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Military Services Fitness Database: Development of a Computerized Physical Fitness and Weight Management Database for the U.S. Army

Donald A. Williamson, PhD*; COL Gaston P. Bathalon, SP USA†; LTC Lori D. Sigrist, SP USA†; H. Raymond Allen, PhD*; COL Karl E. Friedl, MS, USA†; Andrew J. Young, PhD†; Corby K. Martin, PhD*; Tiffany M. Stewart, PhD*; MAJ Lolita Burrell, MS, USA†; Hongmei Han, M. Ap. Stat.*; RADM Van S. Hubbard, PHS‡; Donna Ryan, MD*

ABSTRACT The Department of Defense (DoD) has mandated development of a system to collect and manage data on the weight, percent body fat (%BF), and fitness of all military personnel. This project aimed to (1) develop a computerized weight and fitness database to track individuals and Army units over time allowing cross-sectional and longitudinal evaluations and (2) test the computerized system for feasibility and integrity of data collection over several years of usage. The computer application, the Military Services Fitness Database (MSFD), was designed for (1) storage and tracking of data related to height, weight, %BF for the Army Weight Control Program (AWCP) and Army Physical Fitness Test (APFT) scores and (2) generation of reports using these data. A 2.5-year pilot test of the MSFD indicated that it monitors population and individual trends of changing body weight, %BF, and fitness in a military population.

INTRODUCTION

In November 2001, a workshop convened resulting in Department of Defense Instruction 1308.3 (DoDI 1308.3), DoD Physical Fitness and Body Fat Program Procedures.^{1,2} This workshop recommended several initiatives including a key recommendation to develop a flexible, centralized database system for each military service to track height, weight, percent body fat (%BF), and fitness data of military personnel.

*Pennington Biomedical Research Center, Baton Rouge, LA 70808-4124.

†U.S. Army Research Institute of Environmental Medicine, Natick, MA 01760-5007.

‡Public Health Service, Bethesda, MD 20817-5461.

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Soldiers must meet age- and gender-specific body fat standards, as defined by Army Regulation (AR) 600-9. The Army Weight Control Program (AWCP), to remain in the military.³ Age- and gender-specific weight-for-height allowances are used as the primary screening tool to identify potentially overfat soldiers (individuals who may exceed the body fat standard). Soldiers exceeding the weight allowance are "taped"—gender-specific circumferences are measured that determine %BF from standardized equations.^{4,5} As of May 2007, 13,364 soldiers (2.7% of the active duty Army population) exceeded %BF and were enrolled in the AWCP (personal communication, U.S. Army Medical Command, May 2007). Since 1992, ~24,000 soldiers have been discharged from the Army for failure to comply with AR 600-9 (personal communication, Human Resources Policy Directorate, October 2006). Soldiers discharged from military service for failure to comply with AR 600-9 pose a significant financial cost to the military in terms of training.⁶

In addition to meeting weight allowances and %BF standards soldiers must also meet fitness standards to remain in the military. The Army Physical Fitness Test (APFT), taken twice a year in an active duty population, consists of three events: extended-leg push-ups, bent-knee sit-ups, and a timed 2-mile run.⁷ Soldiers who fail the APFT usually participate in a remedial physical training program and repeated failures can lead to discharge from military service. Since FY1999, the Army has discharged 2,342 soldiers for failing to meet minimum age-specific APFT standards (personal communication, U.S. Army Medical Command, May 2007).

Currently, there is no centralized computer system to efficiently monitor soldier compliance with the AWCP and the APFT. Often, military personnel use several stand-alone computer programs, which may or may not be accurate tools, to monitor current status with the weight and fitness regulations, with limited ability to track compliance over time. Anecdotal evidence identifies a need for a standardized, accurate, and automated system for administering the mandatory AWCP and APFT. The purpose of this pilot study was to develop and test a computerized database system

designed to automate and track height, weight, %BF, and fitness data longitudinally for efficient administration of the AWCP and the APFT.

METHODS

Description of Military Services Fitness Database (MSFD)

The MSFD is an efficient and easy-to-use computer application designed to automate administration of the AWCP and the APFT by recording, calculating, and permanently storing soldiers' body weight, %BF, and fitness data. As such, the MSFD provides the ability to track a soldier's compliance with weight and fitness over time, thereby allowing identification of soldiers progressively gaining weight or performing poorly on the APFT.

