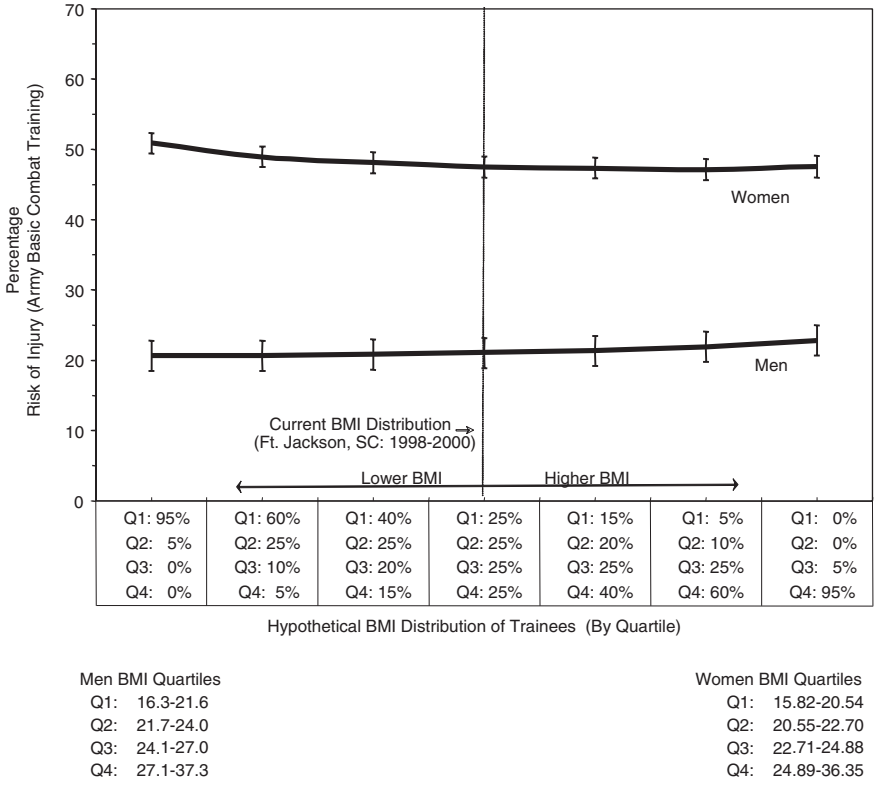
Injury data came from a prospective cohort study of six battalions of male (n = 2,945) and female (n = 2,080) Army trainees during nine weeks of the basic combat training at Fort Jackson, South Carolina, between 1998 and 2000 (Knapik et al., 2001a; Jones, Darkajy, and Knapik, 2004). These data are described in Chapter 4. Demographic characteristics of the recruits used in the BMI/injury analyses are shown in Table 4-5.

To examine injury and attrition risk, USACHPPM initially stratified by quartiles of BMI and run-time performance. Following examination of the data, they combined the middle two quartiles to improve the precision of the estimates of injury attrition risk. Tables 4-6 and 4-7 show the associations of successive levels of BMI and run time with injury and attrition, respectively.

Within categories of fitness, lower BMI recruits tended to have a higher risk of injury for both men and women. However, for the fastest quartile of men, this trend reversed and the higher BMI recruits had a higher risk. Among men, attrition followed a similar pattern to injury. The pattern of female attrition was very different from the pattern of female injury, with the higher BMI women having a higher risk of attrition (within fitness categories). The reasons for these variations need to be better understood, but it is clear that BMI and fitness jointly influence the risk of injury and attrition.

From these data, we projected changes in injury and attrition risk of the recruit population, based on the assumption that the distribution of BMI could shift toward leaner or fatter recruits, either as a result of changes in the U.S. youth population or through future modifications to the current height and weight screening criteria. Figures 5-4 and 5-5 show the results of these projections, which are adjusted for differences in physical fitness (as measured by performance on the entry run test) among BMI groups. However, it is still possible that there are variations in fitness within BMI categories, and these are not accounted for in this analysis.

The results indicate that fluctuations in the BMI distribution have a very limited effect on the overall injury risk (Figure 5-4) provided the current upper bounds for BMI and the current waiver procedures remain largely unaltered. This is also true for attrition among men, however, attrition among women rises as a greater percentage of higher BMI women

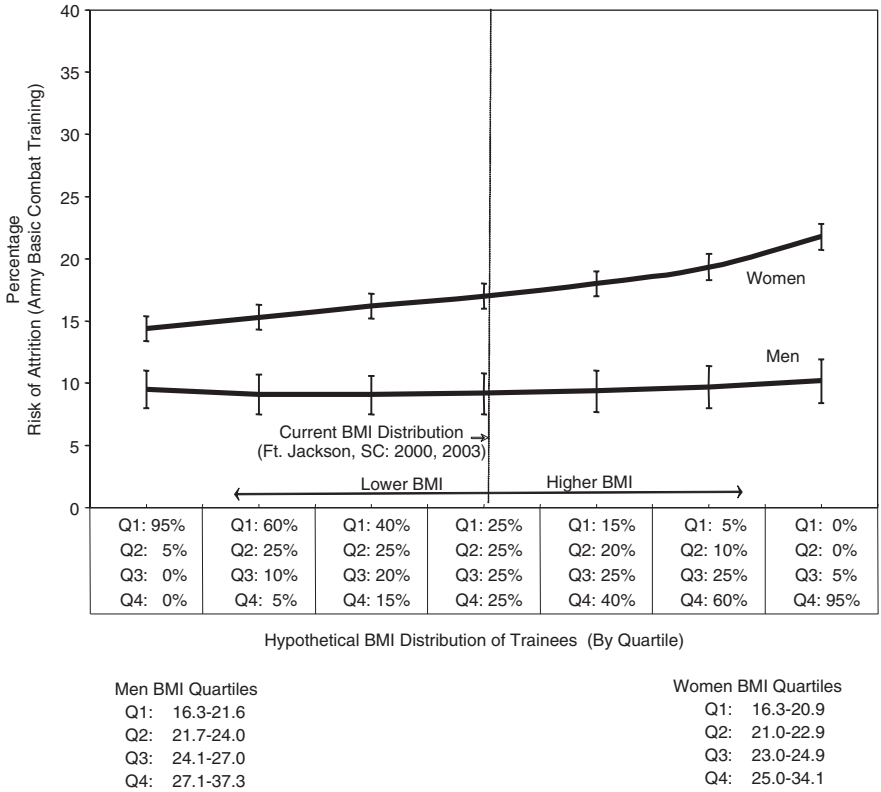


Men BMI Quartiles	
Q1:	16.3-21.6
Q2:	21.7-24.0
Q3:	24.1-27.0
Q4:	27.1-37.3

Women BMI Quartiles	
Q1:	15.82-20.54
Q2:	20.55-22.70
Q3:	22.71-24.88
Q4:	24.89-36.35

FIGURE 5-4 Relationship between risk of injury and body mass index (BMI).
SOURCE: Jones, Knapik, and Darakjy (2004). U.S. Army Center for Health Promotion and Preventive Medicine. Previously unpublished data from samples of male and female trainees at Fort Jackson, South Carolina.

are enlisted (Figure 5-5). Thus, these projections suggest that a shift toward a higher BMI Army would be unlikely to adversely impact injury in men and women, and attrition risk in men, but potentially could increase the attrition risk in women. It should be noted that this conclusion is based on data from those who qualified under the current standard. There are currently no data on the injury and attrition experience of those who are disqualified under current height and weight body fat standards; however, the currently ongoing Assessment of Recruit Motivation and Strength (ARMS) study by the Accessions Medical Standards Analysis and Research Activity (AMSARA) is expected to yield information about the effect of screening in applicants who pass a fitness test but are disqualified on other grounds (Krauss, 2004).



Men BMI Quartiles
Q1: 16.3-21.6
Q2: 21.7-24.0
Q3: 24.1-27.0
Q4: 27.1-37.3

Women BMI Quartiles
Q1: 16.3-20.9
Q2: 21.0-22.9
Q3: 23.0-24.9
Q4: 25.0-34.1

FIGURE 5-5 Relationship between risk of attrition and body mass index (BMI). SOURCE: Jones, Darakjy, and Knapik (2004). U.S. Army Center for Health Promotion and Preventive Medicine. Previously unpublished data from samples of male and female trainees at Fort Jackson, South Carolina.

Body Composition and Military Job Performance

The relationship between body size and composition and the performance of physically demanding military jobs has been discussed by researchers from the U.S Army Research Institute of Environmental Medicine (Harman and Frykman-Scott, 1992; Friedl, 2004). Harman and Frykman-Scott (1992:105) suggest that lifting and carrying are the most common military tasks:

> Typical military lifting tasks include loading artillery shells, lifting supplies onto and removing them from trucks, moving construction equipment, and assembling or disassembling heavy equipment. Most lifts involve raising an object from the ground to between waist and shoulder

height. Carrying is usually associated with lifting. A soldier is generally expected to lift objects weighing as much as 50 kg single-handedly, with heavier objects lifted by more than one individual. In heavy lifting jobs, 85 to 200 pound objects may be lifted and carried up to 200 yards by a single individual. Packs in excess of 100 pounds and other heavy loads may be lifted and carried for several miles.

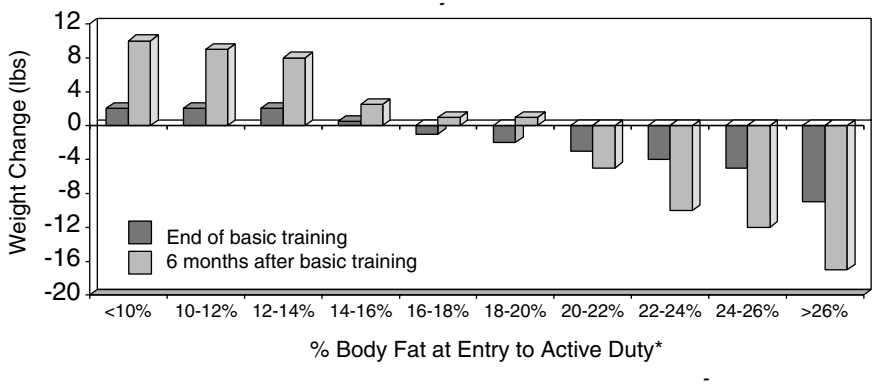
A case is made by Harman and Frykman-Scott that loaded performance tests are the best measures of military task performance and that larger individuals with more lean body mass and more fat mass perform better on these tasks. They found a higher correlation between load carriage performance and lean body mass than between load carriage and percentage of body fat. Based on their results, they conclude that it is more important to screen for lean body mass than for body fat. According to Friedl (2004), today's soldiers are heavier than before, "reflecting both increased muscle and fat components." They are also healthier and more fit than ever before.

Weight Reduction and Maintenance

Each Service provides general guidance on weight management programs, which differ from one installation to another. According to a report on weight management by the Institute of Medicine (2003), the Services have done little with regard to medical and physiological research on weight loss and maintenance, and there is essentially no long-term follow-up beyond six months to evaluate the effectiveness of these programs. Enlisted personnel who exceed weight guidelines are required to participate in weight loss and maintenance programs. Some of the programs have weight loss requirements, and some have behavioral and nutrition counseling.

The Army offers weight control counseling through physical fitness trainers and operates several hospital-based weight loss and weight maintenance programs overseen by physicians (Army Regulation AR 600-9). The Marine Corps program is similar to the Army program and includes diet counseling. The Navy provides a six-month program that is managed by a command-trained physical fitness coordinator and includes mandatory physical exercise. It provides a self-study guide for nutrition and weight control. The Air Force program is centrally controlled and includes behavioral and dietary counseling by medical personnel as well as an exercise program. After the first three months, if weight loss goals are met, the personnel enter a six-month weight management program.

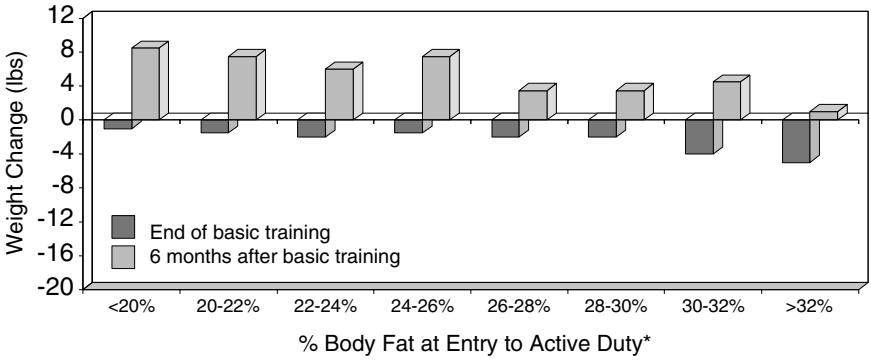
Friedl (2004) measured changes in body weight during basic training and the first six months following basic training for 1,048 male and 816 female recruits according to initial adiposity. Figure 5-6 shows that male



*Retention %BF: 20% - 26%

Male recruits lost body weight during BCT and retained the weight loss up to 6 months post-BCT.

FIGURE 5-6 Changes in weight in male Army recruits.
SOURCE: Committee briefing by the U.S. Army Institute of Environmental Medicine, January 2005.



*Retention %BF: 30% - 36%

Female recruits also lost body weight during BCT but regained the weight loss up to 6 months post-BCT.

FIGURE 5-7 Changes in weight in female Army recruits.
SOURCE: Committee briefing by the U.S. Army Institute of Environmental Medicine, January 2005.

recruits whose body fat measured less than 16 percent gained weight in basic training and continued to gain weight through the first six months while male recruits whose body fat measured 16 to over 26 percent lost weight in basic training and continued to lose weight through the first six months. Figure 5-7 shows the results for female recruits: all lost weight during basic training, regained, and added weight by the end of six months. The weight loss achieved during basic training may be attributed to diet control and vigorous exercise. As noted above, interventions capable of producing systematic weight loss across broad populations over the long term have not been demonstrated to date.

In the civilian sector, the National Heart, Lung, and Blood Institute of the National Institutes of Health has issued *Clinical Guidelines on Identifying, Evaluating, and Treating Overweight and Obesity in Adults* (National Heart, Lung, and Blood Institute, 1998). Evidence concerning the various treatment interventions was identified and evaluated on the strength of the particular treatment to provide efficacy. The evidence supporting various treatments was categorized according to the following (type A providing the strongest evidence): (1) type A—randomized controlled trials in which a large number of studies were performed, (2) type B—randomized controlled trials in which a limited number of studies were performed, (3) type C—nonrandomized trials and observational studies, and (4) type D—panel consensus judgments. The recommendations from this report covered the areas of dietary therapy, physical activity, behavioral therapy, pharmacotherapy, and weight loss surgery.

Reduction in calorie intake was identified as the sine qua non for weight loss. Diet composition under this reduced calorie regimen was not determined to be an important factor, although it was noted that some people perceive certain diet compositions to facilitate "sticking to" an overall reduced calorie diet. Data were not sufficient to define or recommend any particular diet, only to recommend a reduction in total calories. Concerning physical activity, the data showed only a very modest (~ –2 kg) average effect on weight loss. While the guidelines recommend 30 to 45 minutes per day, 3 to 4 days per week of moderate physical activity, the consensus was that physical activity may be adjunctive to a calorie-restricted diet, but alone has little or no effect on obesity.

Some evidence has been found to suggest that some behavioral support can be helpful in encouraging adherence to a calorie restricted diet. Weight loss drugs approved by the Food and Drug Administration were also seen as adjunctive in support of a calorie-restricted diet. And weight loss surgery was endorsed by the National Heart, Lung, and Blood Institute for those with severe intractable obesity.

An Institute of Medicine committee on weight management concluded (2003:111):

Apart from the obvious need to increase energy expenditure relative to intake, none of the strategies that have been proposed to promote weight loss or maintenance of weight loss are universally recognized as having any utility in weight management. The efficacy of individual interventions is poor, and evidence regarding the efficacy of combinations of strategies is sparse, with results varying from one study to another and with the individual. Recent studies that have focused on identifying and studying individuals who have been successful at weight management have identified some common techniques. These include self-monitoring, contact with and support from others, regular physical activity, development of problem-solving skills (to deal with difficult environments and situations), and relapse-prevention/limitation skills. However, an additional factor identified among successful weight managers, and one not generally included in discussing weight-management techniques, is individual readiness that is strong personal motivation to succeed in weight management.

Conclusions and Recommendations

Committee projections based on data provided by the Army suggest that a shift toward a higher BMI force would be unlikely to adversely impact injury and attrition risk in men, but might slightly increase the attrition risk in women. It is important to note that this conclusion is based on data from individuals who qualified under the current standard.

Recommendation 5-1: As BMI is less predictive of injury and attrition than aerobic fitness, we recommend that it not be used as a proxy measure for fitness in the military population.

Recommendation 5-2: As a BMI standard is not justified on the basis of links to injury or attrition, we recommend that such links not be used as the basis for any use of BMI.

Standards for appearance and bearing are issues of military values and thus are outside the committee's charge.

Although a relatively small number of individuals with high motivation and high self-control can lose weight and retain that weight loss through diet and high levels of physical activity, such results are not the norm, and research has not identified programs that have a high likelihood of success for achieving long-term substantial, sustainable weight loss. Given the evidence regarding the difficulties of maintaining weight loss, the committee thinks that it is unrealistic for retention standards to be more stringent than accession standards.

Recommendation 5-3: Any BMI standard used for retention should not be more stringent than a standard used for accession.

ASTHMA

Asthma Trends in the General Population

Asthma is one of the most common chronic illnesses in the United States (Centers for Disease Control and Prevention, 2002). Table 5-4 illustrates that the rate of those who have ever experienced an asthma episode varies between 38 and 43 per 1,000 people in the population. Table 5-5 shows this rate according to age group and gender. The rate is the same in individuals ages 15 to 34 but higher in those under age 15. The rate for non-Hispanic blacks over age 15 is similar but slightly higher when compared with non-Hispanic whites and Hispanics. When reporting episodes experienced in the previous year, blacks report greater frequency (5 percent) than Hispanics (4 percent) (Centers for Disease Control and Prevention, 2004). In the group ages 15 to 34, 4 percent report current asthma symptoms with slightly higher rates during the winter months (7 percent). Women report a higher level of current symptoms (8 percent) than men (6 percent). CDC data from 1980 to the mid-1990s indicate that women were over twice as likely than men to be hospitalized for asthma (Centers for Disease Control and Prevention, 2004).

TABLE 5-4 Rates of Experiencing an Asthma Episode in the Past 12 Months Among Persons of All Ages: United States, 1997-2003

	Rate per 1,000 Population (95% Confidence Interval)	
Year	Crude Estimate	Age-Adjusted[a]
1997	41.8 (39.7-43.8)	41.5 (39.4-43.5)
1998	39.5 (37.4-41.7)	39.3 (37.2-41.5)
1999	38.6 (36.4-40.9)	38.5 (36.2-40.7)
2000	40.0 (37.7-42.2)	39.9 (37.6-42.1)
2001	43.2 (40.8-45.5)	43.1 (40.8-45.4)
2002	42.6 (40.2-44.9)	42.5 (40.2-44.9)
2003	38.7 (36.5-40.9)	38.7 (36.5-41.0)

[a]Estimates are age-adjusted to the 2000 projected U.S. standard population using three age groups: 0-14 years, 15-34 years, and 35 years and over.
SOURCE: Centers for Disease Control and Prevention (2004). Early release of selected estimates based on data from the January-March 2004 National Health Interview Survey (NHIS), Figure 15.1.

TABLE 5-5 Rates of Experiencing an Asthma Episode in the Past 12 Months Among Persons of All Ages, by Age Group and Gender: United States, 2003

Age and Sex	Rate per 1,000 Population	95% Confidence Interval
0-14 years		
Total	54.4	49.2-59.7
Male	63.3	55.2-71.3
Female	45.2	38.0-52.4
15-34 years		
Total	38.6	34.7-42.6
Male	30.4	25.0-35.9
Female	46.9	40.8-52.9
35 years and over		
Total	32.2	29.5-34.9
Male	18.5	15.3-21.7
Female	44.4	40.3-48.5

SOURCE: Centers for Disease Control and Prevention (2004). Early release of selected estimates based on data from the January-March 2004 National Health Interview Survey (NHIS), Figure 15.2.

Figure 5-8 illustrates that 181 out of 10,000 adults made outpatient visits for asthma in 2002. Figures 5-9 and 5-10 show that 24 of 10,000 made asthma emergency department visits and 13 were hospitalized. Figure 5-11 shows that 1.9 adults per 10,000 died from asthma in 2002. In 1996 death rates (rate per 20 million) for asthma in the group ages 15 to 24 are dramatically higher for blacks (20) than whites (.5) (Centers for Disease Control and Prevention, 1996).

Asthma in Military Populations

Complete asthma prevalence data for the military population are not available; however, recruitment data and a few small studies suggest that it is commonly observed among recruits and military personnel. Asthma has been among the top 10 conditions for which waivers are requested. Between May 2003 and April 2004, 3,700 applicants were rejected at one military entrance processing station for medical disqualifiers in the lungs and chest; approximately 38 percent of these sought and received a waiver. An analysis by gender, race, and Service branch shows that a smaller percentage of female enlistees received waivers (29 percent) compared with male enlistees (39 percent); a slightly higher percentage of white enlistees received waivers (40 percent) compared with black enlistees (34 percent); and a slightly lower percentage of Air Force enlistees (30 per-

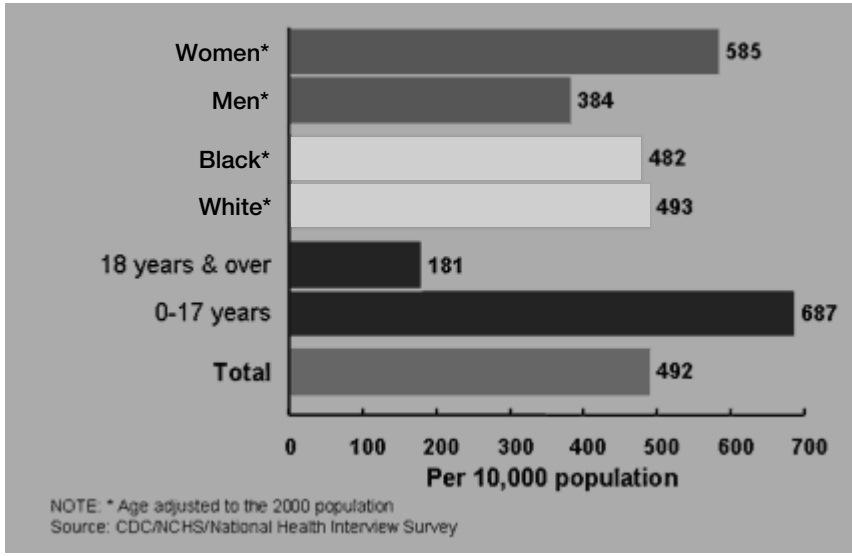


FIGURE 5-8 Asthma outpatient visits, 2002.
SOURCE: Centers for Disease Control and Prevention (2002b).

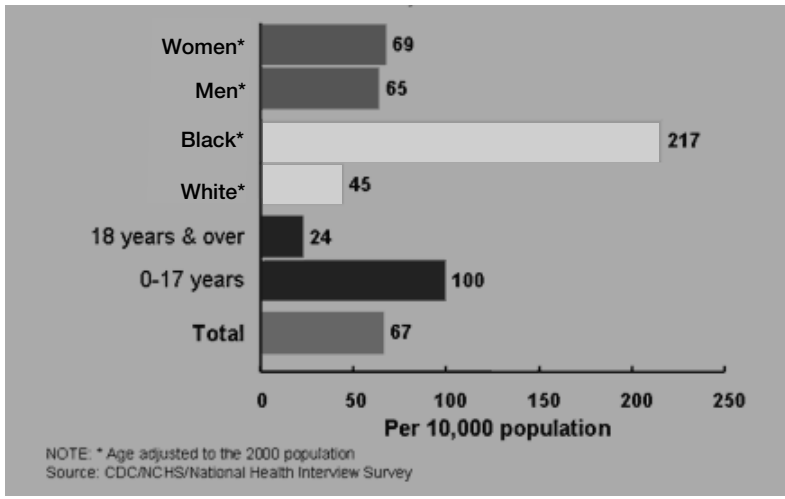


FIGURE 5-9 Asthma emergency department visits, 2002.
SOURCE: Centers for Disease Control and Prevention (2002b).

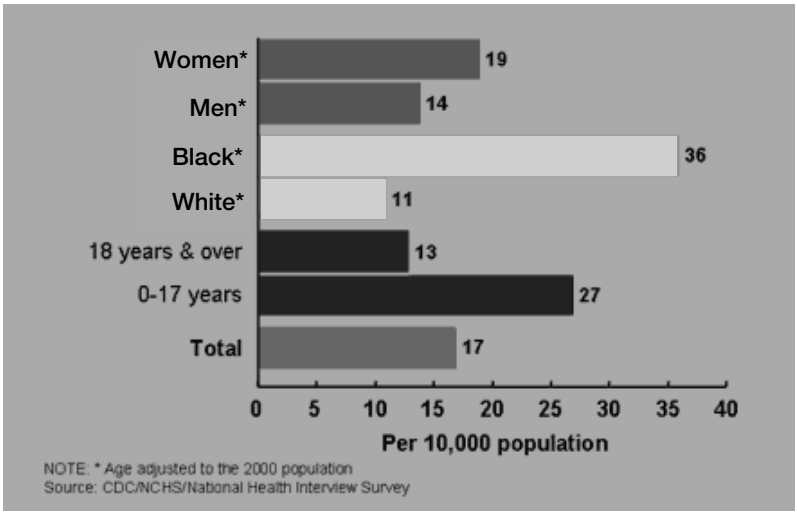


FIGURE 5-10 Asthma hospitalizations, 2002.
SOURCE: Centers for Disease Control and Prevention (2002b).

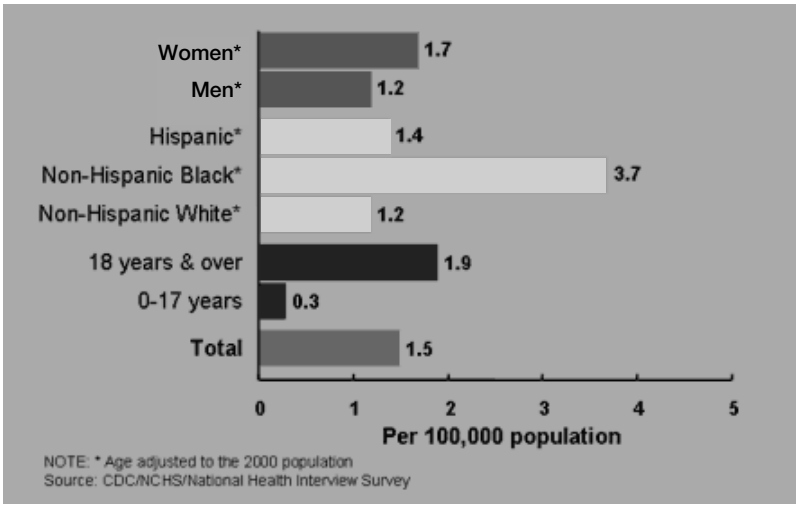


FIGURE 5-11 Asthma deaths, 2002.
SOURCE: Centers for Disease Control and Prevention (2002a).

cent) received waivers compared with the other three Services (see tables in Appendix B). A further breakdown of the lung and chest disqualifiers by International Classification of Diseases (ICD-9) coding shows that over 70 percent of those in the chest and lung area were coded as having some form of asthma. These results were obtained through the committee's analysis of data provided from the U.S. Military Entrance Processing Command Integrated Resource System database.

DoD Instruction 6130.4 on accession health standards states:

> Asthma (493), including reactive airway disease, exercise-induced bronchospasm or asthmatic bronchitis, reliably diagnosed and symptomatic after the 13th birthday is disqualifying. Reliable diagnostic criteria may include any of the following elements: Substantiated history of cough, wheeze, chest tightness and/or dyspnea which persists or recurs over a long period of time, generally more than 12 months.

Recruits can request an asthma waiver and, if granted, can move forward to basic training. Some personnel develop asthma during military service and unless disqualified can continue their duties.

A number of investigations conducted with military personnel contribute to understanding how asthma is evident in this population. For example, Young et al. (2001) sampled active and retired military service personnel (1997-1998) enrolled in TRICARE (a military health care system) and residing in region 11 (includes Washington, Oregon, and northern Idaho) of the United States. They found that being a woman, being younger, engaging in less exercise, and having a higher BMI were all associated with the presence of asthma.

Other studies have looked at participation in military life and activities for people with asthma. The AMSARA active-duty enlistee study followed 313 "existing prior to service" discharges at Fort Jackson. Findings must be considered with caution as the self-administered survey had a low return rate. Data show that 14 percent of total discharges were for asthma. Many more asthmatics (26 to 1) believed that they could not have completed basic training because of their condition. Discharges were eight times more likely to have a history of asthma. Of those with asthma, two-thirds experienced daily or continuous symptoms, and two-thirds had symptoms one night a week or more.

Clark and colleagues (2000) reviewed records of 587 disqualified recruits and found that there was no difference in their attrition compared with the general military population (Clark et al., 2000). Sims and colleagues reviewed 119 Navy disqualification packages for individuals with asthma and found that enlisted personnel and submarine recruits were significantly more likely to be discharged than other types of personnel (Sims, Tibbles, and Jackman, 1999). More blacks were disqualified, and

most disqualifications for mild asthma followed a diagnostic work-up. Krauss (2004) conducted a 5-year study following a cohort of 3,398 active-duty recruits. In a one-year period (2002), just over 5 percent of disqualifications of first-time applicants were for asthma. Those with asthma waivers were more likely to remain on active duty than those without asthma. Of those identified with asthma (17 percent), 70 percent had preenlistment symptoms.

AMSARA data on a cohort followed for five years explored asthma outcomes among Navy recruits and active-duty enlistees who were identified with asthma after enlistment. As part of this effort, Project REMAIN looked at data on the experience of 162 Navy recruits during 9 months (2001) and observed that 66 had asthma. They found that mild asthmatics were more likely to leave active duty soon after diagnosis. Recruits without asthma were more likely than asthmatics to remain in training. However, after training there was no difference in retention rates. Recruits with asthma were 1.4 times more likely to make medical visits. Mild asthmatics were at no additional risk of hospitalization than the general military population.

A REMAIN case control three-year follow-up study was conducted at the Great Lakes Naval Training Center of personnel identified with asthma after enlistment. Findings indicated that 40 percent of mild asthmatics were retained on active duty with no adverse consequences. The greatest frequency of health care use and recruitment loss occurred in basic training. Following training there were no attrition differences between those recruits with or without asthma, although health care costs were higher (relative risk: RR 1.7 for those with asthma). Figure 5-12, using AMSARA accession data (Krauss, 2004), shows that the probability of enlistees in all Services granted a waiver for asthma remaining on active duty was greater over a four-year period than enlistees with no asthma waiver.

Asthma Interventions

Diagnosis and treatment guidelines for asthma have been provided by the National Asthma Education and Prevention Program (National Institutes of Health, 1997). The guidelines discuss interventions that enable individuals with asthma to function more fully and exert optimal control over the disease. Daily use of anti-inflammatory medicine in people with persistent asthma has been associated with reduced symptoms and emergency department use.

Meta-analyses of nonpharmacological interventions for asthma have been conducted. Gibson and colleagues (2002) reviewed self-management

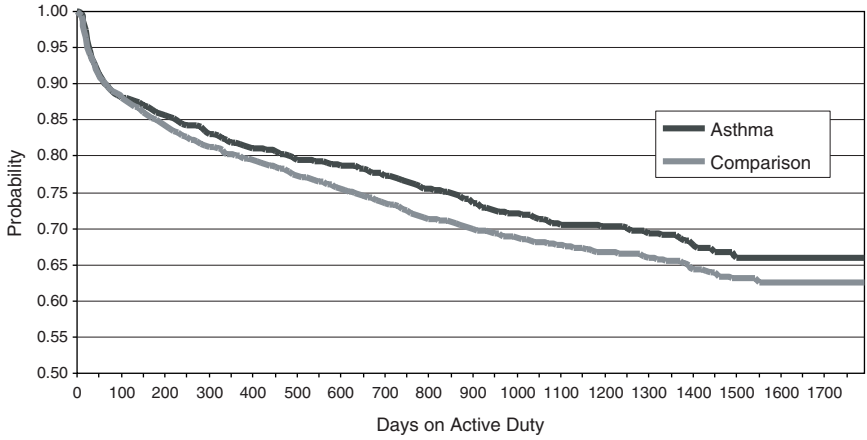


FIGURE 5-12 Probability of remaining on active duty among enlistees granted a waiver for asthma versus matched comparison subjects, all Services.
SOURCE: Krauss (2004).

education studies of adults and found that such interventions improve asthma outcomes. Janson and Roberts (2003) observed that mild asthmatics as well as those with more severe disease can benefit from educational interventions. Both group and individualized self-management programs can produce positive results (Wilson et al., 1993). Use of asthma action plans as part of these programs has been shown to be important to positive results (Gibson et al., 2002). Clark et al. (2000) showed that clinicians can be trained to enhance self-management by patients, and this results in fewer symptoms and less health care use with no more physician time expended. No evaluations of interventions for military personnel are available, however.

Issues for the Military

Asthma is ubiquitous in the general population, affecting about 8 percent of the population, with higher prevalence noted among blacks compared with others and women compared with men. An appreciable number of potential military recruits can therefore be expected to have asthma.

Available data indicate that military personnel with asthma waivers, in fact, have lower attrition rates than those without the condition, although studies show that their health care costs are higher. Some evi-

dence suggests those with asthma discovered after enlistment are more likely to drop out during basic training. A reasonable question is whether or not having asthma should make an individual ineligible for military service. Currently, asthma at any level of severity precludes participation in the military. It is likely that individuals without symptoms for a prolonged period of time or even those with mild and infrequent symptoms could carry out their service requirements, especially if they received optimal medical therapy and self-management education. However, there are costs associated with ensuring timely access of personnel to needed medical therapies and making self-management education available. Furthermore, existing data are not informative regarding whether the conduct of certain military operations is more conducive to problems for those with asthma than others, for example, whether environmental conditions or specific tasks may trigger exacerbations. Nonetheless, in general, available data do not suggest a negative service trajectory after initial training for individuals with asthma compared with those without. Using asthma as an exclusionary factor for military service is likely to work against minorities and women, as these groups exhibit the highest prevalence of asthma.

It may be that the goal-oriented climate of military recruitment discourages disclosure by some individuals who have asthma. Data suggest that those who have the condition but do not initially disclose it may drop out more frequently from basic training, while those who disclose a history of the illness at the time of enlistment and receive a waiver have lower attrition rates. Encouraging disclosure in a benign environment is a desired goal.

CONCLUSION

In light of current data, the existing standard and waiver process regarding asthma is appropriate. Research on the cost-benefit consequences of enlisting individuals with more severe asthma would be needed prior to recommending any change in enlistment policy regarding asthma.

6

Mental Health

A high level of contextual performance is expected in the military (Fiedler, Oltmanss, and Turkheimer, 2004). This contextual performance is related to building and maintaining the military's social and organizational structure (Hogan and Rybicki, 1998). The prototype military personnel is expected to get the job done, volunteer for tasks, get along well with others, obey orders, rules, and procedures, and support the military's objectives (Fiedler, Oltmanss, and Turkheimer, 2004). Emotional stability and conscientiousness are important factors for successful military job performance (Salgado, 1998).

A major component of the success of a mission is the ability of a soldier to adapt to mission stressors (Shigemura and Nomura, 2002). This includes missions for both wartime and peacetime. Psychological adaptation is therefore a critical mental health component for military personnel. Stressors associated with transition from civilian to military life include changes in living arrangements, geographic locations, peer relationships, support systems, schedules, priorities, and control over one's life (McCraw and Bearden, 1990). Separation from family and friends, difficulties in communication with home, and loss of privacy are other common stressors (Orsillo et al., 1998).

Soldiers in wartime missions must deal effectively with the stress and anxiety associated with potential loss of their lives and their fellow soldiers. Peacekeeping missions also have a number of stressors that require psychological adaptation. Stressors associated with peacekeeping missions include isolation, a sense of powerlessness, boredom, coping with the mission's unpredictability, dealing with shifting rules of engagement,

struggling with conflicting personal views, being unable to identify a clear enemy, and questionable lasting impact of the mission (Bartone, Adler, and Vaitkus, 1998; Lundin and Otto, 1996; Henshaw, 1993; Maguen et al., 2004).

This chapter examines the mental health standards currently in place, to characterize the youth population in terms of these standards, and to assess the current system for tracking the progress of enlistees with preexisting mental health conditions during their first term of enlistment. The focus is on such mental conditions as depression and anxiety disorders and their effects on the individual's ability to function in a military context. (An examination of normal personality measures related to job performance is outside the scope of the committee's charge.)

MENTAL HEALTH OF THE YOUTH POPULATION

According to *Mental Health: A Report of the Surgeon General* (U.S. Department of Health and Human Services, 1999), almost 21 percent of children ages 9 to 17 in the United States have a diagnosable mental or addictive disorder associated with at least minimum impairment. The prevalence rate is 11 percent when significant functional impairment is required as part of the diagnostic criteria. This means that a total of 4 million children have a major mental illness resulting in significant impairment at school, at home, and with peers.

In 1991-1992 the National Institute of Mental Health conducted the Methods for the Epidemiology for Child and Adolescent Mental Disorders Survey with a sample of 1,285 youth ages 9 to 17. It found that 11.5 percent met criteria for a psychiatric disorder with moderate impairment: anxiety disorders (7.2 percent), depression (4.2 percent), disruptive behavior disorders (6 percent), and substance use disorder (2 percent) (Shaffer et al., 1996). As is evident from the sum of the individual rates of prevalence, there is substantial psychiatric comorbidity in this population, in particular between anxiety disorders and depression and substance abuse and depression. Demographic features were as follows: female (44.6 percent) and male (55.4 percent), Caucasian or other (64 percent), black (20 percent), and Hispanic (15.7 percent) (Narrow et al., 1998).

Estimates of the prevalence rate of attention deficit hyperactivity disorder (ADHD) among youth range from 7 to 16 percent (Faraone et al., 2003). Prevalence rates in boys have been found to be two to three times higher than for girls (Ford, Goodman, and Meltzer, 2003; Dulcan et al., 1997). Recent evidence demonstrates that childhood ADHD is a predictor for adolescent substance use (Molina and Pelham, 2003). Stimulant therapy for childhood ADHD has been shown to reduce the risk of subsequent adolescent drug and alcohol use disorders (Wilens et al., 2003).

The Youth Risk Behavior Surveillance System (YRBSS), conducted in 2003, was a national school-based survey of 15,214 students in grades 9 to 12. Students were asked about depressive symptoms and suicide during the 12 months preceding the survey. Over a quarter (28.6 percent) of students nationwide reported that they felt so sad or hopeless almost every day for more than two weeks that they stopped doing some usual activities. The prevalence rate was higher among girls (35.5 percent) than boys (22 percent). The prevalence rate was higher among Hispanic (35 percent) than white (26 percent) and black (26.3 percent) students. Combining gender and ethnicity, the prevalence rates were as follows: Hispanic girls (45 percent), white girls (33 percent), black girls (31 percent), Hispanic boys (26 percent), black boys (22 percent), and white boys (19.6 percent). During the 12 months preceding this survey, 17 percent of students reported that they had seriously considered suicide, 8.5 percent of students attempted suicide one or more times, and 3 percent of students made a suicide attempt that resulted in an injury, poisoning, or overdose that required treatment.

Anxiety disorders have a high prevalence rate in youth. The rate of childhood anxiety disorders in a primary care setting has been reported to be 35 percent (Chavira el al., 2004). In a sample of incoming college freshman, 11.8 percent of the students reported experiencing a panic attack during the past year (Valentiner, Mounts, and Deacon, 2004).

Differences in assignment of diagnoses have been found to be based on the ethnicity of the youth. For example, one study reported that blacks were more likely to be assigned a diagnostic code related to abuse or neglect of a child and were less likely to be diagnosed with a mood disorder when compared with non-Hispanic whites. Hispanics were more likely than non-Hispanic whites to be diagnosed with adjustment disorders, anxiety disorders, and psychotic disorders and were less likely to be diagnosed with attention deficit hyperactivity disorder (Yeh et al., 2002).

In summary, a synthesis of these varying prevalence rates suggests that, in the youth population from which the military draws its enlistees, roughly 10 to 15 percent of older adolescents will have at least one criterion-based psychiatric diagnosis that causes a high level of functional impairment (other than attention deficit hyperactivity disorder), with a significant proportion of those suffering from two or more psychiatric disorders.

Psychotropic Medication Use

There has been a substantial increase in the use of psychotropic medications, particularly antidepressants and stimulants, for children and adolescents with psychiatric disorders.

Patterns in the use of psychotropic medication for treatment of 900,000 youths ages 2 to 19 were assessed from the time period 1987-1996 using patient prescription data from Medicaid services and a health maintenance organization (Zito et al., 2003). The total psychotropic medication prevalence for youth increased by 200 to 300 percent during that period of time and included most classes of medication. There was a 4- to 10-fold increase for antidepressants and a 3- to 7-fold increase for stimulants. The 1996 prevalence rate for psychotropic medication in youth ranged from 5.9 to 6.3 percent, with stimulants and antidepressants ranked first and second. The authors concluded that the utilization of psychotropic medication by youth during the 1990s nearly reached adult utilization rates.

The prevalence of the use of psychotropic medications among youths in 1999-2000 ranged from 3.5 to 4.5 percent in the age group 0 to 17. This information was obtained from youth enrolled in a children's insurance program in the mid-Atlantic states (Safer, Zito, and Gardner, 2004).

An estimate of the use of psychotropic medication by 559,769 youth with psychiatric diagnoses in the U.S. Mental Health Service System was conducted in 1997 (Warner, Pottick, and Muckherjee, 2004). Estimates of medication use among youth ages 6 to 12 and ages 13 to 17 were similar (33 and 34 percent, respectively). Boys had significantly higher rates of medication use than girls (35 compared with 28 percent). The diagnoses and percentage treated with medication were as follows: psychotic disorders (66 percent), attention deficit hyperactivity disorder (52 percent), mood disorder (45 percent), anxiety disorder (32 percent), conduct disorder (28 percent), personality disorders (23 percent), developmental and pervasive disorders (20 percent), and adjustment disorder (15.5 percent). Overall, 32.5 percent of youth in the mental health service system were treated with a psychotropic medication.

A retrospective study to assess antidepressant utilization was conducted using outpatient prescription and clinical service records of youths ages 2 to 19 and enrolled in Medicaid and health maintenance organizations during 1988-1999 (Zito et al., 2002). It was found that there was a 3- to 5-fold increase in the prevalence of antidepressant treatment of youth who were younger than 20 years old. The prevalence rate for antidepressant use in youth was 0.6 percent in 1988 and 1.9 percent in 1994. Attention deficit hyperactivity disorder, followed by depression, was the most common diagnosis associated with antidepressant use.

The prevalence rate of the use of antidepressants for youths younger than age 18 was assessed using nationwide data of ambulatory prescription claims for the years 1998-2002 (Delate et al., 2004). The overall prevalence of antidepressant use among children increased from 1.6 percent in 1998 to 2.4 percent in 2002, for an annual adjusted increase of 9.2 percent.

The growth in the overall prevalence of antidepressant use was greater among girls (68 percent) than boys (34 percent).

In summary, among youth populations with a diagnosis of depression, anxiety, or other psychiatric disorder other than attention deficit hyperactivity disorder, roughly one-third to one-half receive psychotropic medication, for an overall rate of 4 to 6 percent of psychotropic drug use among adolescents of an age from which military enlistees are drawn. Of those adolescents with attention deficit hyperactivity disorder, roughly half will be using stimulant medication.

Treatment Services

In the Methods for the Epidemiology for Child and Adolescent Mental Disorders Survey, for youth with a psychiatric disorder, ambulatory services were used by 24 to 45 percent and school-based services were used by 27 to 64 percent. Those who used inpatient services ranged from 2 to 15 percent (Narrow et al., 1998).

Psychiatric hospitalization among youth ages 5 to 18 from 1990-1999 was assessed in a retrospective cross-sectional time trend study using the Washington State Comprehensive Hospital Abstract Reporting System dataset (Garrison et al., 2004). The rate of hospitalization for school-age children (ages 5 to 14) increased by 22 percent during the 1990s (from 8 percent in 1990 to 13 percent in 1999). Among adolescents ages 15 to 19, there was no significant change in the rate of psychiatric hospitalization, but the proportion of hospitalizations due to psychiatric conditions increased from 14.5 percent in 1990 to 21.5 percent in 1999. Mental illness accounted for one-third of all hospital days for youth in 1999 and surpassed injury as the leading cause of hospitalization for youth in Washington State.

Of 3,803 youth ages 2 to 14 in the child welfare system, 48 percent had clinically significant emotional or behavioral problems. However, only one-fourth (11.7 percent) received any specialty mental health care during the 12 months prior to the survey. Outpatient services were used most commonly (15 percent), whereas psychiatric hospitalization was the least commonly used service (3 percent) (Burns et al., 2004).

Ethnicity has been related to receipt of mental health treatment services. Compared with whites, black and Asian teenagers with depression were found to be less likely to seek mental health treatment, especially in the case of males (Sen, 2004).

Socioeconomic factors have been associated with mental health service utilization in youths. Elevated service use for boys compared to girls and for single-parent compared to two-partner households as well as

underuse by blacks and Hispanic groups have been reported (Zahner and Daskalakis, 1997).