Data Entry, Calculation, and Storage

The MSFD provides instant and automated feedback on whether a soldier passed or failed the APFT, and whether a soldier exceeded the weight-for-height screening. When required, circumference measurements are entered directly

Rzoiac, Jckch D

Personal Information **APFT** Profile Information Training Information TDY/Leave PROFIS

Date: 16 Oct 03 ☐ Diagnostic Test

	NUM	SCORE	
PU	45	71	✓
SU	45	67	✓
Alt	14	36	69 ✓
Min		Sec	
TOTAL		207	✓

Alt Event: Bicycle Test, 6.2-Mile **GO**

Height (inches): 66 Weight (pounds): 249 Max Weight (lbs) = 168 **NO GO**

Body Fat Measurements

	1	2	3	Avg
Abdomen (in)	46.25	46.00	46.00	46.00
Neck (in)	17.75	18.00	18.00	18.00

Grid

Body Fat Content Worksheet

Abdominal Avg	46.00
Neck Avg	18.00
Abdominal - Neck	28.00
Abdomen-Neck Factor	110.65
Height Factor	78.07
Percent Body Fat	32.58

Max % Body Fat = 24 **NO GO**

Notes

Administrator PT Age = 38 APFT Saved P

FIGURE 1. A sample data entry page from the MSFD. These sample data are anonymous; the soldier's name consists of a randomly generated list of letters.

Developmental Counseling Form

Preview Page 1

DEVELOPMENTAL COUNSELING FORM

For use of this form, see FM 22-100; the proponent agency is TRADOC

DATA REQUIRED BY THE PRIVACY ACT OF 1974

AUTHORITY: 5 USC 301, Departmental Regulations; 10 USC 3013, Secretary of the Army and E.O. 9397 (SSN)

PRINCIPAL PURPOSE: To assist leaders in conducting and recording counseling data pertaining to subordinates.

ROUTINE USES: For subordinate leader development IAW FM 22-100. Leaders should use this form as necessary.

DISCLOSURE: Disclosure is voluntary.

PART I - ADMINISTRATIVE DATA

Name (Last, First, MI)	Rank/Grade	Social Security No.	Date of Counseling
Rzoiaac Jckch D	SGT	403-08-5093	10/20/2003
Organization		Name and Title of Counselor	

PART II - BACKGROUND INFORMATION

Purpose of Counseling: (Leader states the reason for the counseling, e.g., performance/professional growth or event-oriented counseling, and includes the leader's facts and observations prior to the counseling.)

To:

- * Discuss the soldier's noncompliance with the Army Weight and Body Fat Standards IAW AR 600-9.
- * Discuss possible course of actions and solutions.
- * Inform the soldier of the possible adverse effects this could have on his/her career.

PART III - SUMMARY OF COUNSELING

Complete this section during or immediately subsequent to counseling.

Key Points of Discussion:

On 16 Oct 03, following a record APFT you were weighed with the following results:

1. Your authorized screening weight IAW AR 600-9 is: 168 lbs.
Your current weight is: 249 lbs., you are over your screening weight by: 81 lbs.
2. Your authorized Body Fat % IAW AR 600-9 is: 24%
Your current Body Fat is: 32.58%, you are over your allowable Body Fat by: 8.58%.

As a result, I am recommending to the commander that you be placed in the Army Overweight Program. Should the Commander place you in the overweight program, the following actions will be taken:

1. You will be flagged in accordance with AR 600-8-2 suspending all favorable actions to include military and civilian schooling.

FIGURE 2. An example of one of the forms that the MSFD automatically produces, when required. These sample data are anonymous; the soldier's name consists of a randomly generated list of letters and the Social Security number is a randomly generated list of numbers.

into the database and the %BF is calculated using the official Army body fat equation.³ For this study, the body fat equation from the 1987 version of AR 600-9 was used to calculate percent body fat. AR 600-9 states that all measurements at each site must be within 0.50 inches, therefore, the program allows more than three measurements at each site and alerts the user to discrepancies that are >0.50 inches. The automation of the body fat equation eliminates human error typically associated with manual calculation of %BF. Figure 1 displays a soldier's data for the APFT: height, weight, and %BF from the circumference tape test.

Output and Reports

The MSFD expedites and automates permanent record keeping and completion of Department of the Army (DA)

forms required for administration of the AWCP and the APFT. Although required fields for these forms are automatically entered with data previously stored in the MSFD, the user can edit and save any field before printing. The DA forms included in the MSFD are: DA Form 268, Report To Suspend Favorable Personnel Actions (FLAG); DA Form 4856, Developmental Counseling Form (Fig. 2); DA Form 5500-R, Body Fat Content Worksheet (Male); DA Form 5501-R, Body Fat Content Worksheet (Female); and DA Form 705, Army Physical Fitness Test Scorecard. The user can also print all endorsements, complete with necessary information, that are required for placing a soldier on the AWCP.