In summary, of those adolescents with a psychiatric disorder, roughly 5 to 10 percent will have received inpatient treatment services.

When the above studies of prevalence, psychotropic medication use, and hospitalization are synthesized, the following picture emerges. Of a population of 10,000 older adolescents from which the military draws its enlistees, roughly 2,500 will experience symptoms of a psychiatric disorder other than attention deficit hyperactivity disorder, of whom roughly 1,000 to 1,200 will suffer severe functional impairment from their psychiatric disorder. Of these, roughly 400 to 600 will be prescribed psychotropic medication, and 20 to 60 will be hospitalized as part of their treatment program. Of the same 10,000 adolescents, roughly 800 will have attempted suicide and 300 will have made a serious suicide attempt. Also, of the same 10,000 adolescents, roughly 750 to 1,500 will be diagnosed with attention deficit hyperactivity disorder, and, of those, about 250 to 500 will be receiving treatment with stimulant or antidepressant medication.

MENTAL HEALTH OF THE MILITARY POPULATION

Lifetime prevalence rates of mental disorders were determined for the total active-duty U.S. Army population from 2000 using a logistic regression projection (Messer et al., 2004). This method was used because no observations were available and sociodemographic differences were prominent. The predicted prevalence rates for the Army population were as follows: any mental disorder (37.5 percent), depressive disorders (6 percent), anxiety disorders (16.6 percent), antisocial personality disorder (8.3 percent), and schizophrenia (1 percent).

Mental disorders among U.S. military personnel were investigated using an analysis of hospitalizations among all active-duty military personnel from 1990 to 1999 and ambulatory visits from 1996 to 1999 (Hoge et al., 2002). The category of mental disorders was the leading discharge diagnosis among men and second leading diagnosis among women. Mental disorders accounted for 13 percent of all hospitalizations and 23 percent of all inpatient bed days. A total of 47 percent of individuals hospitalized for the first time for a mental disorder left military service within six months. The rate of attrition was significantly higher than the 12 percent rate of attrition after hospitalization for other disease categories. In 1998 and 1999, 6 percent of the military population received ambulatory mental health services. The researchers concluded that mental disorders are the most important source of medical and occupational morbidity among active-duty U.S. military personnel.

A cohort of U.S. Army soldiers first psychiatrically hospitalized in 1998 was followed up for two years (Hoge et al., 2005). The attrition rate within six months following a hospitalization for mental disorder was 45 percent compared with 11 percent for other medical illnesses. A secondary mental health diagnosis also increased the risk of attrition to 27 percent at six months.

Mental health–related separations for Air Force basic military trainees were assessed for the year 2001: 4.2 percent of separations were attributable to mental health disorders, with adjustment disorders and depressive disorders being the top diagnostic categories (Englert, Hunter, and Sweeney, 2003).

In the 2000 annual report, AMSARA described a five-year, retrospective cohort study of the relationship between waivers for mental health and attrition during the first two years of service. This study compared 502 first-time enlistees across the Services who were granted waivers for depression with a matched group of 1,501 recruits who were qualified on all physical, medical, and mental criteria. The overall results show that recruits with mental health waivers are significantly less likely to remain in military service than those in the comparison group; the probability of retention was .62 versus .72 at the two-year mark. Specific analyses by Service and gender were also performed. For men in the Marine Corps, the retention rate for those with waivers was significant lower; for men in the Navy, it was marginally lower; and for men in the Army, there were no significant differences between the two groups. For woman in the Army, the retention rate was significantly lower for those with waivers, whereas for women in the Navy, no significant differences were found.

The mental health effects of exposure to combat duty in Iraq or Afghanistan for U.S. combat infantry units (three Army units and one Marine Corps unit) were investigated by Hoge et al. (2004). In these groups, exposure to combat was significantly greater among those deployed to Iraq than those deployed to Afghanistan. After duty in Iraq, 15.6 to 17 percent of the military personnel met screening criteria for major depression, generalized anxiety, or posttraumatic stress disorder compared with 9.3 percent before deployment to Iraq. After duty in Afghanistan, 11.2 percent met criteria for these disorders. Posttraumatic stress disorder accounted for the largest difference in the pre- and postdeployment rates. Importantly, only 23 to 40 percent of these military personnel sought mental health care. Concern about stigmatization as well as other barriers (e.g., difficulty scheduling an appointment, difficulty getting time off from work, transportation problems) were cited by military personal as reasons for not seeking mental health care.

These data are less complete than those for the general adolescent population described above, so there is considerably greater difficulty in

building a complete picture of prevalence, treatment, and consequences of mental illness in military populations. In general, of 10,000 active-duty military personnel, perhaps 3,000 to 3,500 will experience some form of mental illness or psychiatric symptoms during their military career, with roughly similar short-term risk in the period following deployment to combat duty, such as in Iraq or Afghanistan. Of these, perhaps only 750 to 1,400 will seek care for their mental illness, which is similar to the roughly 600 such personnel who seek mental illness care in general in any single year. Mental disorders are the leading cause of medical and occupational morbidity, hospitalization, and separation for a medical reason, but population-based risk and prevalence data for such outcomes are not available.

MILITARY STANDARDS

In 2005 the Department of Defense (DoD) revised the list of mental health disorders that are causes for rejection for appointment, enlistment, or induction into military service. The disorders included are categorized as learning, psychiatric, and behavioral (E1.25):

- For learning disorders and attention deficit hyperactivity disorder, the criteria have been changed to allow eligibility for individuals who can demonstrate passing academic performance without the use of academic or work accommodations or medications in the previous 12 months.
- Any individual with current or a history of psychotic disorders, such as schizophrenia, paranoid disorder, or other unspecified psychosis, is disqualified.
- Current mood disorders, such as major depression, bipolar disorder, or depressive disorder not otherwise specified, are disqualifying. In addition, a history of mood disorders requiring outpatient care for longer than six months by a physician or other mental health professional, or inpatient treatment in a hospital or residential facility, is disqualifying. A history of symptoms consistent with a mood disorder of repeated nature that impairs school, social, or work efficiency is also disqualifying.
- Current or a history of anxiety disorders, including panic disorder, agoraphobia, social phobia, simple phobias, obsessive-compulsive disorder, acute reactions to stress, and posttraumatic disorder are disqualifying conditions.
- Any individual with current or a history of adjustment disorder within the previous three months is disqualified.
- A history of suicidal behavior, including gesture or attempts or a history of self-mutilation, is disqualifying.
- Current or a history of conduct or behavioral disorders is disqualifying due to concerns about the ability to adapt to military service.

- Current or a history of personality disorders is disqualifying because of concern that immaturity, instability, personality inadequacy, impulsiveness, or dependency will interfere with adjustment to military service.
- Current or a history of dissociative disorders, including hysteria and depersonalization, as well as current or a history of a somatoform disorder, such as hypochondriasis or chronic pain disorder, are disqualifying conditions.
- Individuals with current receptive or expressive language disorder that interferes with the production of speech or ability to repeat commands are disqualified.
- Any individual with current or a history of psychosexual conditions, such as transsexualism, exhibitionism, transvestism, voyeurism or other paraphilias, are disqualified.

Age cutoffs are used for some standards. After the 13th birthday, if an individual has enuresis, encopresis, or sleepwalking, then he or she is disqualified. Similarly, eating disorders, including anorexia nervosa and bulimia, occurring after the 13th birthday and lasting longer than three months are disqualifying conditions.

A single item on the medical prescreen form, which is completed at the recruiting station, is related to psychiatric disorders (Item 16). The item is worded "seen a psychiatrist, psychologist, counselor or other professional for any reason (inpatient or outpatient) including counseling or treatment for school, adjustment, family, marriage or any other problem to include depression, or treatment for alcohol, drug or substance abuse."

If an applicant responds "yes" to Item 16, he or she is requested to explain the affirmative response. All documentation relating to an affirmative response is sent directly from the treating clinician or hospital to the military entrance processing station (MEPS) chief medical officer. If an applicant has been diagnosed or treated since age 12 for attention deficit disorder or attention deficit hyperactivity disorder, academic skills or perceptual deficit, or has an individual education plan, the recruiter is instructed to contact the MEPS for additional instruction.

At the military entrance processing station, recruits complete a medical history questionnaire. A history of treatment for a mental condition depends solely on self-report. Although recruits undergo a medical evaluation, there is no formal psychiatric assessment.

DATA AVAILABILITY

As noted in Chapter 3 there is a paucity of available data on health and medical conditions in military databases. In some cases data are not

entered into the system; in other cases, data accessibility is limited due to privacy concern; and in still other cases, relevant data on conditions and outcomes are not linked.

As for all other categories of health and medical conditions, data on the number and percentage of applicants who are screened out at the recruiting stations for mental health reasons are not collected. Data on the number and percentage of medical prescreens identified with mental health issues (positive response to Item 16 on the medical prescreen form) that are forwarded to the MEPS are also not collected.

The committee obtained data from the MEPCOM Integrated Resource System (MIRS) for medical failures and waivers from May 1, 2003, to April 30, 2005, in all active forces. Of 429,116 total applicants, 4,303 failed for psychiatric reasons (Code 40), or 6.1 percent of all failures. Of the 4,303 failures, 1,468 were granted a waiver (34 percent). Using standardized medical billing and diagnostic codes (International Classification of Diseases [ICD]), the 4,303 psychiatric failures are divided among roughly 50 diagnoses, of which roughly 25 percent are attention deficit and hyperactivity disorder and related problems, 15 percent are drug and alcohol abuse and related disorders, and the remainder are categorized among a wide range of mood and anxiety disorders (see tables in Appendix B).

The number and percentage of recruits per year who leave the military during basic or advanced training due to all psychiatric conditions are available, but not for specific diagnoses or mental illness conditions. The number and percentage of recruits with mental health waivers who leave during basic or advanced training are believed to be available by linking existing databases, but this information is not generally sought nor used by the military, not routinely monitored for patterns or trends, and not routinely available. The number and percentage of applicants with mental health waivers who receive mental health care in basic or advanced training could possibly be determined through detailed review of individual medical charts and personnel databases, but for obvious reasons this approach has some significant cost implications, as well as raising the issue of privacy concerns. Similarly, no data are available about the attrition of recruits who have received outpatient mental health care, but these data could also be developed with appropriate direction and financial support.

The 2003 Annual Report of the Accessions Medical Standards Analysis and Research Activity makes limited data available about mental health disqualifications, waivers, hospitalization, and "existing prior to service" discharges:

- Mental health disqualifications: In 2002, the mental health conditions for which medical disqualifications occurred at the MEPS were

coded: neurotic disorders (1.4 percent, N = 918 people) and depressive disorders (0.4 percent, N = 271 people).

- Waivers at MEPS: Data are available for the top 10 DoD diagnoses of waivers considered and granted for active-duty enlisted applicants in 1997-2001 and 2002 for the Army, Navy, Marines, and Air Force. Diagnoses of physiological malfunction arising from mental factors; neurotic, mood, somatoform, dissociative or factious disorders; attention deficit hyperactivity disorder; and major depression accounted for the mental health disorders that resulted in granting of a waiver (see Table 6-1).
- Hospitalization: Hospitalization data are available for Army active enlistees for the period 1997-2002. The category of neurotic and personality disorders and the category of other psychoses accounted for all mental health hospitalizations (see Table 6-2).
- Existing prior to service discharges: Existing prior to service (EPTS) discharges of enlistees occur < 180 or fewer days after beginning military service. Data on EPTS discharges for active-duty enlistees are available for the period 1997-2002. Psychiatric conditions were the most common cause of EPTS discharges reported for the Navy and the Marines (47 and 36 percent, respectively) and the second leading cause of discharge in the Army (15 percent) (see Table 6-3). In 2001, according to data from the Army, the Marines, and the Navy, there were 207 EPTS discharges for depression. No Air Force records were reviewed because of a policy of administratively discharging recruits with mental illness. The percentage of EPTS discharge/accessions were as follows: Marines 0.22; Army 0.16; Navy 0.08; total 0.15.

A study conducted at Fort Leonard Wood, Missouri, from September 2002 to March 2003 found that reliance on EPTS coding alone underestimated the number of mental health conditions that contributed to discharge. Psychiatric conditions were also coded under non-EPTS codes (i.e., other mental and physical conditions and entry-level separation).

CURRENT SCREENING PROCESS

Psychiatric Exclusion Criteria

There is increased recognition of depression in children and a concomitant increase in the use of mental health treatment for this disorder in youth. The typical duration of treatment is approximately one year for a single episode of depression. The current DoD fitness standards exclude any individual who has a history of a mood disorder for which outpatient treatment has been rendered for longer than six months by a physician or mental health professional. In effect, that criterion eliminates any appli-

TABLE 6-1 Waivers Granted for Active-Duty Applicants for the Four Services

			1997-2001				2002				
			Applied		Granted		Applied		Granted		
Service	Code[a]	Definition	Count	%	Count	%	Count	%	Count	%	Rank
Army	306	Physiological malfunction arising from mental factors	845	2.2	844	2.9	352	2.4	350	4.0	7
	314	Attention deficit hyperactivity disorder	510	1.3	402	1.4	325	2.3	279	3.2	9
Navy	733	Physiological malfunction arising from mental factors	969	3.8	696	4.9	314	6.3	210	9.2	8
	300	Neurotic, mood, somatoform, dissociative or factitious disorders	723	2.8	361	2.6	104	2.1	17	0.8	9
Marines	733	Physiological malfunction arising from mental factors	607	4.0	455	5.2	153	5.0	114	8.9	8
	300	Neurotic, mood, somatoform, dissociative or factitious disorders	424	2.8	235	2.7	126	4.2	52	4.1	9
	314	Attention deficit hyperactivity disorder	373	2.5	263	3.0	158	5.2	100	7.8	10
Air Force	314	Attention deficit hyperactivity disorder	402	4.1	304	7.3	127	4.6	91	6.1	5
	296	Major depressive disorder	288	2.9	117	2.8	47	1.7	29	2.0	8

[a]ICD-9 code for Army applicants; DoD code for all others.

TABLE 6-2 Hospitalization Rate for Active-Duty Personnel (Army)

Category	1997-2001	2002	Rank
Neurotic and personality disorders	8.53	8.51	3
Other psychoses	3.21	3.60	6

TABLE 6-3 Existing Prior to Service Discharges of Enlistees, 1997-2002

	Army		Navy		Marines		Air Force	
Category	Count	%	Count	%	Count	%	Count	%
Psychiatric-other	2,986	14.8	7,629	46.6	2,649	36.2	92	2.2
Schizophrenia	37	0.2	43	0.3	11	0.2	1	0.0

SOURCE: Accession Medical Standards Analyses and Research Activity (2003).

cant who has ever received treatment for a mood disorder in the past. For example, if a nine-year-old received treatment for depression during fourth grade and had no further episodes of depression, he or she would be disqualified from military service.

Consideration should be given to altering this disqualifying criterion because (1) there will be increasing numbers of applicants who have received treatment for depressive disorders and (2) there is no evidence base to support exclusion of individuals who have received outpatient care for longer than 6 months. A more reasonable approach would be to use an age cutoff, similar to that used for eating disorders, such as disqualification if a mood disorder occurs after the 13th birthday.

As is the case for depression, there is increased recognition of the early age of onset of anxiety disorders. The DoD fitness standards exclude any individual who has a history of anxiety disorders. For example, an individual with separation anxiety disorder at age six who refused to go to school because he wanted to stay home with his mother would therefore be disqualified from serving in the military. Given the high prevalence of anxiety disorders in youth and the lack of scientific rationale for the exclusion of an individual with a history of anxiety disorders, consideration should be given to altering this disqualifying criterion. An age cutoff for occurrence or treatment of these disorders may be appropriate, such as disqualification if the disorder occurs after the 13th birthday.

Medical Prescreen of Medical History Report

Unlike most other items on the medical prescreen, which lists specific disorders, the one item that is related to mental health is a treatment item. The item is very broad and includes any psychiatric disorder or mental health concern and any treatment. Because this item is so broad and sweeping, disorders that would be of more concern regarding enlistment in the military service have equal weight with minor mental health issues. The medical prescreen should include mental health items of clinical importance, which can be explained more fully as noted in the instructions in Item 2B if the applicant responds affirmatively. Potential prescreen items include a history of suicide attempts, depression, bipolar disorder (manic depressive illness), anxiety disorder, attention deficit hyperactivity disorder requiring medication treatment within the past year, schizophrenia and psychotic conditions, and psychiatric hospitalization.

DoD has issued a small business innovative research request for proposals to develop a screening test for detection of major psychiatric disorders in young adults. The aim is to develop a reliable screening instrument to identify individuals at risk of having a mental health problem prior to entering the military. However, there is significant controversy about the utility and value of mass screening for mental health conditions in the military. Rona and colleagues (Rona, Hyams, and Wessely, 2005) emphasize the need for caution, citing the lack of acceptability of screening instruments, obstacles to confidentiality, questionable validity of available instruments, potential to cause more harm than benefit, and diversion of resources from more effective mental health care programs. On the basis of a literature review relating to World Wars I and II, Jones, Hyams, and Wessely (2003) concluded that screening programs did not succeed in reducing the incidence of mental health problems.

Medical Evaluation

In addition to a medical history form, it would be reasonable to have recruits complete a brief questionnaire regarding current symptoms of mental disorders, which could subsequently be reviewed by the medical officer at the MEPS. The Primary Care Evaluation of Mental Disorders (PRIME-MD) Patient Health Questionnaire (PHQ) is a self-administered instrument that has high sensitivity (75 percent) and specificity (90 percent) (Spitzer et al., 1999). The questionnaire includes items related to depression, anxiety, and somatic symptoms and alcohol abuse. It takes approximately three minutes for a physician to review it. This screening questionnaire or others selected should be studied specifically in military populations with regard to performance characteristics.

The current medical evaluation does not include a formal psychiatric assessment. The medical evaluation provides an opportunity to identify in person individuals who have psychiatric disorders that may adversely affect their performance in the military or lead to attrition or discharge. A brief standardized mental status examination that would address mood, anxiety, psychotic symptoms, and suicide would be important to include as a routine component of the medical evaluation. The addition of this examination has the potential to identify individuals who did not reveal a preexisting condition on the screening forms either through conscious omission or lack of awareness.

CONCLUSIONS AND RECOMMENDATIONS

Disqualifying Criterion

The current DoD fitness standards exclude any individual who has a history of a mood disorder for which outpatient treatment has been rendered for longer than six months by a physician or mental health professional. Consideration should be given to altering the disqualifying criterion for depression because (1) there will be increasing numbers of applicants who have received treatment for depressive disorders and (2) there is no evidence base to support exclusion of individuals who have received outpatient care for longer than six months.

As is the case for depression, there is increased recognition of the early age of onset of anxiety disorders. The DoD fitness standards exclude any individuals who have a history of anxiety disorders. Given the high prevalence of anxiety disorders in youth and the lack of scientific rationale for the exclusion of an individual with a history of anxiety disorders, consideration should be given to altering this disqualifying criterion. The committee's determination of a reasonable cutoff was based on clinical evidence from the civilian youth population. For an adolescent, it takes one to two years to recover from an episode of major depression (Emslie, Mayes, and Ruberu, 2005). Following discontinuation of medication, the period of relapse is greatest during the first year of medication withdrawal. Because relapse rates are high in adolescents, a medication-free period of two years (e.g., ages 16-17) would allow time to assess the clinical response. A cutoff for disqualification of the 13th birthday is a conservative stance designed to decrease the likelihood of a recurrent episode of depression during combat duty. A similar clinical logic applies to anxiety disorders.

Recommendation 6-1: We recommend that disqualification for mood and anxiety disorders should occur only if disorders occur after the

applicant's 13th birthday. We recognize that the imprecision with which age cutoffs can accurately predict the likelihood of performance problems due to mental illness suggests that waivers may be commonly requested, and frequently granted, for illness occurring after age 13. However, using the 13th birthday as a cutoff allows sufficient time for clinical follow-up of a diagnosed mood or anxiety disorder to identify potential recruits with a risk of recurrence

Mental Health Screening

There is a single item on the self-report medical prescreen form completed at the recruiting station that is related to psychiatric disorders. Applicants are asked whether they have "seen a psychiatrist, psychologist, counselor or other professional for any reason (inpatient or outpatient) including counseling or treatment for school, adjustment, family, marriage or any other problem to include depression, or treatment for alcohol, drug or substance abuse." Applicants responding "yes" are requested to explain the affirmative response, and all documentation relating to an affirmative response is to be sent directly from the treating clinician or hospital to the MEPS chief medical officer.

The committee concludes that the single item (2.a.(16), DD Form 2807-2) addressing psychiatric disorders on the medical prescreen form does not contain sufficient specificity for research and evaluation purposes.

Recommendation 6-2: Specific mental health disorders should be included on the medical prescreen report form. Recommended items include depression after the age of 13, bipolar disorder (manic depressive illness) after the age of 13, anxiety disorders after the age of 13, exposure to trauma, attention deficit hyperactivity disorder with medication treatment in the past year, schizophrenia and psychotic disorders, and hospitalization for mental illness care. A positive response to this screening question would require open-ended amplification regarding the specific diagnosis.

At the MEPS, the available information about the history of treatment for a mental condition depends solely on self-report. The committee concludes that the history questionnaire can usefully be augmented with a short set of questions regarding current symptoms and that a brief standardized mental status examination that addresses mood, anxiety, psychotic symptoms, and suicide would be important to include as a routine component of the medical evaluation.

Recommendation 6-3: A brief self-report questionnaire regarding current symptoms of mental health conditions should be administrated at the MEPS.

Recommendation 6-4: A brief mental status examination should be conducted by the medical officer at the MEPS.

There is minimal systematic data collected by the Services regarding individuals with mental health conditions. The prevalence and impact of specific mental health conditions on military performance or attrition rates require further careful study. Mental illness is often coded in vague terms (e.g., adjustment disorder) or is handled administratively without attaching a diagnostic category.

Some elements of a complete database describing the impact of mental illness on military personnel exist, and the committee has reason to think that other data elements could be developed through appropriate linkage of existing databases.

Recommendation 6-5: Data about mental health disorders from recruitment through active duty should be collected and maintained so that informed decisions can be made regarding recruitment and retention of applicants with mental illness. These data should be obtained for all the Services and should create an accurate picture of the impact of mental illness on military personnel from recruitment through separation, with a particular focus on the outcome of recruits who request and receive mental illness waivers for specific diagnoses, as well as the rates and diagnoses leading to attrition during training and active duty. Further studies using complete data sets should be designed to determine whether there are any differences in retention and performance between recruits with and without a history of psychiatric disorders, such as depression and anxiety disorders.

7

Substance Abuse and Cigarette Use

This chapter discusses enlistment standards and related issues in the general areas of substance use and abuse, specifically alcohol, drugs, and cigarettes. While there are specific enlistment standards that relate to alcohol and drug abuse, currently there are no enlistment standards with respect to smoking cigarettes. There has been considerable interest, however, in whether smoking impacts military effectiveness, and both the Army and the Navy have undertaken longitudinal studies to examine (among other things) the effect of cigarette smoking on attrition and other outcomes. Some studies suggest that preservice smoking is related to behavioral issues that correlate with injury and attrition.

The chapter has two sections, one for alcohol and drug abuse and one for cigarette use.

ALCOHOL AND DRUG ABUSE

Current Requirements and Enlistment Standards

The general U.S. Department of Defense (DoD) requirements relating to alcohol and drug abuse are set forth in DoD Directive 1304.26 under "Moral Character." The DoD standard is quite general, stating only that individuals should be disqualified "who have exhibited antisocial behavior or other traits of character that would render them unfit to associate with military personnel." Military leaders generally agree that individual performance and unit morale would suffer greatly if individuals were allowed to be drunk or be high on drugs while on duty.

As with most moral character standards, the specific standards for alcohol and drug abuse are set by each Service, although there are some broad similarities across them. Generally, a history of more severe types of alcohol and drug abuse or dependence is disqualifying, but limited "recreational" use of marijuana does not now require a waiver. Prior to 1990, even limited use of marijuana required a waiver, but that waiver requirement was phased out by the Services during the early 1990s. Alcohol use does not require a waiver unless the recruit tests positive at the physical.

Between these two extremes, the Services distinguish several degrees of severity of drug and alcohol abuse, and there are some important differences among the branches. The specific standards for each level of severity are summarized in Table 7-1. The table shows that drug trafficking, the most severe abuse, is disqualifying for all Services, and alcohol dependence is disqualifying for all Services except the Navy (which requires a waiver if no longer dependent). All Services also agree that limited or recreational use of marijuana use does not require a waiver.

If an applicant has a positive test for drugs other than marijuana during the physical, the Air Force will disqualify but the other three Services will issue a waiver if the applicant reapplies one year later and the retest is negative. The Army, Navy, and Marine Corps will issue a waiver for a positive test for marijuana or alcohol if a retest is negative six months after the original positive test. The Air Force is more stringent and, in fact, a positive test for marijuana is disqualifying. The Air Force will issue a waiver for a positive alcohol test if the recruit gets treatment and is alcohol-free for two years.

Limited preservice use of drugs other than marijuana and alcohol has the most diverse standards. The Army does not require a waiver, while the Marine Corps will issue a waiver after the applicant fills out a drug abuse screening form. The Air Force will issue a waiver for nonnarcotics, such as amphetamines and barbiturates, but narcotics are disqualifying. Finally, the Navy also distinguishes between nonnarcotic and narcotic drugs. In the case of nonnarcotics, the Navy does not require a waiver if the use was more than one year prior to screening, but narcotics use requires a waiver if use was over one year prior. Use within the past six months is disqualifying.

Youth Characteristics and Supply Issues

Trends in Substance Abuse

Current enlistment standards reflect the reality that some consumption of alcohol is commonplace among youth, despite the fact that in most

TABLE 7-1 Summary of Military Standards for Alcohol and Drug Abuse

Type of Use/ Abuse	No Waiver Required	Waiver Possible	No Waiver Possible
Drug trafficking			All Services
Alcohol/drug dependence		Navy: If no longer dependent	Army, Air Force, Marine Corps
Positive test for other drugs		Army: If retest negative after one year Navy: Same as Army Marine Corps: Same as Army	Air Force
Positive test for marijuana or alcohol		Army: If retest negative after six months Navy: Same as Army Marine Corps: Same as Army Air Force: Alcohol—if treated and abstains for two years	Air Force: Marijuana
Chronic marijuana use		Navy: No use in past year Navy: If used during past year	Army, Air Force, and Marine Corps
	Limited Use of Other Drugs		
Stimulants and depressants	Army: Must disclose Navy: Use more than one year ago		Navy: Use within six months
Narcotics	Army: Must disclose	Navy: Use over one year ago	Navy: Use within six months
Limited use of marijuana	All Services		

SOURCE: HumRRO, Moral Character Enlistment Standards, preliminary report (1998).

states it is illegal to consume any alcoholic beverage under age 21. Moreover, occasional or "recreational" use of marijuana is also fairly common among youth, and the military decided during the early 1990s that occasional use of marijuana would not be disqualifying under moral character standards. Supply issues are therefore more focused on heavy or chronic use of illicit drugs or alcohol, especially when they indicate drug depen-

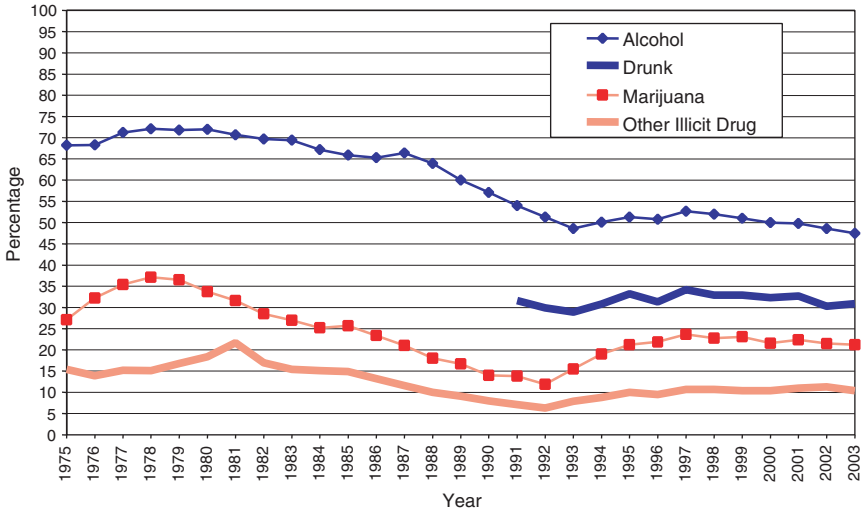


FIGURE 7-1 Trends in substance abuse by high school seniors during the past 30 days.
SOURCE: Johnston et al. (2004).

dence. In examining trends in youth characteristics, then, we distinguish between mere use of alcohol or marijuana and more chronic indicators of abuse, such as being drunk or using illicit drugs other than alcohol.

The best information on trends in substance abuse for the youth population comes from long-term national surveys conducted by the Monitoring the Future project at the University of Michigan. These surveys started in 1975, so the project has produced nearly 30 years of long-term data on use of cigarettes, alcohol, and drugs. The survey samples 8th, 10th, and 12th grade students, but for the purpose of recruiting standards, the high school senior group provides the most relevant data.[1]

Figure 7-1 shows trends in alcohol and illicit drug use for high school seniors from 1975 to 2003. All substance abuse measures discussed in this chapter are based on use during the past 30 days, which is more indicative of chronic or regular usage. There are two indicators for alcohol: any consumption and being drunk (a measurement that began in 1991). Interestingly, alcohol consumption dropped significantly between 1980 and

[1]Unlike cigarette use (see the next section), marijuana and other illicit drug use reaches a maximum at approximately 17 and 18 years of age, so the Monitoring the Future data are a good indicator of recent trends.

1993, from a high of over 70 percent to a low of about 50 percent. It has fluctuated only slightly since that time, standing at about 47 percent in 2003. The percentage of those who were drunk in the past 30 days has changed very little between 1991 and the present, standing at just over 30 percent in 2003.

Marijuana use also shows a steep drop between 1978 and 1992, from a maximum of 37 percent to a low of 12 percent. The rate began rising again in the early 1990s and reached a more recent maximum of just under 25 percent in 1997, and it has remained at about that level since that time. The use of other illicit drugs is about half the level of marijuana, and it shows a similar pattern but with somewhat less pronounced swings. The rate of other illicit drug use has remained very close to 10 percent for the past eight years or so. On the basis of the recent trends shown here, it is reasonable to assume that these rates will probably remain at about the same levels for the next 5 to 10 years.

Substance Abuse by Gender and Race/Ethnicity

Figures 7-2a and 7-2b show the trends in alcohol consumption separately for six gender-by-race groups. Both gender and race/ethnicity are related to rates of alcohol use, but the gender effects are much smaller than the race effects. Interestingly, both male and female white youth have the highest rates of alcohol consumption and black youth the lowest. Hispanic youth are in between but are closer to whites than blacks in their consumption rates. During the early part of this time span, white male rates were about 10 points higher than white female rates, starting in 1985 or so the difference has been only about 5 points. By 2004, about 55 percent of white young men report recent drinking compared with 50 percent of white young women.

Alcohol use for black youth is substantially lower than for white youth, and this is true for both genders. Like white youth, the trends for blacks show substantial declines since 1975, and the difference between genders is somewhat larger. In 2004 the rate of recent drinking was 35 percent for black young men compared with 25 percent for black young women. Again, Hispanics rates are about 5 points below white rates for both genders.

Illicit drug use by race and gender is shown in Figures 7-3a and 7-3b. Interestingly, total illicit drug use among young men differs very little among the three races, particularly in the past 10 years or so. Generally, black youth reveal the lowest rates, and in 2004 the rates are 28 percent for white, 25 percent for Hispanic, and 22 percent for black young men. The race differences are larger for young women. The trend patterns are similar to those for the total youth population, but black young women have

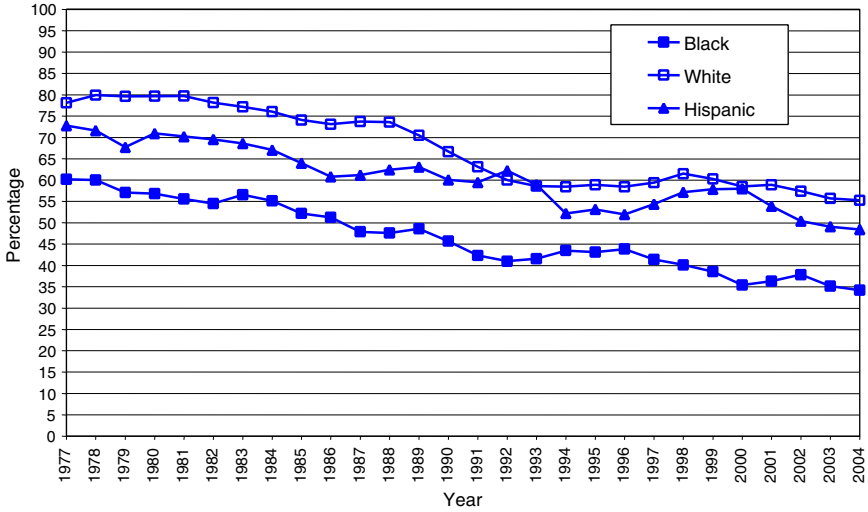


FIGURE 7-2a Use of alcohol by young men in the past 30 days.
SOURCE: Johnston et al. (2004).

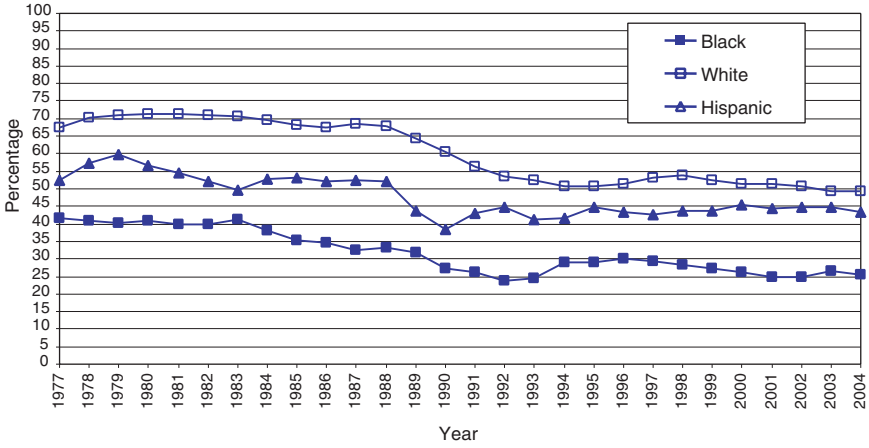


FIGURE 7-2b Use of alcohol by young women in the past 30 days.
SOURCE: Johnston et al. (2004).

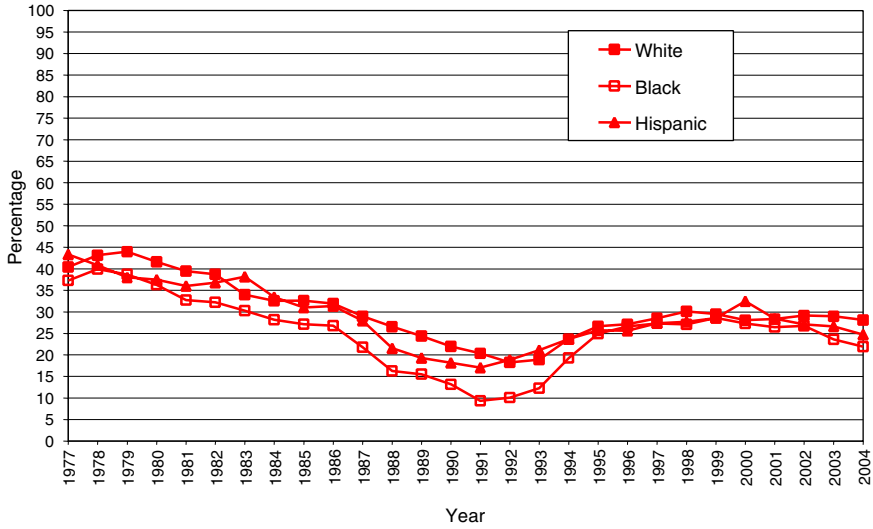


FIGURE 7-3a Use of illicit drugs by young men in the past 30 days.
SOURCE: Johnston et al. (2004).

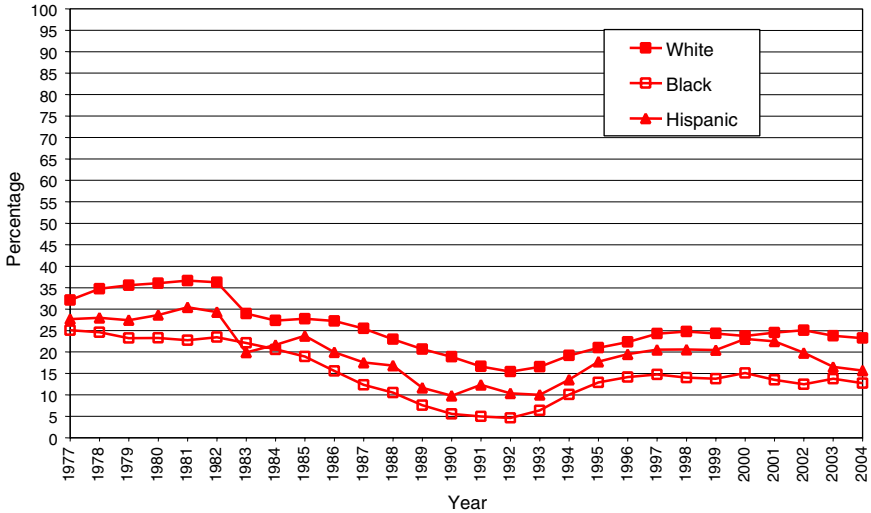


FIGURE 7-3b Use of illicit drugs by young women in the past 30 days.
SOURCE: Johnston et al. (2004).

rates that are consistently 10 points below white young women. In 2004 the rates of illicit drug use are 23 percent for white, 16 percent for Hispanic, and 13 percent for black young women.

Substance Abuse and Military Performance

What is the evidence on the relationship between substance abuse and military performance? The primary outcome for evaluating moral character standards has been attrition rates. Since serious substance abusers are ineligible for enlistment in the first place (e.g., chronic alcoholism, dependence on illicit drugs), the main question here concerns waivers granted for less serious forms of substance abuse as outlined in Table 7-1. Since occasional use of marijuana no longer requires waivers, we are restricted to evaluating attrition for enlistees who enter with some type of drug or alcohol waiver.

Attrition rates for all major waiver categories were obtained from the Defense Manpower Data Center (DMDC) for fiscal year (FY) 2000 through FY 2003 (see the tables in Appendix B for the full attrition analysis). Waiver categories are distinguished for alcohol abuse only, marijuana use only, both drugs and alcohol, and illicit drugs other than marijuana. We combined the marijuana category with the drug and alcohol category (which had small numbers) and requested 12-, 24-, and 36-month attrition rates.

Alcohol Abuse and Other Illicit Drugs

We found that in recent years the Services have granted very few waivers for alcohol abuse alone or other illicit drugs alone. For the past several years, fewer than 76 persons each year entered with alcohol abuse waivers, and only about 100 had waivers for illicit drug use other than marijuana. The very small number of waivers means that attrition rates cannot be reliably measured; therefore, the impact of these two behaviors on attrition rates was not evaluated for these two categories. Regardless of attrition, the number of waivers is so small that there is no reason to change enlistment standards for these two conditions and no reason to consider the effectiveness of in-service treatment programs. In effect, the Services accept very few individuals who test positive for alcohol or illicit drugs other than marijuana.

Marijuana Use

As mentioned earlier, no waiver is required for persons reporting limited marijuana use before entry and the drug test is negative at the physical examination. However, a substantial number of waivers are

TABLE 7-2 Attrition Rates for Accessions with Marijuana Waivers

	Attrition rates (by percentage)			
	Accessions	12-month	24-month	36-month
Marijuana waivers				
FY 2000				
Men	2,168	17	27	34
Women	180	31	42	48
Total	2,348	18	28	35
FY 2001				
Men	2,604	16	30	37
Women	253	27	38	46
Total	2,857	17	31	38
No waiver				
FY 2000				
Men	119,282	14	21	26
Women	29,386	20	28	34
Total	148,668	15	22	27
FY 2001				
Men	125,831	13	20	25
Women	29,940	19	27	34
Total	155,771	14	22	27

granted for marijuana usage as indicated by a positive test at the physical (the Air Force does not grant waivers for this condition; see Table 7-1).

Table 7-2 shows the number of accession and attrition outcomes for persons given marijuana waivers compared with accessions and attrition outcomes for persons without any type of waiver for FY 2000 and FY 2001. The number of waivers range from 2,000 to 3,000 per year, which is only about 1.5 percent of total accessions. Interestingly, 12-month attrition rates are only slightly elevated for persons with marijuana waivers, by about 3 percent in both years (18 and 17 percent versus 15 and 14 percent, respectively). Also, it should be noted that attrition rates are somewhat higher for female drug waivers than male drug waivers, although the number of women receiving waivers is very small.

Attrition rates at 24 months are more elevated for those with marijuana waivers; the difference is 6 percent in FY 2000 and 9 percent in FY 2001. Even this difference is modest. Finally, the difference gets somewhat larger by 36 months. After three years of service, attrition rates are elevated by about 10 percentage points for marijuana waivers compared with persons with no waivers. It should be noted that this difference is

substantially less than the attrition rate difference for high school graduates compared with nongraduates shown in Chapter 3.

It appears that those with marijuana waivers get through the training period with no higher likelihood of leaving the services prematurely than those without waivers. The fact that attrition rises at a somewhat higher rate over time for those with waivers could indicate the effect of the random testing program on those with waivers who continue to use marijuana; the longer a marijuana user stays in the military, the more likely he or she will be caught by the test and dismissed.

Cost-Performance Trade-Off Analysis

It is unclear at this point whether a formal cost-performance analysis would suggest any changes to the enlistment standards being used for substance abuse behavior. First, we have observed only a small number of waivers for alcohol dependence or nonmarijuana drug use, so as long as these numbers remain low, these waivers do not impact appreciably on recruiting numbers. Second, attrition rates for marijuana use are only slightly elevated at the 12-month point, when a cost-performance analysis is most pertinent, because this is the period when the largest training investments occur. Moreover, the attrition differences at 24 and 36 months are greater but still modest at the 24-month point. On one hand, it is not clear whether these elevated rates would justify changes in the waiver policy, because the longer persons stay in the Service past 12 months (the maximum length of most training periods), the more likely they are to repay the initial training investment. On the other hand, there are relatively few of these waivers (1.5 percent), which means excluding all of them would not have a very large impact on recruiting costs. A formal cost-performance trade-off analysis would be required to test whether stricter standards for marijuana waivers would be cost-effective.

Conclusions and Recommendations

Few persons enter the military with serious substance abuse, but about 1.5 percent of accessions enter with a marijuana waiver. Attrition is not significantly elevated at 12 months of military service for those with marijuana waivers, but it is modestly elevated at 24 and 36 months of service. It is unclear at this point whether a cost-performance analysis would suggest any changes to the current standard, since the savings from reduced training costs may or may not exceed the additional costs of recruiting.

Recommendation 7-1: We recommend that DoD undertake a formal cost-performance trade-off analysis to determine whether a stricter standard for marijuana waivers would be justified on cost-effectiveness grounds.

CIGARETTE USE

Current Standards and Requirements

Cigarette smoking has periodically surfaced as an issue in the U.S. military. Historically the military has been seen as a safe haven for smokers, a place where smoking was not only accepted but often encouraged. As far back as 1898, when the Navy's surgeon general threatened to ban cigarettes aboard ships, he was forced to back down because of a potential mutiny (Moyer, 2000; Patrone, 1996). By World War I, American soldiers began receiving tobacco rations, which were promoted by such military leaders as General John J. Pershing, commander of American forces in France (London, Whelan, and Case, 1996:40): "Tobacco is indispensable as a daily ration. We must have thousands of tons of it without delay. It is essential for the defense of democracy."

The practice of tobacco rations ended in 1975. Military veterans are also familiar with the expression, "The smoking lamp is lit," a centuries-old nautical term to indicate that smoking was permitted. For many years, military exchanges sold cigarettes with large price discounts, free from the warning labels required on cigarette packages sold in the civilian market (Evans, 1998).[2]

As it turned out, the smoking lamp was lit quite often in the military. This may help to explain why three-quarters of all military veterans have smoked, according to studies in the late 1990s (Harris, 1997).[3] In 1996, DoD estimated that 448,000 active-duty members were smokers (32 percent of the total force), and that smoking costs DoD about $530 million annually in health expenses, along with $345 million in lost productivity. The Worldwide Survey of Substance Abuse Among Military Personnel indicated that the proportion of military members who smoked declined

[2]Warning labels were not required on cigarettes sold or distributed through the military system until 1970, five years after the establishment of the requirement for products sold in civilian stores.

[3]Although the Harris report suggests that this is higher than in the civilian sector, the National Household Survey on Drug Abuse reports a comparable rate of lifetime smoking for men 35 or older.

during the 1980s and 1990s, as it did in the civilian world. At the same time, smokeless tobacco gained popularity, especially in the Marine Corps, where almost half of all young men under the age of 25 were reported to be users (Moyer, 2000).

Many of the military's smokers picked up the habit before entering military service. A 1988 survey of Navy recruits, for example, suggested that 28 percent were cigarette smokers when they began boot camp. Around the same period, the Worldwide Survey of Substance Abuse showed that nearly half of the Army's enlisted personnel in the junior pay grades (E-1 to E-3) were smokers, while the comparable rates for the other Services were 39 percent in the Marine Corps, 37 percent in the Navy, and 29 percent in the Air Force (Moyer, 2000:13).

Results from the DoD Survey of Health-Related Behaviors conducted in 2002 shows that cigarette smoking is widespread in all branches of the military, although not more widespread than among civilians with comparable demographic characteristics (Bray, 2004). This particular survey (discussed further in a later section) also indicates that nearly one-third of the military's smokers brought the habit with them when they joined.

Currently, there are no enlistment standards with respect to the use of tobacco or cigarette smoking. However, there has been considerable interest in the military research community on the consequences of smoking on a variety of outcomes, such as health costs and first-term attrition. Several studies have found that cigarette smokers have elevated first-term attrition rates and have suggested that tobacco smoking—perhaps in combination with other applicant characteristics—might be the basis for improved screening techniques. Consequently, this section presents a summary of enlistment standards issues with regard to cigarette smoking and discusses steps DoD might consider in dealing with smoking behavior.

Youth Characteristics and Supply Issues

Figure 7-4 shows trends in cigarette smoking during the past 30 days for all high school seniors from 1977 to 2004. Two indicators are used: the percentage who smoked cigarettes at any time during the past 30 days and those who smoked daily. The rate of recent daily smoking is probably a better indicator of nicotine dependence; and this rate is about 10 points lower than recent episodic smoking. Generally, both indicators of smoking rates declined during the 1970s, remained fairly flat during the 1980s, and began increasing during the 1990s (when marijuana use also began rising). Cigarette smoking rates reached a peak in 1997, and then the rates began declining. By 2003, both rates had reached historic lows of 24 percent for any smoking and 16 percent for daily smoking. The Monitoring

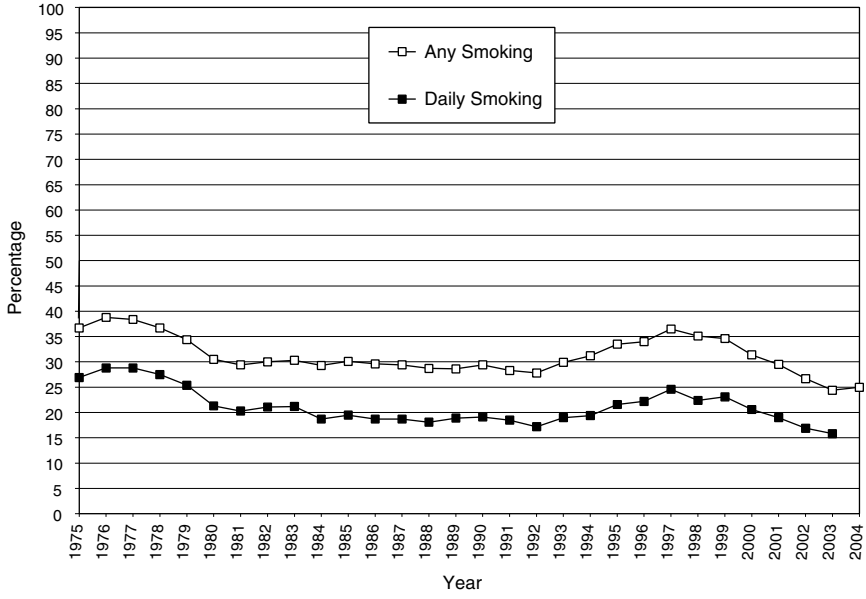


FIGURE 7-4 Cigarette smoking in the past 30 days, high school seniors.
SOURCE: Johnston et al. (2004).

the Future data strongly suggest that cigarette smoking is on the decline among high school seniors in the United States.

Unlike illicit substances, cigarette smoking is illegal only for youth under age 18, and many states have aggressive policies that penalize retailers who sell cigarettes to underage youth. Accordingly, the prevalence of cigarette smoking among high school seniors may not accurately reflect smoking behaviors in the total youth population. Indeed, the National Survey on Drug Use and Health (NSDUH) reveals much higher prevalence rates among older youth and young adults (http://www.oas.samhsa.gov/nhsda).

Figure 7-5 presents the prevalence of any cigarette smoking during the past 30 days by detailed age categories for the total U.S. population. Prevalence rates increase sharply every year during the teens, rising from about 15 percent at age 15 to a peak of about 45 percent at ages 20 or 21. The rate then remains relatively flat until about age 23, when it begins declining, and it then declines steadily thereafter until it reaches a low of about 10 percent for persons 65 and over. Importantly for our purposes, the rate of cigarette smoking for young adults ages 20 to 22 is nearly double the rate for high school seniors.

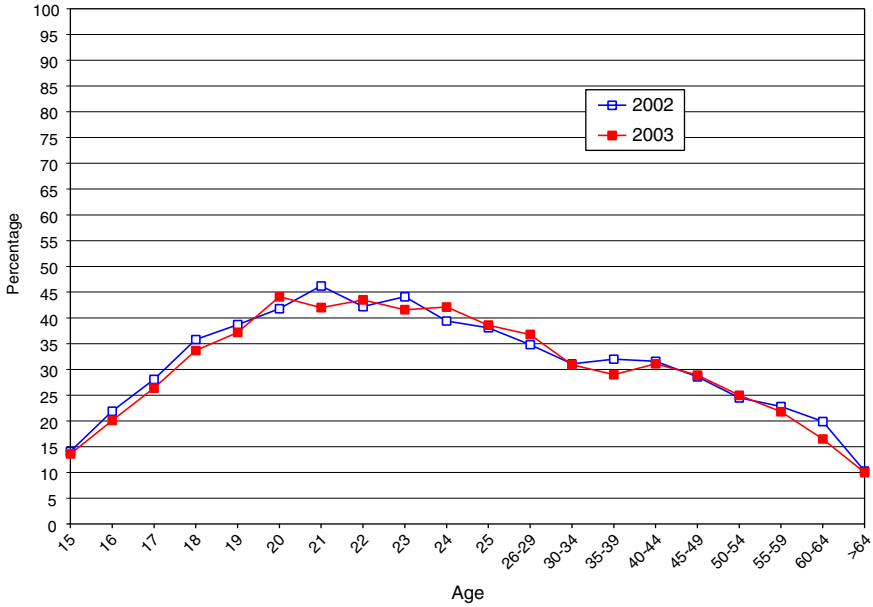


FIGURE 7-5 Any cigarette smoking in the past 30 days, total population by age, 2002 and 2003.
SOURCE: Johnston et al. (2004).

The NHDUH also reports smoking rates by gender and race/ethnicity (<http://www.samhsa.gov/nhsda/2k3tabs/Sect2peTabs1to56.htm>, Table 2.27B [accessed 2003]). For youth ages 18 to 25 in 2003, the rate of smoking during the past 30 days was 52 percent for men compared with 38 percent for women. Consistent with the data on illicit drug use, white youth have the highest rates of smoking at 50 percent, while both blacks and Hispanics have considerably lower rates of cigarette smoking at 34 and 36 percent, respectively. It should be noted that gender differences are much smaller for high school seniors, perhaps because of the legality issue.

What about cigarette smoking among military personnel? Since most first-term military personnel are over age 18, the Monitoring the Future data do not offer a good comparison group for smoking behaviors in the military. There is a fairly recent survey of health behavior among military personnel, and this survey also made a comparison with the civilian population using NSDUH data for similar age groups (Bray et al., 2002).

Table 7-3 compares the percentage reporting any smoking in the past 30 days of military and civilian populations broken down by gender and age groups. The DoD study used the 2001 NSDUH results for the civilian

TABLE 7-3 Any Smoking During the Past 30 Days (percentage)

Age/Gender	DoD	Civilian[a]
Men		
18 to 25	45	42
26 to 55	24	25
All ages	33	32
Women		
18 to 25	30	27
26 to 55	22	22
All ages	26	24
Total		
18 to 25	40	42
26 to 55	24	24
All ages	31	32
N	41,367	8541

[a]Based on the National Household Survey on Drug Abuse for 2001.

SOURCE: Adapted from Bray et al., Department of Defense Survey of Health Behaviors (2002).

comparisons, and it also standardized civilian rates on sociodemographic characteristics so they would be comparable to the military population. Thus the civilian smoking rates shown in this table are not strictly comparable to the smoking rates shown in Figure 7-5.

Two important findings are revealed by the DoD study. First, there is almost no difference in cigarette smoking rates between military and civilian populations of comparable ages and gender. Second, there is a very substantial difference in smoking rates by age group, especially for men. Military men ages 18 to 24 are nearly twice as likely to smoke as those ages 25 to 55 (45 versus 24 percent, respectively). The age difference for women is less pronounced but still significant (30 versus 22 percent). The younger age group overlaps considerably with first-term enlistees, while the older age groups would be comprised primarily of career force members. It should be noted that the prevalence rates for nonsmokers in Table 7-3 are similar to the Army and Navy rates of nonsmokers among recruits discussed in the next section.

The military-civilian comparison discussed to this point has focused on any cigarette use in the past 30 days. The Monitoring the Future data

show that daily cigarette smoking was substantially lower than any smoking during the past 30 days. Similarly, the 2002 DoD Health Survey distinguished a subcategory of "heavy smoking." The rate of heavy smoking in the military was 13 percent in 2002, which is virtually the same as the rate of heavy smoking in 1998 (no comparisons with the civilian population were offered). There were few important differences across the Services, with the exception of the Air Force, in which heavy smoking was 10 percent. The rate of Navy heavy smoking in the DoD survey is similar to its rate of heavy drinking in the Navy study reported in a later section.

Cigarette Smoking and Military Performance

The fact that younger military and civilian populations have similar rates of smoking says nothing about whether smoking has adverse effects on military performance. It is well-documented in medical research that smoking leads to a higher risk of certain diseases, particularly emphysema, cancer, and heart disease. However, most of these diseases do not usually manifest themselves until a person is older, and therefore smoking may not create significant health care costs during the first term of enlistment. Smoking does, however, have adverse affects on physical fitness and on attrition. The following sections treat these in turn.

Injury Risk

In 2000, Jones et al. identified smoking as an injury risk factor that should be addressed in implementing a comprehensive injury prevention program for the military. In a cohort study of nearly 2,000 Army recruits, Altarac and colleagues (2000) identified smoking as a risk factor for injury during basic training. Using a multivariate analyses and controlling for age, education, race, body mass index, and physical fitness, he found that the risk of any injury during basic training was 1.5 times higher in smokers than nonsmokers for men (95 percent confidence interval, CI: 1.1, 2.0) and 1.6 times higher for women (95 percent confidence interval, CI: 1.2, 2.2). The results also showed a modest dose-response relationship between the number of cigarettes smoked in the month prior to basic training and the risk of injury. Similar relationships between smoking and injury in military training have been found in the Army and the Marine Corps (Jones, 1993b; Jones, Shaffer, and Snedecor, 1999) and among Norwegian conscripts (Heir and Eide, 1997). The latter study showed that smokeless tobacco was also related to injury.

A number of recent observational studies have noted that smoking is associated with musculoskeletal disorders and disabilities in the military (Lincoln et al., 2003; Dunn et al., 2003) and civilian workforces (Khatun,

Ahlgren, and Hammarstrom, 2004; Palmer et al., 2003; Thorbjornsson et al., 2000; Leino-Arjas, 1998), even after adjustment for other covariates. Furthermore, smoking has been identified as a risk factor for exercise-related injury in women (Gilchrist et al., 2000).

The mechanisms by which smoking increases the risk of injury warrant detailed investigation. Hier and Eide (1997) proposed a number of these, including reduced regional blood flow to working tissue, metabolic and circulatory effects, and neuromuscular effects. Furthermore, smoking may limit the ability of the recruit to maintain healthy bone and to repair tissue micro damage, which may lead to chronic injury during the repetitive stresses imposed during basic training.

Attrition

High rates of attrition are costly to the military, and a general goal of recruiting policies is to screen out persons with a high likelihood of early attrition. Attrition at 12 months or at the end of specialty training is the most costly type of attrition, because training expenditures are at their maximum and enlistees have not yet contributed any productive man-hours in their jobs or units. Attrition at 3 months is somewhat less costly because of smaller training investments, while attrition at 36 months (or even 24 months) is less costly because trained man-hours have recouped at least some of the initial training investment.

Several recent studies have assessed the effect of cigarette smoking on first-term attrition. Studies were carried out for the Air Force (Klesges et al., 2001), the Army (Strickland, 2004), and the Navy. The Air Force study found that 12-month attrition rates were 19.4 percent for smokers compared with 11.8 percent for nonsmokers. The authors state: "The results of the current investigation suggest that smoking is the single best indicator of premature discharge over one year of training from the U.S. Air Force" (Klesges et al., 2001:9). This study estimated that the higher attrition rate of preservice smokers represents $18 million in higher training costs annually for the Air Force.

We think the Air Force study did not use the correct methodology to arrive at this estimate. We assume that the average cost of training per recruit up to 12 months is $20,000. Applying the formulas presented in Chapter 3, we estimate that the cost of attrition due to smoking (given the Air Force attrition rates and recruiting statistics) would be closer to $38 million per year. However, this is only half of the cost analysis. In order to determine whether screening out smokers would be cost-effective (ignoring, for the time being, the question of whether smokers could be identified in an operational screening environment), we have to also consider

TABLE 7-4 12-Month Attrition Rates by Smoking Status

	No Attrition	Attrition	Total	% Attrition	% Prevalence
ARMY[a]					
None	12,232	2,031	14,263	14.2	49.7
<Daily	4,585	781	5,356	14.6	18.7
Daily	7,024	2,043	9,067	22.5	31.6
Totals	23,841	4,855	28,686	16.9	100.0
NAVY[b]					
None	3,482	811	4,293	18.9	49.2
Light	2,201	741	2,942	25.2	33.7
Heavy	951	547	1,498	36.5	17.2
Totals	6,634	2,099	8,733	24.0	100.0

[a]Smoking defined by frequency of smoking during 6 months before the delayed entry program.
[b]Smoking defined by volume "until recently"; heavy = 1 pack a day or more.

the higher recruiting costs associated with excluding a significant portion of the youth population.

A summary of 12-month attrition rates for the Army and Navy studies is shown in Table 7-4. We stress that the Army and Navy studies defined smoking differently. The Army distinguished among frequency categories, with daily smoking being the highest (during the six months before the delayed entry program); the Navy distinguished the quantity of recent smoking, with a pack or more a day being defined as a heavy smoker.

For the Army, the 12-month attrition rate was 22 percent for daily smokers compared with 14 percent for nonsmokers. This 8-point difference is comparable to the 7-point difference found for the Air Force. The Army study also found that there is no elevated attrition for light smokers, consisting of everyone who smoked less than daily. The prevalence of daily smoking is 32 percent; therefore, excluding daily smokers from the Army would clearly raise recruiting costs appreciably, thereby underscoring the importance of a cost-performance trade-off analysis.

In the Navy study, the 12-month attrition of heavy smokers (those smoking at least a pack a day) is nearly twice that of nonsmokers, 36 percent compared with 19 percent. The attrition rate of light smokers (25 percent) is also elevated, but to a much lesser extent. The prevalence of heavy smokers is only 17 percent; excluding them would therefore not raise recruiting costs as much as excluding daily smokers in the Army. Of

course, there may not be a reliable method for distinguishing between heavy and light smokers.

We cannot be certain as to the reasons for different results in the Army and Navy studies. It could simply be the different definitions, with the Army measuring frequency and the Navy measuring quantity. There is some support for this interpretation in the data themselves, since the Navy's prevalence of heavy smoking is much smaller than the Army's prevalence of daily smoking. On one hand, it is quite likely that some daily smokers smoke less than a pack a day, and therefore heavy smokers are a subset of daily smokers. On the other hand, there is some concern about the representativeness of the Navy sample, because the overall 12-month attrition rate of 24 percent is much higher than the 17 percent reported by the Defense Manpower Data Center for the Navy in 2001 and 2002.[4]

Both studies of Army and Navy recruits suggest a relationship between preservice smoking and behavioral factors. In the detailed study of the 1999 Army cohort, McCloy and Putka (2004) found that smoking prior to the delayed entry program demonstrated significant predictive relationships among three types of in-unit attrition: (1) overall, (2) moral character, and (3) pregnancy or parenthood. They put this finding in perspective, comparing it with the predictive strength of education (McCloy and Putka, 2004:355):

> For the Army FY 1999 cohort in-unit sample from the First Term Project, the rates are 34.2 percent and 21.5 percent (Overall attrition) and 21.9 percent and 10.2 percent (Moral Character) [for smokers and nonsmokers], respectively. [T]he odds ratios for this item rival those of Education Tier for Overall in-unit attrition (ranges of 1.33-1.86 for [pre-DEP smoking]; ranges of 1.38-1.99 for Education Tier).

The Navy study made use of a biographical questionnaire, the Assessment for Security Positions and Enlistment (ASPEN), which included a wide range of questions to gather behavioral information on recruits. In an effort to better understand the relationship between preservice smoking and first-term attrition, Flyer and Eitelberg (2005) cross-tabulated the smoking variable with responses to other questions on ASPEN that could be associated with a behavioral problem. Among the types of behavioral

[4]The rates are somewhat higher for the Navy study population because recruits who enter in the period examined (the months of February through May) historically experience higher attrition. Furthermore, because recruiting tends to be relatively more difficult at the start of the calendar year, the study population has proportionately more nongraduates than would be found in an entire annual cohort, and nongraduates typically have higher attrition rates.

problems associated with smoking were high school misbehavior, criminal offenses, drug use, psychological difficulties, and trouble dealing with authority. For example, 27 percent of nonsmokers admitted to having been suspended from high school at least once; this compares with 42 percent of light smokers and 50 percent of those who smoked heavily. At the same time, 20 percent of nonsmokers indicated that they had "been in trouble with police for nontraffic offenses"; by comparison, 34 percent of light smokers and 43 percent of heavy smokers indicated that they had likewise been in trouble with police. Furthermore, 32 percent of nonsmokers admitted to "causing problems in high school," compared with 51 percent of light smokers and almost double the proportion (60 percent) of heavy smokers; and while 39 percent of nonsmokers admitted to "cutting class" often or occasionally in high school, the comparable proportions were 57 percent for light smokers and 64 percent for heavy smokers. These authors also found that first-term attrition rates are considerably higher for recruits who experienced certain preservice behavioral problems—such as suspension from high school, trouble with police, cutting class, or causing other disruptions in high school—than for those who have relatively clean preservice records. In addition, recruits who were suspended from high school have a first-term attrition rate ranging from 53 percent (three or more suspensions) to 41 percent (one or two suspensions), compared with 33 percent of recruits without any history of high school suspension.

The findings linking behavioral problems to smoking are supported by the earlier work of Tyas and Pederson (1998; see also Maney et al., 2004), who reviewed over 220 studies to synthesize and integrate information on the psychosocial correlates of adolescent smoking. Some of the more interesting trends—at least in helping to understand military attrition—fall under the behavioral category, which is further divided by factors related to school, risk-taking and deviance, and lifestyle. For example, under the category of school, smoking behavior was found in studies to be consistently related to educational aspirations and commitment. At the same time, under the categories of risk-taking and deviance, the following were associated with smoking initiation: having a history of trouble with the police, carrying a weapon, alcohol and other drug use, riding with a drinking driver, physical altercation, not wearing a seatbelt, and so on. Also found to be related to smoking was not following a healthy lifestyle.

As Flyer and Eitelberg (2005) observe, a substantial body of research continues to show that adolescent smokers are more likely than their nonsmoking counterparts to engage in risk-taking and deviant behavior. In addition, smoking has been linked with a greater likelihood of depression, as well as certain other psychiatric problems in teenagers, although the relationships are still largely unexplained. Studies of the psychosocial

correlates of smoking may offer important clues and insight as to why preservice smokers, regardless of education or other demographic factors, have a consistently higher rate of first-term attrition from the military.

The following sections discuss two ways in which smoking behaviors could be used in the screening process. The first is based on the cost-performance trade-off model as described in Chapter 3. This method can suggest whether screening daily or heavy smokers would be cost-effective considering the trade-off between the savings from reduced attrition and the increased recruiting costs. It is crucial to note that this discussion represents the hypothetical situation in which information about an individual's smoking status is known. In an operational setting, reliance on self-reports of smoking is probably not feasible. Awareness that smoking at some level is disqualifying would in all likelihood result in underreporting, if not complete denial, of smoking. However, it is useful to determine whether or not it would be cost-effective to screen out some (e.g., heavy) smokers were it possible to identify them accurately.

The second approach is a less formal analysis of the relationship between smoking and a variety of other behavioral factors, especially those that are already used in screening, such as education. This approach is based on the likelihood that smoking can serve as a marker for a set of behaviors linked to attrition that are more feasibly assessed during the screening process. The identification of factors accounting for the smoking-attrition link may lead to mechanisms for screening these factors directly.

Cost-Performance Trade-off Analysis

The cost-performance trade-off model tries to answer the question of whether the savings in lower attrition costs will more than compensate for the higher recruiting costs if heavy or daily smokers are disqualified for enlistment. We try to answer this using the Army and Navy smoking attrition and prevalence data shown in Table 7-4. We reiterate that this analysis represents an exercise to determine the consequences of screening out some categories of smokers should it be possible to identify smoking status at point of entry. The committee recognizes that smoking status relies on self-report, and that accurate self-reports cannot be expected in an environment in which recruits know that certain levels of smoking are disqualifying.

The Navy Example

In Figure 7-6, we consider the costs and benefits of reducing the proportion of heavy smokers among recruits by 25, 50, and 100 percent.

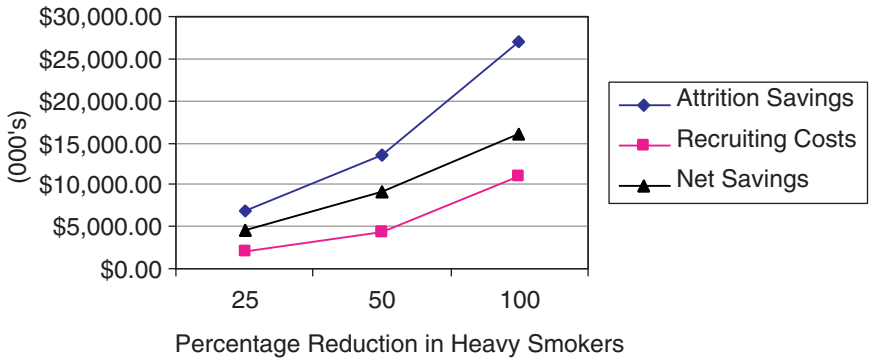


FIGURE 7-6 Benefits and costs from reducing heavy smoker percentage of recruits.

Attrition savings are greater than the increase in recruiting costs at all enlistment standards considered. Net benefits are maximized by excluding all heavy smokers. According to this analysis, almost $5 million could be saved if all heavy smokers were disqualified for service in the Navy.[5] By screening out heavy smokers, the expected first-year aggregate attrition rate for Navy recruits would decline from 19.7 to 18.1 percent, a decline of 1.6 percent.

We now consider whether costs are further reduced if an enlistment standard restricting light smokers is imposed. We assume, in this analysis, that heavy smokers have already been made ineligible for enlistment. We also assume that the number of nonsmoking and light-smoking recruits increased proportionately to compensate for the loss of the heavy smokers. Hence, nonsmokers account for about 59 percent of recruits and light smokers constitute 41 percent.

The difference in first-year attrition rates between nonsmokers and light smokers is about 6.3 percent, much more modest than the difference in first-year attrition between heavy smokers and nonsmokers of about 17.6 percent. Moreover, light smokers constitute about 41 percent of recruits.[6] However, because light smokers are a large proportion of re-

[5]We tested the sensitivity of this result to alternative estimates of the "responsiveness" of recruiting to changes in the eligible population. A standard that disqualified heavy smokers would appear to reduce costs both in the case of "high" responsiveness of recruiting to population (an elasticity of recruits with respect to population of 0.5) and "low" responsiveness, an elasticity of .25.

[6]This is the hypothetical share after heavy smokers have been disqualified for enlistment, reflecting the assumption of a proportionate increase in the share of nonsmokers and light smokers.

cruits, disqualifying them would have a significant effect on aggregate attrition, reducing first-year attrition from 21.4 to about 18.9 percent.

The analysis suggests that an enlistment standard for light smokers, however, would not be cost-effective. The net benefits are negative, and significantly negative, under any standard that limits the proportion of light smokers in the Navy solely on the basis of their smoking behavior.

The Army and Air Force Examples

We now conduct the same type of trade-off analyses for the Army. In the case of the Army, recruits were classified as "nonsmokers," "less than daily smokers," and "daily smokers." The recruit population shares and the 12-month attrition rates are shown in Table 7-4. Immediately, we observe that the attrition rate differences between smokers and nonsmokers are much less dramatic in the Army compared with the Navy. Because the differences in the attrition rate between nonsmokers and less than daily smokers are insignificant, we combine them into a single category for the purposes of analysis. This new category "nonsmokers or infrequent smokers" constitutes 68.4 percent of the recruit population and has an attrition rate of 14.3 percent.

If daily smokers in the Army were ineligible to enlist, the savings in reduced attrition costs would be about $38,400,000. However, the additional recruiting costs resulting from eliminating 32 percent of the market more than offset the savings from lower attrition. The loss that would accrue from such a policy would be about $21,000,000 per year. Policies that would restrict, but not eliminate, daily smokers would also increase costs.

Although a formal analysis was not carried out for the Air Force, the similarity with the Army attrition rates suggests that screening out smokers as identified by the Air Force study would not be cost-effective.

Using Behavioral Factors to Screen Recruits

Flyer and Eitelberg (2005) found that the behavioral issues that may help to explain the relationship between preservice smoking and first-term attrition are similar in many ways to those underlying the relationship between dropping out of high school and early release from the military. Moreover, there is an interaction between education and level of smoking such that certain levels of smoking can magnify the effects of education on attrition.

This point is illustrated in Table 7-5, which presents 12-month attrition rates by education category. The table shows that recruits with Gen-

TABLE 7-5 Navy 12-Month Attrition Rates by Smoking Status and Education

Education	Smoking Status	% Attrition	Number in Sample
HSDG	Nonsmoker	17	3,482
HSDG	Light	22	2,007
GED or NG	Nonsmoker	24	347
ALT	Nonsmoker	26	464
ALT	Light	32	446
HSDG	Heavy	33	912
GED or NG	Light	33	489
ALT	Heavy	40	248
GED or NG	Heavy	44	338
Total sample		24	8,733

HSDG = high school diploma graduate; ALT = alternate credential, such as home schooling, adult education, etc.; GED or NG = General Educational Development or not a high school graduate.

eral Educational Development (GED) certificates or alternate credentials who were nonsmokers had attrition rates somewhat lower than high school graduates who smoked (24 to 26 versus 33 percent). In addition, and perhaps more important, those recruits with GEDs or alternate certificates who were heavy smokers had very high attrition rates (40 to 44 percent), even higher than heavy smokers who were high school graduates.

Given the fact that smoking behavior can magnify the relationship between education and attrition, the question becomes how this information can be used to the military's advantage in screening applicants for enlistment. Several options are worth considering, all without seeking to eliminate all smokers or reduce the pool of prospective recruits. First, assuming that there are unobtrusive ways of determining nonsmoking status, military recruiters could target nonsmoking graduates with high school diplomas because they have the lowest level of attrition among all groups. Second, given that an appreciable number of applicants with GEDs and alternative certificates will be accepted, the Services could target or give priority to the nonsmokers in this group, who have attrition rates only a few points higher than graduates with high school diplomas. Third, if it became feasible to assess quantity of smoking for applicants with GEDs and alternate certificates, then those who were heavy smokers

might be candidates for screening out because of their extremely high rates of early attrition.

Information on preservice smoking behavior is gathered during health screening. Since preservice smoking behavior is an attrition concern as will as a health concern, DoD might consider asking applicants about their smoking behavior during other phases of the application or enlistment process. Applicants who indicate that they smoke, or who are identified as possible smokers during screening or examination, might then be asked to complete a biodata questionnaire to determine if they fit in a high-risk category for first-term attrition. At this point, continued evaluation might be warranted to determine suitability for military service.

CONCLUSIONS AND RECOMMENDATIONS

While cigarette smoking is not permitted during basic and advanced training, smoking is commonplace during the first term, especially among men. However, smoking in the military is no more commonplace than in civilian populations of comparable ages. With respect to military performance, there is evidence that smoking before entry is associated with injury during basic training, probably arising from its adverse effects on numerous physiological characteristics. In addition, studies across all three Services show elevated attrition rates for smokers, although the degree of elevation differs appreciably among the Services, perhaps due to different definitions of the frequency and quantity of smoking. It is clear that screening out all smokers or even frequent smokers would not be feasible simply because of their prevalence. Since smoking is correlated with other recruit characteristics related to lower performance outcomes, further research might identify subgroups of recruits with a set of behavioral characteristics that justify higher priority on entry than other subgroups.

Recommendation 7-2: Further research is needed on the relationship between preservice smoking and military performance, including attrition and other indicators. The research should be conducted across the Services using the same definitions of frequency and quantity of smoking, and the correlates of smoking with other recruit characteristics should be studied. Studies should include the costs and benefits of policy and force management options for dealing with the issue of preservice smoking.

8

Conclusions and Recommendations

The U.S. Department of Defense (DoD) faces both short-term and long-term challenges in selecting and recruiting an enlisted force to meet personnel requirements associated with diverse and changing missions. This report gives guidance to DoD on the physical, medical, and mental health standards used to select members of the enlisted force. This chapter recapitulates the committee's conclusions and recommendations in these areas.

PROCEDURES, REQUIREMENTS, AND STANDARDS

Medical Standards and Screening

The committee reviewed the current medical screening process. DoD's medical enlistment standards (DoD Instruction 6130.4, updated in 2005) form the basis for screening recruits for all Services; these standards include mental health as well as physical conditions. In addition, each Service has its own guidance and regulations for entrance and job assignment. There are several points in the enlistment process at which screening takes place. The first is at the recruiting station, where applicants complete a medical prescreening form. This form is not systematically retained or entered into a database, precluding an understanding of screening decisions made at the recruiting station. Body mass index (BMI) is also estimated at the recruiting station based on height and weight. Note that each Service has it own BMI standards. The second is at the military entrance processing stations (MEPS), where a physician takes a

medical history and conducts a brief examination, and where vision and hearing tests, HIV and drug testing, height and weight (BMI) measurement, and an orthopedic/neurological examination are conducted. Here candidates are classified as medically qualified, disqualified with a condition that may be considered for a waiver, or permanently disqualified with a condition viewed as nonwaivable. Third, disqualified candidates seeking a waiver apply to Service-specific waiver authorities, and a review is conducted. Finally, additional medical evaluation may be done in basic and advanced individual training, as well as in operational units.

Conclusion: To adequately assess the impact of medical standards on applicant flow and disqualification rates, information about screening that takes place before the military entrance processing station physical is required.

> **Recommendation 2-1:** The Services should develop a procedure for maintaining data from the DoD Form 2807-2 (Medical Prescreening of Medical History Report) in an automated form for all applicants, including those who are disqualified at the recruiting station.

Physical Fitness Standards and Screening

There are no DoD-wide physical fitness standards for entry into the Services. The assumption is that a medically qualified recruit can develop the needed level of physical fitness over the course of basic combat training. There are Service-specific initiatives aimed at addressing physical fitness prior to accession. For example, the Air Force has implemented a short strength test administered at the MEPS, and the Army and the Marine Corps have programs addressing fitness while recruits are in the delayed entry program (DEP). Currently, however, fitness is viewed primarily a training issue, rather than an accession standards issue.

Physical Demands of Military Service

Studies show that technology is increasing the physical demands of some jobs and decreasing the demands of others. This leads to the question of whether it is feasible or advisable to set differing physical and medical standards for different military occupational specialties (MOSs). With limited exceptions, there is little research detailing the physical requirements of individual MOSs. However, the crucial feature underlying the question of setting lower standards for some MOSs than for others is the DoD policy decision that every uniformed Service member be combat-ready. This implies a common set of requirements for combat tasks regardless of one's primary MOS. While part of the charge to the commit-

tee was to review evidence on the physical requirements of military jobs, we found no research detailing the fitness requirements of all of the common military tasks required for combat readiness.

Conclusion: In order to understand the fitness requirements needed to perform the set of common military tasks within each service, an analysis of the requirements of each task is needed. While the requirements of a few tasks (e.g., carrying a loaded pack) have been studied, there is no systematic analysis of the entire set of common tasks in each Service.

> **Recommendation 2-2:** We recommend that research be undertaken to determine the fitness requirements (based on defining the functional requirements) of the common tasks cutting across military occupational specialties in each Service, with the goal of using this research to set fitness standards.

The committee notes that each Service has some form of routine physical fitness testing for all members. While all include components measuring aerobic capacity, upper body muscle strength, and abdominal muscle strength, the components vary considerably by Service, as do the standards for passing. While the research we recommend would provide a scientific underpinning for specifying the physical requirements for combat-readiness, the current annual fitness testing standards serve as the Services' current operational definition of the physical requirements of military service.

We note that the use of different fitness measures by the Services makes it difficult to assess fitness across the Services. While acknowledging that each Service may have reason to set standards differently from the others and may have reason to implement additional Service-specific measures, the use of a common set of basic fitness measures would aid understanding of fitness across the Services.

> **Recommendation 2-3:** We recommend that an inter-Service panel develop a common core set of uniformly administered fitness measures for use across the Services in research studies on physical fitness and its policy implications for military service. This does not preclude the use of additional Service-specific measures or the setting of differing standards by each Service.

FRAMEWORK FOR EVALUATING MEDICAL AND PHYSICAL STANDARDS

The committee reviewed methods for examining the linkage between a medical or fitness standard and an outcome of interest (e.g., attrition,

performance). Methods for specifying these linkages are well established; the key need is for systematic data collection and management, thus permitting the application of these methods. Such methods are used by the Services in evaluating standards in other domains, such as cognitive ability and educational attainment. However, the committee found that empirical justification for many physical and medical standards is lacking.

Conclusion: Some standards are justified on prima facie grounds, based on an incontrovertible link between the standard and fitness for service (e.g., blindness, deafness, paralysis). Many, however, are based on a presumed link between the standard and an outcome of interest. The evaluation framework linking standards to outcomes is applicable to all such physical and medical enlistment standards.

> **Recommendation 3-1:** We recommend that data be collected that would allow the study of empirical links between physical and medical characteristics and performance-based outcomes, such as attrition and injury.

Establishing a correlation between a physical or medical standard and an outcome of interest means that the Services can affect the outcome of interest by changing the cutoff score on the standard (i.e., increasing or decreasing the stringency of the standard). Doing so, however, has cost implications, as setting a more stringent standard would result in higher recruiting costs.

The committee examined potential applications of the accession quality cost-performance trade-off model, a computer-based optimization model used to evaluate standards in the domain of cognitive and education standards, to the evaluation of standards in the physical and medical domains. The model aids in the identification of how to obtain the highest level of the outcome of interest at the lowest cost.

Conclusion: Application of the cost trade-off model requires valid data on enlistee health and fitness throughout the tour of duty, as well as the ability to link health and fitness measures to such outcomes as lost work time and attrition. This requires ready access to and linkage between health and personnel databases.

> **Recommendation 3-2:** We recommend that DoD undertake a project to develop the data and technology necessary for a cost-performance trade-off model that could be applied to setting and evaluating medical and physical standards.

> **Recommendation 3-3:** We recommend that DoD commission a review of the medical databases necessary for evaluating and assessing

medical and physical enlistment standards and create a mechanism for integrating or linking the medical databases with existing personnel databases at the Defense Manpower Data Center, subject to all legal requirements.

PHYSICAL FITNESS AND MUSCULOSKELETAL INJURY

Physical Characteristics of Military Basic Training

Basic combat training is designed to be an intense program that orients and indoctrinates new recruits to their Service. One essential component of it is physical fitness training. In order to graduate from basic training, recruits must have demonstrated that they are capable of passing Service-specific routine physical fitness tests. In this respect, basic training performs an (expensive) screening function for the Services. The selection process for enlisted personnel does not include any measurement of physical fitness. Thus, the basic training system must be capable of providing effective physical fitness training to individuals who vary widely in the levels of fitness they bring to the system.

Individual Factors, Training Demands, and Injury and Attrition

Musculoskeletal Injury

Research has identified several risk factors for musculoskeletal injury, including individual characteristics, physical demands, and psychosocial demands. Individual characteristics include age, gender, race, physical structure, previous injury, previous physical activity, and physical fitness. Physical demands are physical stressors, such as running, marching, lifting, carrying, and jumping imposed by the training and work environment. Psychosocial demands include pressure to perform and requirements to conform to a particular social or organizational structure. Because the causal pathways to musculoskeletal injury include a consideration of all these factors, it is important to consider their interactions.

Musculoskeletal injuries resulting from basic and advanced individual training pose the single most significant medical impediment to military readiness. In 1994 and 1995, these types of injuries were the leading cause of disability in all Services and were the leading cause of hospitalizations for the Army, the Navy, and the Marine Corps. High incidence rates of musculoskeletal injuries result in enormous monetary costs, lost work and training time, and recruit attrition. The injury rate for women is about twice as high as that for men.

Fitness, Injury, and Attrition

The scientific literature points strongly toward the conclusion that low physical fitness is causally linked to increased risk of orthopedic injury during basic military training and attrition from military service prior to completion of the first term of enlistment. Female recruits are more likely than their male counterparts to experience orthopedic injuries during military training, but statistical adjustment for the gender difference in physical fitness largely eliminates the male vs. female differences in injury rates. Furthermore, some experimental studies examining modified training methods reinforce the view that physical fitness is an important determinant of injury and attrition outcomes in military recruits. Findings suggest that modification of training programs to consider individual fitness and moderation of exposure to running exercises early in training can reduce injury rates.

There are extensive bodies of knowledge on measurement of physical fitness and on exercise training for the enhancement of physical fitness. These bodies of knowledge, if applied carefully in identifying modified approaches to screening and training military recruits, would seem to hold out considerable promise for reducing negative outcomes during basic military training. Several types of modified protocols, whether used individually or in combination, appear likely to reduce injuries and attrition during first-term military service. Fundamentally, it is possible to conceive of changes in the characteristics of the recruit population (e.g., physical fitness screening procedures at the preenlistment or induction stages), changes in preinduction preparation protocols (e.g., preinduction physical training programs), and changes in basic training protocols (e.g., modification of physical training during basic military training) that would provide important benefits.

Psychosocial Factors and Injury

Psychosocial factors, such as pressure to perform, the organization of tasks, and social context, may also contribute to musculoskeletal injuries and attrition among military recruits. Studies show that there is a strong interaction among physical requirements of the task, the psychosocial environment, and the personality profile of the person. The personality characteristics of the individual can interact strongly with the psychosocial environment and lead to increased coactivation of the musculoskeletal system. This coactivation typically increases joint loading and may lead to increases in cumulative tissue degeneration and increased risk of musculoskeletal disorders.

Although very few studies in the military have focused on psychosocial factors and how they might impact musculoskeletal injury, the combination of high physical training, preparing for combat, and intense operational tempo is bound to place psychological stress on military recruits. Military studies have linked decision authority, experienced responsibility for work, increased time pressure, and greater cognitive processing demands to musculoskeletal pain intensity and symptom reporting. The psychosocial environment thus merits consideration in designing interventions aimed at reducing musculoskeletal injury.

Gender and Musculoskeletal Injury

Since the injury rates of female recruits in basic training are higher than those for male recruits, time lost from training for these injuries is also higher, and attrition rates are higher, consideration should be given to designing different training regimens for women. In the context of integrated training, it may still be possible to separate some of the physical training by gender. Currently, the standards recognize a difference between physical abilities of men and women but the training does not adequately take these into account.

All of these findings lead to a series of interrelated conclusions and recommendations as to areas showing considerable promise for reduction of injury and attrition, without harm to the resulting levels of attained fitness.

Conclusion: Currently, none of the Services systematically conducts comprehensive standardized physical fitness testing at the time of recruitment. Standardized physical fitness testing prior to basic training would permit the identification of recruits at higher risk of injury and attrition. Individuals classified as not meeting a designated physical fitness standard could be assigned to remedial physical training prior to basic training (preship intervention), or to a modified basic training regime, or to both. There is a range of options for a physical fitness test (or tests) that would be valid, reliable, feasible to implement, and likely to be cost-effective.

> **Recommendation 4-1:** A standardized physical fitness test should be selected and routinely implemented at some point prior to the initiation of basic military training.

Conclusion: Preship interventions aimed at improved physical fitness merit consideration. There is clear evidence that such programs would increase physical fitness in most recruits with low fitness, but evidence

that these programs would reduce the incidence of injury or attrition in basic training is limited.

> **Recommendation 4-2:** Research should be conducted to examine the relationship between physical training programs prior to basic training and the incidence of injury or attrition during basic training, focusing on recruits who would fall below a designated physical fitness standard at the start of basic training.

Conclusion: Although training outcomes are the result of several interrelated factors, preliminary, direct evidence suggests that imposing limited physical demands at entry to military training and increasing physical training demands as fitness levels increase could produce comparable levels of physical fitness to current training regimes, with markedly reduced injury rates. This approach should be considered when redesigning basic training.

> **Recommendation 4-3:** Basic training's physical and psychological demands should be tailored to broad categories of initial fitness levels and gradually increased over the duration of the training (in accordance with exercise prescription science and injury prevention principles) so that optimal fitness is achieved with minimal risk of musculoskeletal disorders, traumatic injury, and attrition.

Conclusion: The literature supports the notion that, due to biomechanical and physical fitness differences, men and women have different risks of musculoskeletal disorders, traumatic injury, and attrition as a function of basic military training. In addition, these differences can impact the path to optimal fitness. Therefore, male and female training protocols should ideally be tailored differently. Female recruits have lower average levels of physical fitness and conditioning, at the initiation of basic training, than male recruits. However, it is currently unclear whether the higher risk of injury during basic training observed in women is entirely a function of their lower (on average) physical fitness, or whether it is also partly driven by the other numerous musculoskeletal, biomechanical, and neuromuscular differences between women and men. It is therefore unknown whether tailoring the demands of basic training to an individual's fitness level (as per Recommendation 4-3) will fully address the problem of the higher risks of injury and attrition observed in female recruits.

> **Recommendation 4-4:** Research should be undertaken to address the causes of the increased risk of injury and attrition in women. This research should address differences between men and women in physical fitness and should also address musculoskeletal, biomechanical, and neuromuscular factors.

MEDICAL STANDARDS

The committee focused on two medical issues for which medical waivers from disqualification are commonly sought: BMI/body fat and diseases of the lungs.

Body Composition and Body Fat

The percentage of children and adults who are overweight or obese is a growing problem in the United States. Widely endorsed definitions categorize a BMI between 25 and 29.9 as overweight and 30 or greater as obese. Among adolescents, the BMI level that identified the highest 5 percent of the population in 1963 is now exceeded by 15.5 percent. The prevalence of obesity is greater for Mexican American and black children than for their white counterparts.

Standards for BMI and body fat are determined by each Service. Current standards could temporarily disqualify 15 to 25 percent of the male and 25 to 50 percent of the female youth population. It is important to note that the BMI standard for remaining in the military is often different from the entry standard. For men, the retention standard is generally more stringent than the entry standard; 25 to 40 percent of the youth population would not meet the retention standard. For women, some Services impose a modestly more stringent retention standard and some a modestly less stringent standard.

One argument for a BMI/body fat standard is the research linking overweight to long-term health outcomes. We note, however, that the vast majority of enlistees serve a single tour of duty, while the negative health outcomes of being overweight tend to emerge much later in life. Thus the committee focused on consequences of being overweight for outcomes during military service.

A second argument is that BMI/body fat is a proxy for physical fitness and is an indicator of risk for injury. The committee reviewed research examining the relationship between BMI and a direct fitness measure and injuries. Although there is a systematic relationship between fitness and injury for both men and women, there is virtually no relationship between BMI and injury rates for men, and the small relationship observed for women reflects a slightly higher injury rate for low BMI (i.e., very lean) women. The committee conducted a series of simulations to project the change in injury rates should the Services increase the number of high BMI individuals enlisted; our findings show that injury rates would change minimally.

Another potential argument is that BMI/body fat is a predictor of attrition. The committee reviewed research examining the relationship

between BMI and attrition in basic training, and conducted simulations examining the effect of an increase in the number of high BMI individuals enlisted. As with the injury analyses, a shift in the distribution of BMI toward heavier recruits had very little effect on attrition risk in men. For women, however, there was a higher risk of attrition in the higher BMI groups. Attrition of women is already nearly twice as high as attrition of men, and to further increase this gender differential is a concern. However, the committee's projections show that increasing the proportion of high (25 to 34) BMI women from the current 23.6 to 40 percent would result in only a 1 point increase in the attrition rate. There could thus be access to an expanded recruit pool if the Services were willing to accept such an increase in the attrition rate.

Conclusion: Committee projections based on data provided by the Army suggest that a shift toward a higher BMI force would be unlikely to adversely impact injury and attrition risk in men, but might slightly increase the attrition risk in women. It is important to note that this conclusion is based on data from individuals who qualified under the current standard.

Recommendation 5-1: As BMI is less predictive of injury and attrition than aerobic fitness, we recommend that it not be used as a proxy measure for fitness in the military population.

Recommendation 5-2: As a BMI standard is not justified on the basis of links to injury or attrition, we recommend that such links not be used as the basis for any use of BMI.

One final potential rationale for the use of BMI/body fat is as a proxy for appearance and military bearing.

Conclusion: Standards for appearance and bearing are issues of military values and thus are outside the committee's charge.

The fact that some Services have a more stringent BMI standard for retention than for entry led the committee to review research on the likelihood that individuals will be able to lose weight and maintain that weight reduction over time. That research is generally pessimistic about the prospects for long-term weight reduction. Although a relatively small number of individuals with high motivation and high self-control can lose weight and retain that weight loss through diet and high levels of physical activity, such results are not the norm, and research has not identified programs that have a high likelihood of success for achieving long-term substantial, sustainable weight loss. Given the evidence re-

garding the difficulties of maintaining weight loss, the committee thinks that it is unrealistic for retention standards to be more stringent than accession standards.

Recommendation 5-3: Any BMI standard used for retention should not be more stringent than a standard used for accession.

Asthma

Asthma is ubiquitous in the general population, affecting about 8 percent of the population, with higher prevalence noted among blacks compared with others and women compared with men. An appreciable number of potential military recruits can therefore be expected to have asthma. Currently, asthma at any level of severity precludes participation in the military without a waiver.

Available data indicate little difference after basic training between military personnel with and without asthma. A reasonable question is whether or not having asthma should make an individual ineligible for service. As reflected in the current waiver system, it is likely that individuals without symptoms for a prolonged period of time or even those with mild and infrequent symptoms could carry out their service requirements, especially if they received optimal medical therapy and self-management education. However, there are costs associated with ensuring timely access of personnel to needed medical therapies and making self-management education available. Furthermore, existing data are not informative regarding whether the conduct of certain military operations are more conducive to problems for those with asthma than others, for example, whether environmental conditions or specific tasks may trigger exacerbations. Nonetheless, in general, available data do not suggest a different service trajectory after initial training for individuals with asthma compared with those without.

Basic training appears to provide a natural screening process for individuals with asthma, as the greatest attrition occurs during this phase of service. Individuals with asthma leave at a higher rate in basic training. Basic training is a costly facet of military activity and a careful cost-benefit analysis would be needed to determine whether or not the Services should enlist individuals with asthma knowing that a number are sure to drop out during training. It is important to note, however, that much of the research on asthma and attrition in basic training focuses on individuals whose asthma is diagnosed after enlistment. As recruiting decisions can be made only on the basis of information known prior to enlistment, information on the attrition of individuals whose condition is known or

knowable prior to enlistment is needed for the application of cost-benefit analysis.

Conclusion: In light of current data, the existing standard and waiver process regarding asthma is appropriate. Research on the cost-benefit consequences of enlisting individuals with more severe asthma would be needed prior to recommending any change in enlistment policy regarding asthma.

MENTAL HEALTH

Psychological adaptation to military service is critical for successful completion of a tour of duty. Stressors associated with transition from civilian to military life include changes in living arrangements, geographic locations, peer relationships, support systems, schedules, priorities and control over one's life, separation from family and friends, difficulties in communication with home, and loss of privacy. Soldiers in wartime missions must deal effectively with the stress and anxiety associated with potential loss of their lives and their fellow soldiers. Stressors associated with peacekeeping missions include isolation, a sense of powerlessness, boredom, coping with unpredictability of the mission, dealing with shifting rules of engagement, struggling with conflicting personal views, being unable to identify a clear enemy, and questioning the lasting impact of the mission. All of these features highlight the importance of mental health.

Lifetime prevalence rates of mental disorders for the total active duty U.S. Army population were projected at 37.5 percent for any mental disorder, 5.8 percent for depressive disorders, 16.6 percent for anxiety disorders, 8.3 percent for antisocial personality disorders, and 1.1 percent for schizophrenia. Those hospitalized for a mental disorder have a higher subsequent rate of attrition (45 percent) than those hospitalized for other reasons (11 percent).

Mental Health Enlistment Standards

DoD has recently revised the mental health disorders that are causes for rejection for enlistment into the military service. For learning disorders and attention deficit hyperactivity disorder, the criteria have been changed to allow eligibility for individuals who can demonstrate passing academic performance without the use of academic and/or work accommodations or medications in the previous 12 months.

An age cutoff (the 13th birthday) is used for some standards, including those for enuresis, encopresis, sleepwalking, and eating disorders.

There is increased recognition of depression in children and a concomitant increase in the use of mental health treatment for this disorder in youth. The typical duration of treatment is approximately one year for a single episode of depression. The current DoD fitness standards exclude any individual who has a history of a mood disorder, including depression, who received outpatient treatment for longer than six months from a physician or mental health professional. The committee's determination of a reasonable cutoff was based on clinical evidence from the civilian youth population. For an adolescent, it takes one to two years to recover from an episode of major depression. Following discontinuation of medication, the period of relapse is greatest during the first year of medication withdrawal. Because relapse rates are high in adolescents, a medication-free period of two years (e.g., ages 16-17) would allow time to assess the clinical response. A cutoff for disqualification of the 13th birthday is a conservative stance designed to decrease the likelihood of a recurrent episode of depression during combat duty. A similar clinical logic applies to anxiety disorders.

Conclusion: Consideration should be given to altering the disqualifying criterion for depression because (1) there will be increasing numbers of applicants who have received treatment for depressive disorders and (2) there is no evidence base to support exclusion of individuals who have received outpatient care for longer than six months.

As is the case for depression, there is increased recognition of the early age of onset of anxiety disorders. DoD fitness standards exclude any individuals who have a history of anxiety disorders.

Conclusion: Given the high prevalence of anxiety disorders in youth and the lack of scientific rationale for the exclusion of an individual with a history of anxiety disorders, consideration should be given to altering this disqualifying criterion.

Recommendation 6-1: We recommend that disqualification for mood and anxiety disorders should occur only if disorders occur after the applicant's 13th birthday. We recognize that the imprecision with which age cutoffs can accurately predict the likelihood of performance problems due to mental illness suggests that waivers may be commonly requested, and frequently granted, for illness occurring after age 13. However, using the 13th birthday as a cutoff allows sufficient time for clinical follow-up of a diagnosed mood or anxiety disorder to identify potential recruits with a risk of recurrence.

Mental Health Screening

There is a single item on the self-report medical prescreen form completed at the recruiting station that is related to psychiatric disorders. Applicants are asked whether they have "seen a psychiatrist, psychologist, counselor or other professional for any reason (inpatient or outpatient) including counseling or treatment for school, adjustment, family, marriage or any other problem to include depression, or treatment for alcohol, drug or substance abuse." Applicants responding "yes" are requested to explain the affirmative response, and all documentation relating to an affirmative response is to be sent directly from the treating clinician or hospital to the MEPS chief medical officer.

Conclusion: The single item (2.a.(16), DD Form 2807-2) addressing psychiatric disorders on the medical prescreen form does not contain sufficient specificity for research and evaluation purposes.

> **Recommendation 6-2:** Specific mental health disorders should be included on the medical prescreen report form. Recommended items include depression after the age of 13, bipolar disorder (manic depressive illness) after the age of 13, anxiety disorders after the age of 13, exposure to trauma, attention deficit hyperactivity disorder with medication treatment in the past year, schizophrenia and psychotic disorders, and hospitalization for mental illness care. A positive response to this screening question would require open-ended amplification regarding the specific diagnosis.

At the MEPS, recruits complete a medical history questionnaire. The available information about the history of treatment for a mental condition depends solely on this self-report. Although recruits undergo a medical evaluation at the MEPS, there is no formal psychiatric assessment.

Conclusion: The history questionnaire can usefully be augmented with a short set of questions regarding current symptoms and a brief standardized mental status examination that addresses mood, anxiety, psychotic symptoms, and suicide. This would be important to include as a routine component of the medical evaluation.

> **Recommendation 6-3:** A brief self-report questionnaire regarding current symptoms of mental health conditions should be administrated at the military entrance processing station.

> **Recommendation 6-4:** A brief mental status examination should be conducted by the medical officer at the MEPS.

There is minimal systematic data collected by the Services regarding individuals with mental health conditions. The prevalence and impact of specific mental health conditions on military performance or attrition rates require further careful study. Mental illness is often coded in vague terms (e.g., adjustment disorder) or is handled administratively without attaching a diagnostic category.

Conclusion: Some elements of a complete database describing the impact of mental illness on military personnel exist, and the committee has reason to think that other data elements could be developed through appropriate linkage of existing databases.

Recommendation 6-5: Data about mental health disorders from recruitment through active duty should be collected and maintained so that informed decisions can be made regarding recruitment and retention of applicants with mental illness. These data should be obtained for all Services and should create an accurate picture of the impact of mental illness on military personnel from recruitment through separation, with a particular focus on the outcome of recruits who request and receive mental illness waivers for specific diagnoses, as well as the rates and diagnoses leading to attrition during training and active duty. Further studies using complete data sets should be designed to determine whether there are any differences in retention and performance between recruits with and without a history of psychiatric disorders, such as depression and anxiety disorders.

SUBSTANCE ABUSE AND TOBACCO USE

Alcohol and Drug Abuse

The general DoD requirements relating to moral character are quite general, stating only that individuals should be disqualified "who have exhibited antisocial behavior or other traits of character that would render them unfit to associate with military personnel." Military leaders generally agree that individual performance and unit morale would suffer greatly if individuals were allowed to be drunk or be high on drugs while on duty.

The specific standards for alcohol and drug abuse are set by each Service, although there are some broad similarities across them. Generally, a history of more severe types of alcohol and drug abuse or dependence is disqualifying, while limited "recreational" use of marijuana does not now require a waiver. Alcohol use does not require a waiver unless the recruit tests positive at the physical. Between these two extremes, the

Services distinguish several degrees of severity of drug and alcohol abuse, and there are some important differences among the branches.

Alcohol consumption dropped significantly between 1980 and 1993, from a high of over 70 percent to a low of about 50 percent. It has fluctuated only slightly since that time and stood at about 47 percent in 2003. For both males and females, white youth have the highest rates of alcohol consumption and black youth the lowest. Hispanic youth are in between but are closer to whites than blacks in their consumption rates.

Marijuana usage also shows a steep drop between 1978 and 1992, from a maximum of 37 percent to a low of 12 percent. The rate began rising again in the early 1990s and reached a more recent maximum of just under 25 percent in 1997, and it has remained at about that level since that time. The use of other illicit drugs is about half the level of marijuana, and it shows a similar pattern but with somewhat less pronounced swings. Total illicit drug use among men differs very little by race; however, differences are found by gender. Black women have rates that are consistently 10 points below white women.

Substance Abuse and Military Performance

The primary outcome for evaluating moral character standards is attrition. Serious substance abusers are ineligible for enlistment in the first place (e.g., chronic alcoholism, illicit drug dependence), and very few waivers are granted for those who test positive at the MEPS for alcohol or illicit drugs other than marijuana. The main question therefore concerns waivers granted for positive tests for marijuana. Since a history of occasional use of marijuana no longer requires a waiver, we were restricted to evaluating attrition of enlistees who enter with a waiver for marijuana. Such waivers range from 2,000 to 3,000 per year, which is about 1.5 percent of total accessions.

At 12 months, attrition is elevated for marijuana waivers by only 3 percent; female rates are more elevated, but very few women receive these waivers. Attrition rates at 24 months are more elevated (6 to 9 percent), but even this difference is modest. Finally, 36-month attrition is elevated by 10 percentage points. On one hand, it is not clear whether these elevated rates would justify changes in the waiver policy; the longer persons stay in the Service past 12 months (the maximum length of most training periods), the more likely they are to repay the initial training investment. On the other hand, there are relatively few of these waivers, which means excluding them would not have much impact on recruiting costs. A formal cost-performance trade-off analysis would be required to test whether stricter standards for marijuana waivers would be cost-effective.

Conclusion: Few persons enter the military with serious substance abuse, but about 1.5 percent of accessions enter with a marijuana waiver. Attrition is not significantly elevated at 12 months of military service for those with marijuana waivers, but it is modestly elevated at 24 and 36 months of service. It is unclear at this point whether a cost-performance analysis would suggest any changes to the current standard, since the savings from reduced training costs may or may not exceed the additional costs of recruiting.

> **Recommendation 7-1:** We recommend that DoD undertake a formal cost-performance trade-off analysis to determine whether a stricter standard for marijuana waivers would be justified on cost-effectiveness grounds.

Tobacco Use

Results from the DoD Survey of Health-Related Behaviors conducted in 2002 suggest that cigarette smoking is widespread in all branches of the military. This particular survey also indicates that nearly one-third of the military's smokers brought the habit with them when they joined. Not surprisingly, then, cigarette smoking was found to be most prevalent among members in the junior pay grades, ranging from a rate of nearly 50 percent for junior enlisted personnel (E-1 to E-3), to 24 percent for senior enlisted personnel (E-7 to E-9), to just over 10 percent for junior officers (O-1 to O-3).

One of the most interesting recent discoveries of research on the first-term attrition of new recruits relates to preservice smoking behavior. A series of studies over the past six years produced a variety of interesting findings. An initial Navy study found that attrition from Navy boot camp was nearly twice as high for smokers (15 percent) than for nonsmokers (8 percent). A follow-up study found that differences in attrition between preservice smokers and nonsmokers continued beyond boot camp through the first year of service, leading to the conclusion that the ban on smoking in boot camp was not the primary factor in explaining the higher rates of attrition among smokers. Additional research found that recruits who required some form of enlistment waiver were approximately 1.5 times more likely than their counterparts without a waiver to have smoked before entering military service. A subsequent Air Force study found that preservice smokers were approximately 1.8 times more likely to be discharged during the first year of service than were nonsmokers. A large-scale Army study found that the odds of attrition for soldiers who smoked prior to entering the delayed entry program were 1.54 times those of nonsmokers.

Recruits who smoked were considerably more likely than nonsmokers to have had behavioral problems before enlistment, including high school misbehavior, criminal offenses, drug use, psychological difficulties, and trouble in dealing with authority. Thus preservice smoking is linked with some psychological factor or behavioral predisposition that raises the risk of being discharged early from the military. Interestingly, these smoking effects are independent of education, which has long been recognized as having a strong link to attrition.

Conclusion: Smoking in the military is no more commonplace than in civilian populations of comparable ages. Smoking before entry is associated with injury during basic training, probably arising from its adverse effects on numerous physiological characteristics. Studies across the Services show elevated attrition rates for smokers, although the degree of elevation differs appreciably among the Services, perhaps due to different definitions of the frequency and quantity of smoking. It is clear that screening out all smokers or even frequent smokers would not be feasible simply because of their prevalence. Since smoking is correlated with other recruit characteristics related to lower performance outcomes, further research might identify subgroups of recruits with a set of behavioral characteristics that justify higher priority on entry than other subgroups.

Recommendation 7-2: Further research is needed on the relationship between preservice smoking and military performance, including attrition and other indicators. The research should be conducted across the Services using the same definitions of frequency and quantity of smoking, and the correlates of smoking with other recruit characteristics should be studied. Studies should include the costs and benefits of policy and force management options for dealing with the issue of preservice smoking.

RECOMMENDATIONS AND POLICY OPTIONS

This volume has examined a wide variety of aspects of military recruitment, including issues of physical fitness, body mass and obesity, medical conditions, mental health, and drug and tobacco use. The results of the committee's work led to five broad categories of conclusions and recommendations: reducing injuries and attrition, increasing the pool of eligible youth, developing databases and procedures needed to study the relationship between standards and outcomes, identifying standards that need further investigation, and identifying standards that should be retained.

Injuries and Attrition

Two recommendations concern reducing injury and attrition: (1) develop a standardized fitness test for use in the recruiting process and (2) tailor the demands of basic training to the fitness levels of recruits. Recommendations aimed primarily at reducing attrition involve obtaining better information about recruits' mental health status via the use of a brief self-report of mental symptoms at the military entrance processing station, accompanied by a brief mental status exam by a physician.

Increasing the Pool of Eligible Youth

Three recommendations concern increasing the proportion of the youth population eligible for entry into military service: (1) do not use BMI as a proxy for fitness, (2) do not use a BMI standard for retention that is more stringent than a BMI standard for entry, and (3) do not require documentation or further medical reviews for self-reported mood and anxiety disorders that occur before the 13th birthday.

Developing Databases and Procedures

Five recommendations concern developing databases and administrative procedures to permit a broader and more probing inquiry into the relationship between standards and outcomes than is possible in light of data available today: (1) maintain data from the medical history form completed by recruits at the recruiting station, (2) develop a common core of physical strength and fitness measures across the Services, (3) collect data permitting the linkage between medical standards and outcomes, (4) increase the specificity of the single mental health item on the medical history prescreen administered at the military entrance processing station, and (5) collect and retain mental health data from recruitment through length of service.

Identifying Needed Research

Six recommendations concern substantive research studies needed prior to recommending changes in a current standard or in implementing a new one: (1) analyze the physical requirements of the set of common military tasks across military occupational specialties to obtain a clearer picture of the physical demands of these tasks, (2) study prebasic training fitness interventions to determine whether they are a viable and cost-effective route to reduced injury and attrition, (3) examine the causes of increased injury and attrition in women, (4) compare attrition rates of

enlistees with and without mental health conditions existing prior to service, (5) conduct a cost-benefit analysis regarding the effects of increasing the stringency of the current marijuana waiver policy, and (6) conduct further research on the relationship between smoking and attrition, with particular attention to the behavioral factors driving the observed relationship.

Standard Retention

One issue concerns retaining a current standard. Due to the prevalence of asthma, the committee carefully reviewed the literature on the relationship between asthma and outcomes of interest to the Services and concluded that the current standard and waiver process are appropriate.

The committee concluded its earlier study of the role of youth attitudes toward the military and of aptitude and educational standards by noting that recruiting is a complex process, with no single route toward achieving recruiting goals. We end here with the same conclusion. We think, however, that we have been able to highlight a variety of important issues meriting attention as efforts to improve the effectiveness of the recruiting process continue.

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Appendix A

Medical Standards for Appointment, Enlistment, or Induction in the Armed Forces

Department of Defense (DoD) Instruction 6130.4, "Criteria and Procedure Requirements for Physical Standards for Appointment, Enlistment, or Induction in the Armed Forces," lays out the medical standards that applicants must meet in order to enter military service. This instruction was most recently updated on January 18, 2005. Instruction 6130.4 is available on line at http://www.dtic.mil/whs/directives/corres/html/61304.htm.

Appendix B

Analysis of Waivers for Disqualifying Conditions

TABLE B-1 Active Accessions and Cumulative Attrition Rates by Waiver Type, All Services

	FY 2000			
	Accessions	12 Months	24 Months	36 Months
No waiver				
Women	29,386	20	28	34
Men	119,282	14	21	26
Total	148,668	15	22	27
Drugs				
Women	180	31	42	48
Men	2,168	17	27	34
Total	2,348	18	28	35
Weight				
Women	420	20	27	31
Men	3,081	17	22	27
Total	3,501	17	23	27
Disease				
Women	1,079	25	31	38
Men	4,651	16	22	27
Total	5,730	18	24	29
Dependents				
Women	477	25	33	40
Men	1,312	17	24	28
Total	1,789	19	26	31
Mental				
Women	295	15	23	29
Men	1,202	16	22	27
Total	1,497	16	22	28
Law violations				
Women	878	19	28	34
Men	8,289	17	26	32
Total	9,167	17	26	32
Other				
Women	595	22	30	36
Men	3,777	22	31	37
Total	4,372	22	31	37
All accessions				
Women	33,619	20	28	34
Men	145,214	15	22	27
Total	178,833	16	23	28

FY 2001			
Accessions	12 Months	24 Months	36 Months
29,940	19	27	34
125,831	13	20	25
155,771	14	22	27
253	27	38	46
2,604	16	30	37
2,857	17	31	38
315	20	28	32
2,619	16	21	25
2,934	17	22	26
1,034	21	32	39
4,331	14	21	26
5,365	16	23	28
501	22	31	36
1,188	14	19	23
1,689	16	23	27
271	15	24	28
1,182	14	20	25
1,453	14	21	25
831	18	27	33
8,481	14	23	29
9,312	14	24	30
273	20	27	34
2,168	20	30	37
2,441	20	30	37
33,653	19	28	
149,323	14	21	26
182,976	15	22	27

Continued

TABLE B-1 Continued

	FY 2002		
	Accessions	12 Months	24 Months
No waiver			
Women	28,115	18	26
Men	127,167	13	19
Total	155,282	14	20
Drugs			
Women	210	29	43
Men	2,364	17	28
Total	2,574	18	29
Weight			
Women	214	20	24
Men	2,445	17	21
Total	2,659	18	21
Disease			
Women	885	22	32
Men	3,924	15	21
Total	4,809	16	23
Dependents			
Women	308	18	27
Men	1,062	14	17
Total	1,370	15	21
Mental			
Women	246	23	33
Men	773	13	18
Total	1,019	15	22
Law violations			
Women	893	18	26
Men	9,832	13	21
Total	10,725	14	22
Other			
Women	330	23	26
Men	1,788	17	27
Total	2,118	18	0
All accessions			
Women	31,354	19	27
Men	150,156	13	19
Total	181,510	14	21

FY 2003	
Accessions	12 Months
27,678	20
125,006	12
152,684	14
140	31
1,817	16
1,957	17
211	18
2,056	13
2,267	14
1,007	22
4,734	15
5,741	16
251	18
923	11
1,174	12
177	27
281	17
458	21
850	18
8,580	14
9,430	14
251	25
1,827	16
2,078	17
30,676	20
145,732	13
176,408	14

TABLE B-2 Accessions and Cumulative Attrition Rates by Waiver Type, FY 2000 and FY 2001 Combined

	Air Force			
	Accessions	12 Months	24 Months	36 Months
No waiver				
Women	14,633	11	17	21
Men	42,005	10	14	17
Total	56,638	10	14	18
Drugs				
Women	4	*a*	*a*	*a*
Men	39	15	23	26
Total	43	16	26	28
Weight				
Women	140	9	15	18
Men	215	14	17	20
Total	355	12	16	19
Disease				
Women	471	18	22	27
Men	1,367	10	13	17
Total	1,838	12	15	19
Dependents				
Women	291	15	22	27
Men	537	9	12	14
Total	828	11	15	19
Mental				
Women	421	14	20	26
Men	1,710	14	20	25
Total	2,131	14	20	25
Law violations				
Women	593	14	19	25
Men	3,765	11	17	21
Total	4,358	11	17	21
Other				
Women	37	19	24	35
Men	88	14	16	18
Total	125	15	18	23
All accessions				
Women	16,714	12	17	22
Men	50,000	10	14	18
Total	66,714	10	15	19

Army			
Accessions	12 Months	24 Months	36 Months
25,636	24	36	44
93,959	14	22	28
119,595	16	25	32
210	30	45	55
1,917	13	31	42
2,127	14	32	43
80	30	38	44
256	17	24	31
336	20	27	34
1,124	27	38	47
4,861	16	23	28
5,985	18	26	32
255	23	33	39
146	14	19	23
401	20	28	33
55	18	42	47
84	21	26	35
139	20	32	40
468	19	34	42
5,407	12	24	31
5,875	13	24	32
4	*a*	*a*	*a*
50	20	22	28
54	20	22	30
28,026	25	36	44
107,482	14	23	29
135,508	16	25	32

Continued

TABLE B-2 Continued

	Marine Corps			
	Accessions	12 Months	24 Months	36 Months
No waiver				
Women	3,540	23	29	33
Men	45,542	15	20	24
Total	49,082	16	21	25
Drugs				
Women	68	35	41	43
Men	1,635	18	25	29
Total	1,703	19	26	30
Weight				
Women	327	23	32	35
Men	4,813	17	22	26
Total	5,140	17	22	27
Disease				
Women	83	24	30	35
Men	954	18	22	26
Total	1,037	19	22	27
Dependents				
Women	15	*a*	*a*	*a*
Men	583	17	24	28
Total	598	18	24	28
Mental				
Women	69	14	25	25
Men	400	13	18	23
Total	469	13	19	23
Law violations				
Women	55	22	27	35
Men	1,439	16	22	26
Total	1,494	17	23	26
Other				
Women	58	29	38	43
Men	484	19	27	31
Total	542	20	28	33
All accessions				
Women	4,240	23	30	34
Men	56,139	16	21	25
Total	60,379	16	21	25

Navy			
Accessions	12 Months	24 Months	36 Months
15,517	18	24	29
63,607	15	23	27
79,124	16	23	28
151	24	31	38
1,181	19	30	36
1,332	20	30	36
188	20	25	29
416	15	23	26
604	16	23	27
435	19	24	29
1,800	18	24	28
2,235	18	24	28
417	30	39	45
1,234	18	25	30
1,651	21	29	34
21	*a*	*a*	*a*
190	22	34	40
211	22	34	40
593	22	32	36
6,159	20	31	37
6,752	20	31	37
769	21	28	35
5,323	22	32	38
6,092	22	31	38
18,292	19	25	30
80,916	16	24	29
99,208	17	24	29

Continued

TABLE B-2 Continued

	DoD			
	Accessions	12 Months	24 Months	36 Months
No waiver				
Women	59,326	20	28	34
Men	245,113	14	21	25
Total	304,439	15	22	27
Drugs				
Women	433	29	40	47
Men	4,772	16	29	36
Total	5,205	17	30	37
Weight				
Women	735	20	28	31
Men	5,700	17	22	26
Total	v6,435	17	22	27
Disease				
Women	2,113	23	31	38
Men	8,982	15	22	26
Total	11,095	17	23	28
Dependents				
Women	978	24	32	38
Men	2,500	15	22	26
Total	3,478	18	25	29
Mental				
Women	566	15	24	29
Men	2,384	15	21	26
Total	2,950	15	21	27
Law violations				
Women	1,709	19	28	34
Men	16,770	15	25	31
Total	18,479	16	25	31
Other				
Women	868	21	29	35
Men	5,945	22	31	37
Total	6,813	22	31	37
All accessions				
Women	67,272	20	28	31
Men	294,537	14	21	26
Total	361,809	15	22	28

[a]Less than 25 accessions.

TABLE B-3 FOLLOWS

TABLE B-3 Medical Failures and Waivers, May 1, 2003 to April 30, 2005, Active Forces (most frequent medical failures, ranked by frequency; excludes cases with 2+ failures)

Medical Status		Accessions	
Name	Code	No Waiver	Waiver
No failure	—	213,614	
All other[a]	88		7,528
Weight	54		7,524
Marijuana[b]	50M		1,727
Psychiatric	40		1,468
Lower extremity	34		1,858
Lungs/chest	28		1,402
Hearing	71		1,032
Vision	62		1,172
Upper extremity	33		1,500
Skin	38		1,115
Totals		213,614	26,326
Total accessions			
Total not accessed			
Total applicants			

NOTE: MEPS Integrated Resource System Medical Failures.
[a]All other medical fail codes with N < 2000.
[b]Positive test at physical.
SOURCE: MIRS Summary Tabulations, Two-Year Revised Data.

Not Accessed		Total Applicants			
No Failure	Failure	No Failure	Failure	% Waived	% Occurrence
145,468		359,082			
	13,276		20,804	36	29.7
	8,788		16,312	46	23.3
	7,069		8,796	20	12.6
	2,835		4,303	34	6.1
	2,200		4,058	46	5.8
	2,298		3,700	38	5.3
	2,605		3,637	28	5.2
	1,696		2,868	41	4.1
	1,340		2,840	53	4.1
	1,601		2,716	41	3.9
					100.0
145,468	43,708	359,082	70,034	38	
			239,940		
			189,176		
			429,116		

TABLE B-4 Medical Failures and Waivers By Gender, Race, and Service

Medical Status		Accessions	
Name	Code	No Waiver	Waiver
Women			
No failure	—	33,215	
Weight	54		2,055
All other[a]	88		1,394
Marijuana[b]	50M		105
Vision	62		242
Psychiatric	40		150
Lungs/chest	28		168
Lower extremity	34		226
Skin	38		176
Hearing	71		80
Upper extremity	33		100
Totals		33,215	4,696
Men			
No failure	—	180,399	
All other[a]	88		6,134
Weight	54		5,469
Marijuana[b]	50M		1,622
Psychiatric	40		1,318
Lower extremity	34		1,632
Hearing	71		952
Lungs/chest	28		1,234
Upper extremity	33		1,400
Skin	38		939
Vision	62		930
Totals		180,399	21,630
Black			
No failure	—	31,357	
All other[a]	88		995
Weight	54		974
Marijuana[b]	50M		331
Lungs/chest	28		211
Lower extremity	34		228
Vision	62		150
Hearing	71		101
Skin	38		144
Psychiatric	40		92
Upper extremity	33		106
Totals		31,357	3,332

Not Accessed		Total Applicants			
No Failure	Failure	No Failure	Failure	% Waived	% Occurrence
29,185		62,400			
	3,147		5,202	40	37.0
	3,192		4,586	30	32.6
	614		719	15	5.1
	444		686	35	4.9
	461		611	25	4.3
	405		573	29	4.1
	312		538	42	3.8
	352		528	33	3.8
	313		393	20	2.8
	116		216	46	1.5
					100.0
29,185	9,356	62,400	14,052	33	
116,283		296,682			
	10,084		16,218	38	29.0
	5,641		11,110	49	19.8
	6,455		8,077	20	14.4
	2,374		3,692	36	6.6
	1,888		3,520	46	6.3
	2,292		3,244	29	5.8
	1,893		3,127	39	5.6
	1,224		2,624	53	4.7
	1,249		2,188	43	3.9
	1,252		2,182	43	3.9
					100.0
116,283	34,352	296,682	55,982	39	
21,227		52,584			
	2,023		3,018	33	30.2
	1,314		2,288	43	22.9
	1,491		1,822	18	18.2
	409		620	34	6.2
	278		506	45	5.1
	267		417	36	4.2
	297		398	25	4.0
	237		381	38	3.8
	226		318	29	3.2
	114		220	48	2.2
					100.0
21,227	6,656	52,584	9,988	33	

Continued

TABLE B-4 Continued

Medical Status		Accessions	
Name	Code	No Waiver	Waiver
White			
No failure	—	154,339	
All other[a]	88		5,657
Weight	54		5,489
Marijuana[b]	50M		1,223
Psychiatric	40		1,271
Lower extremity	34		1,481
Hearing	71		781
Lungs/chest	28		1,018
Upper extremity	33		1,240
Vision	62		848
Skin	38		817
Totals		154,339	19,825
Other			
No failure	—	15,236	
All other[a]	88		465
Weight	54		598
Marijuana[b]	50M		93
Hearing	71		90
Psychiatric	40		62
Lungs/chest	28		82
Vision	62		81
Lower extremity	34		75
Skin	38		69
Upper extremity	33		81
Totals		15,236	1,696
Air Force			
No failure	—	36,145	
All other[a]	88		1,079
Weight	54		826
Psychiatric	40		267
Lower extremity	34		259
Lungs/chest	28		145
Vision	62		154
Upper extremity	33		215
Marijuana[b]	50M		
Skin	38		139
Hearing	71		60
Totals		36,145	3,144

Not Accessed		Total Applicants			
No Failure	Failure	No Failure	Failure	% Waived	% Occurrence
101,603		255,942			
	9,073		14,730	38	29.7
	5,872		11,361	48	22.9
	4,623		5,846	21	11.8
	2,170		3,441	37	6.9
	1,615		3,096	48	6.2
	1,779		2,560	31	5.2
	1,502		2,520	40	5.1
	1,052		2,292	54	4.6
	1,084		1,932	44	3.9
	1,079		1,896	43	3.8
					100.0
101,603	29,849	255,942	49,674	40	
12,855		28,091			
	1,341		1,806	26	29.0
	1,043		1,641	36	26.3
	652		745	12	11.9
	313		403	22	6.5
	284		346	18	5.5
	252		334	25	5.4
	191		272	30	4.4
	191		266	28	4.3
	162		231	30	3.7
	110		191	42	3.1
					100.0
12,855	4,539	28,091	6235	27	
23,801		59,946			
	1,942		3,021	36	35.9
	862		1,688	49	20.1
	320		587	45	7.0
	325		584	44	6.9
	341		486	30	5.8
	292		446	35	5.3
	218		433	50	5.1
	410		410	0	4.9
	264		403	34	4.8
	296		356	17	4.2
					100.0
23,801	5,270	59,946	8,414	37	

Continued

TABLE B-4 Continued

Medical Status		Accessions	
Name	Code	No Waiver	Waiver
Army			
No failure	—	93,986	
All other[a]	88		3,759
Weight	54		4,105
Marijuana[b]	50M		575
Psychiatric	40		677
Lower extremity	34		919
Hearing	71		692
Lungs/chest	28		652
Upper extremity	33		755
Vision	62		609
Skin	38		532
Totals		93,986	13,275
Marine Corps			
No failure	—	39,469	
All other[a]	88		1,291
Weight	54		1,201
Marijuana[b]	50M		605
Psychiatric	40		325
Lungs/chest	28		295
Lower extremity	34		331
Hearing	71		147
Upper extremity	33		262
Skin	38		201
Vision	62		190
Totals		39,469	4,848
Navy			
No failure	—	44,014	
All other[a]	88		1,399
Weight	54		1,392
Marijuana[b]	50M		547
Lungs/chest	28		310
Lower extremity	34		349
Psychiatric	40		199
Hearing	71		133
Vision	62		219
Skin	38		243
Upper extremity	33		268
Totals		44,014	5,059

[a]All other medical fail codes with N < 2000.
[b]Positive test at physical.
SOURCE: MIRS Summary Tabulations, Two-Year Revised Data.

Not Accessed		Total Applicants			
No Failure	Failure	No Failure	Failure	% Waived	% Occurrence
48,895		142,881			
	5,888		9,647	39	29.1
	4,254		8,359	49	25.3
	3,409		3,984	14	12.0
	1,362		2,039	33	6.2
	971		1,890	49	5.7
	1,174		1,866	37	5.6
	939		1,591	41	4.8
	542		1,297	58	3.9
	656		1,265	48	3.8
	632		1,164	46	3.5
					100.0
48,895	19,827	142,881	33,102	40	
30,008		69,477			
	2,182		3,473	37	28.0
	1,249		2,450	49	19.7
	1,569		2,174	28	17.5
	501		826	39	6.7
	430		725	41	5.8
	373		704	47	5.7
	483		630	23	5.1
	246		508	52	4.1
	263		464	43	3.7
	269		459	41	3.7
					100.0
30,008	7,565	69,477	12,413	39	
42,764		86,778			
	3,264		4,663	30	29.0
	2,423		3,815	36	23.7
	1,681		2,228	25	13.8
	588		898	35	5.6
	531		880	40	5.5
	652		851	23	5.3
	652		785	17	4.9
	479		698	31	4.3
	442		685	35	4.3
	334		602	45	3.7
					100.0
42,764	11,046	86,778	16,105	31	

Appendix C

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LTC David Niebuhr, Accessions Medical Standards Analysis and Research Activity
Louis Pappamichiel, U.S. Military Entrance Processing Command
LTC Gene Piskator, U.S. Army Accession Command
Dan Putka, HumRRO
Dr. Valerie Rice, U.S. Army Medical Department Center and School
LtCol Dan Weaver, U.S. Military Entrance Processing Command

Appendix D

Biographical Sketches of Committee Members and Staff

Paul R. Sackett (*Chair*) is professor in the Department of Psychology at the University of Minnesota, Twin Cities. His research interests revolve around legal, psychometric, and policy aspects of psychological testing, assessment, and personnel decision making in workplace settings. He has served as the editor of *Personnel Psychology*, as president of the Society for Industrial and Organizational Psychology, as cochair of the Joint Committee on the Standards for Educational and Psychological Testing, as a member of the National Research Council's Board on Testing and Assessment, and as chair of the American Psychological Association's Board of Scientific Affairs. He has a Ph.D. in industrial and organizational psychology from the Ohio State University.

David J. Armor is professor of public policy in the School of Public Policy at George Mason University, where he served as director of the Ph.D. program from 2002 to 2005. He teaches graduate courses in multivariate statistics and social policy and conducts research in education, military manpower, and family policy. He began his research in military manpower while at the Rand Corporation, and between 1986 and 1989 he served as principal deputy and acting assistant secretary for force management and personnel in the U.S. Department of Defense. While at Rand and the Department of Defense, he contributed to the Job Performance Measurement Project and subsequent efforts to validate enlistment standards for education and aptitudes. He was also a member of the National Research Council's Committee on Military Enlistment Standards. He has a Ph.D. in sociology from Harvard University.

Noreen M. Clark is dean of the School of Public Health and Marshall H. Becker professor of public health at the University of Michigan. Her research specialty concerns the social and behavioral aspects of chronic disease management. She uses asthma and heart disease as models to explore elements of self-regulation, including a patient's ability to observe, judge, and react appropriately to his or her own efforts to manage disease. She has also conducted large-scale trials of behavioral and educational interventions in clinical and community settings aimed at improving disease management by patients, families, and health care providers. She serves as national program director for the Robert Wood Johnson Foundation Allies Against Asthma Program. She is a member of the Institute of Medicine, former president of the Society for Public Health Education, and former editor of *Health Education and Behavior*. She has a Ph.D. from Columbia University.

Mark J. Eitelberg is professor of public policy at the Naval Postgraduate School. Recently, he was a visiting research collaborator with the Office of Population Research, Woodrow Wilson School of Public and International Affairs, Princeton University. He is former editor of the journal, *Armed Forces & Society*. He has worked with a number of agencies, commissions, and private organizations, including the Human Resources Research Organization (as senior scientist for eight years), the Brookings Institution, the Rand Corporation, the Technical Cooperation Program (an international consortium of defense scientists), and the National Research Council's Committee on Techniques for the Enhancement of Human Performance, among others. An author and editor of numerous publications, he is editing a four-book set, *Americans in Arms*. He has M.P.A. and Ph.D. degrees from the Wagner School of Public Service at New York University.

Barbara C. Hansen is professor of internal medicine and director of the Obesity, Diabetes and Aging Research Center at the College of Medicine of the University of South Florida. Her work focuses on the relationships between overweight and diabetes, examining their causes from the perspective of defective conditions in the body, its cells, and even its molecules. For more than a dozen years, her research group has been conducting a study to see if a weight control regimen can prevent middle-age diabetes and extend life span. A member of the Institute of Medicine, she has served as an adviser and consultant to many other leading scientific societies and organizations, including the National Institutes of Health, the Robert Wood Johnson Foundation, and the National Institute for Environmental Health Sciences. She has authored numerous scientific

papers as well as the book, *A Common Sense Guide to Weight Loss for People with Diabetes*. She served on the Institute of Medicine's Subcommittee on Military Weight Management Programs. She has a Ph.D. in physiology and psychology from the University of Washington.

Paul F. Hogan is vice president and senior economist at The Lewin Group in Fairfax, Virginia. He has more than 20 years of experience in applying microeconomics, statistics, and operations research methods to problems in labor economics, including labor supply and demand, efficient staffing methods, and performance and cost measurement. He served as the senior analyst on the President's Military Manpower Task Force and as director of manpower planning and analysis in the Office of the Secretary of Defense, the office charged with staffing methods and criteria used by military departments to determine demands for personnel. He was awarded the Secretary of Defense Distinguished Civilian Service medal in 1982 and 1985, and the Navy Superior Civilian Service medal in 1980. His doctoral studies include economics, econometrics, and finance at the University of Rochester and his undergraduate degree is in economics from the University of Virginia.

William S. Marras is a professor of industrial and systems engineering at the Ohio State University. He is the director of the university's Biodynamics Laboratory and codirector of the Institute for Ergonomics. He also is the recipient of the Honda endowed chair in transportation research. He holds academic appointments in the Department of Industrial, Welding, and Systems Engineering, the Department of Physical Medicine, and the Biomedical Engineering Center. His research involves industrial biomechanics issues, laboratory biomechanics studies, mathematical modeling, and clinical studies of the back and wrist. He was a member of the National Research Council's Committee on Musculoskeletal Disorders and the Workplace and is currently a member of the Committee on Human Factors. He has an M.S. in engineering and a Ph.D. in bioengineering and ergonomics from Wayne State University.

Stephen W. Marshall is assistant professor at the University of North Carolina at Chapel Hill, with joint appointments in the Department of Epidemiology in the School of Public Health and the Department of Orthopedics in the School of Medicine. His main area of research is injury prevention, occupational injury, biostatistics, epidemiological methods, and epidemiological data analysis. He is a member of the American College of Sports Medicine, the American Public Health Association, and the Society for Epidemiologic Research. Before coming to the University of North Carolina in 1994, he worked in the Injury Prevention Research Unit

at the University of Otago, Dunedin, New Zealand, and at the Wellington School of Medicine in New Zealand. He has a Ph.D. in epidemiology from the University of North Carolina at Chapel Hill.

Anne S. Mavor (*Study Director*) is the staff director for the Committee on Human Factors and the Committee on the Youth Population and Military Recruitment. Her previous National Research Council work has included studies on occupational analysis and the enhancement of human performance, modeling human behavior and command decision making, human factors in air traffic control automation, human factors considerations in tactical display for soldiers, scientific and technological challenges of virtual reality, emerging needs and opportunities for human factors research, and modeling cost and performance for purposes of military enlistment. For the past 25 years, her work has concentrated on human factors, cognitive psychology, and information system design. She has an M.S. in experimental psychology from Purdue University.

Russell R. Pate is a professor of exercise physiology in the Arnold School of Public Health at the University of South Carolina. His scholarly work has focused primarily on the relationships between physical activity and health in children and adolescents. He has served as president of the American College of Sports Medicine and as chairman of the Physical Fitness Council of the American Alliance for Health, Physical Education, Recreation, and Dance and has been recognized with scholar awards from both organizations. He has a Ph.D. in exercise physiology from the University of Oregon.

Garrison Rapmund is a board-certified pediatrician and senior fellow of the Krasnow Institute for Advanced Study at George Mason University. He has spent his entire career in biomedical research. He was the assistant surgeon general of the U.S. Army for Research and Development and retired in the grade of major general. From his role as a scientific adviser at the National Institutes of Health, the Federal Aviation Administration, and national laboratories of the Department of Energy, he has extensive knowledge of biological science activities in the civilian sector. For 10 years Rapmund was also a member of a review panel concerned with technology transfer and commercialization of technology from the Ballistic Missile Defense Organization to the life sciences. He served for six years on the U.S. Air Force Scientific Advisory Board, where he was chair of the human systems panel. He also serves as an external adviser to the Applied Physics Laboratory of Johns Hopkins University. He was awarded the Joseph E. Smadel Medal of the Infectious Diseases Society of America for his military field research on mite-borne typhus in Asia. He is

a graduate of Harvard University and the College of Physicians and Surgeons of Columbia University.

Thomas L. Schwenk is professor and chair of the Department of Family Medicine at the University of Michigan and associate director of the University of Michigan Depression Center. His research focuses on psychiatric issues in primary care, including the delivery of mental health services in primary care. He has also studied the incorporation of the behavioral sciences in primary care training, the nature of difficult physician-patient relationships, and the care of patients with chronic pain and chronic fatigue. He is involved in associated translation and dissemination work regarding psychiatric epidemiology and the role of primary care in the mental health care system, including consultations with the American Academy of Family Physicians and the American Board of Family Medicine. A member of the Institute of Medicine, he is board-certified in family medicine and sports medicine and has additional interests in psychiatric issues in athletes and the promotion of exercise as a therapeutic agent in chronic disease. He has an M.D. from the University of Michigan.

William J. Strickland is vice president of the Human Resources Research Organization (HumRRO) in Alexandria, Virginia. He also directs its Workforce Analysis and Training Systems Division. He is a retired Air Force colonel who was director of human resources research at the U.S. Air Force Armstrong Laboratory. In that position, he was responsible for all Air Force research in the areas of manpower and personnel, education and training, simulation and training devices, and logistics. Earlier in his career, he commanded an Air Force recruiting squadron, was the chief of market research for Air Force recruiting, and was the deputy director for operations for Air Force recruiting. A fellow of the American Psychological Association, he is a past president of its Division of Military Psychology. He has a Ph.D. in industrial and organizational psychology from the Ohio State University.

Stephen B. Thomas is the Philip Hallen professor of community health and social justice and director of the Center for Minority Health in the Graduate School of Public Health at the University of Pittsburgh. In 1998, he was a member of the Institute of Medicine's Committee on Reducing the Odds: Preventing Perinatal Transmission of HIV in the United States. In 1997, he was an invited guest at the White House ceremony for the presidential apology to survivors of the syphilis study at Tuskegee. Over the past 15 years, he has applied his expertise in behavioral science and health education in the African American community. His work has addressed the translation of evidence-based public health science into cul-

turally competent community-based interventions. He is on the board of directors of the Center for the Advancement of Health and the National Advisory Council for Active Living by Design, sponsored by the Robert Wood Johnson Foundation. In 2004, he was awarded the Alonzo Smyth Yerby Award by the Harvard University School of Public Health for his contributions toward the elimination of racial and ethnic health disparities. He has a Ph.D. (1985) from Southern Illinois University in Carbondale.

Karen Dineen Wagner is the Robert L. Stubblefield professor in child psychiatry, vice chair of the Department of Psychiatry and Behavioral Sciences and director of the Division of Child and Adolescent Psychiatry at the University of Texas Medical Branch. Her research focuses on the treatment of depression and bipolar disorder in children and adolescents. She has authored numerous scientific papers in leading psychiatric journals. She is a member of the National Advisory Mental Health Council of the National Institutes of Health, as well as other scientific and professional organizations. In 2004, she was awarded an honorary doctorate from the State University of New York for her accomplishments in the field of child and adolescent psychiatry. She has a Ph.D. in clinical psychology from Temple University and an M.D. from the State University of New York at Stony Brook. She completed her residency in psychiatry at Beth Israel Hospital and a fellowship in child and adolescent psychiatry at McLean Hospital, both with Harvard Medical School.

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