An efficient and useful feature of the MSFD is the ability to generate ~50 different reports summarizing the body weight,

Grade	LastName	FirstName	Department	PUScore	SUScore	RunScore	AltEventScore	TotalScore	Pass	APFTDate
E5	Rzoiac	Jckch	IMD	71	67	0	69	207	1	16 Oct. 2003
O4	Salkar	Roxyl	IMD	100	60	80	0	240	1	17 Oct. 2003
O4	Sbadli	Mtngg	IMD	85	82	71	0	238	1	15 Oct. 2003
O4	Sdmrtqy	Lqdyg	IMD	60	71	67	0	198	1	03 Nov. 2003
E2	Sepkes	Rvslp	IMD	72	76	77	0	225	1	16 Oct. 2003
E7	Sfbepu	Mdbts	IMD	100	86	98	0	284	1	01 Oct. 2003
O3	Stegsy	Kivlj	IMD	76	83	94	0	253	1	16 Oct. 2003
E5	Slmdd	Mzming	IMD	85	77	66	0	228	1	14 Oct. 2003
O1	Shvtzs	Jqsox	IMD	75	71	79	0	225	1	16 Oct. 2003
E5	Sinkwo	Mkqox	IMD	100	88	97	0	285	1	20 Oct. 2003
O5	Sijay	Muaaa	IMD	67	68	63	0	198	1	16 Oct. 2003
E6	Smisyk	Wjicj	IMD	64	62	63	0	189	1	17 Oct. 2003
E4	Smzieg	Jwxso	IMD	76	75	77	0	228	1	16 Oct. 2003
O3	Sodoce	Eqlil	IMD	67	61	100	0	228	1	21 Oct. 2003
E4	Sodmmv	Myvke	IMD	100	100	71	0	271	1	15 Oct. 2003
O1	Sigvkc	Grdoi	IMD	99	92	86	0	277	1	16 Oct. 2003
O4	Sistkj	Mgjoa	IMD	70	67	84	0	221	1	16 Oct. 2003
E5	Ssonmv	Bjgtc	IMD	100	100	92	0	292	1	18 Oct. 2003
E8	Ssuctf	Bmzoq	IMD	87	74	88	0	249	1	15 Oct. 2003
E6	Ssteje	Jhntn	IMD	78	81	75	0	234	1	17 Oct. 2003
E6	Shlib	Cybel	IMD	67	73	0	70	210	1	16 Oct. 2003
O3	Suxok	Jguld	IMD	100	100	100	0	300	1	17 Oct. 2003
O5	Swderg	Cncun	IMD	93	64	100	0	257	1	15 Oct. 2003
E6	Sziesv	Pqxpp	IMD	78	86	92	0	256	1	15 Oct. 2003
E5	Tcpoup	Eefqv	IMD	73	69	79	0	221	1	16 Oct. 2003
O4	Tqghlj	Lomjl	IMD	100	95	95	0	290	1	14 Oct. 2003
E4	Tfapki	Riznh	IMD	99	99	100	0	298	1	15 Oct. 2003
E5	Tgvspw	Tvinr	IMD	78	61	61	0	200	1	15 Oct. 2003

FIGURE 3. A sample report from the MSFD of soldiers who passed the APFT. These sample data are fictitious; the soldier's name consists of a randomly generated list of letters, with the exception of the first two soldiers whose names were fabricated.

%BF, and fitness data of soldiers by a number of variables to include rank, age, gender, and medical profile status. These reports include a list of soldiers who passed the most recent APFT (Fig. 3) those who failed the APFT, exceeded the body fat standard, were previously or are currently on a medical profile, or need to take an APFT. The reports may be generated for all assigned personnel or filtered to report special interest groups (e.g., by rank, gender, organization, unit). Data may be sorted by any field, printed, or exported in a Microsoft Excel spreadsheet to allow for further data analysis.

Research Participants and Procedures

Three medical companies at Womack Army Medical Center (WAMC), Fort Bragg, NC used the MSFD from July 2003 to December 2005 for a total of five measurement periods (6-month periods) for the APFT and mandatory weigh-in (fall 2003, spring 2004, fall 2004, spring 2005, and fall 2005). The

TABLE 1. Demographic Characteristics of the Sample

	Men (<i>n</i> = 423)	Women (<i>n</i> = 261)
Age (yr)	32.7 ± 0.41 (18–39)	31.5 ± 0.53 (18–36)
Height (cm)	177.9 ± 0.34 (160–201)	164.1 ± 0.39 (147–178)
Weight (kg)	82.9 ± 0.61 (52–132)	66.5 ± 0.61 (36–101)
BMI (kg/m ²)	26.2 ± 0.16 (18.6–40.3)	24.7 ± 0.20 (18.3–35.6)

Data are means ± SE (range). BMI, body mass index. Comparisons are not significant (*p* = NS).

MSFD replaced three locally developed computer programs (i.e., Excel spreadsheets) being used to monitor current soldier compliance with the AWCP and the APFT. These programs were unable to track compliance longitudinally and they were not officially approved Army computer applications, which would ensure accurate calculation of %BF. The users were provided a training period before implementation.

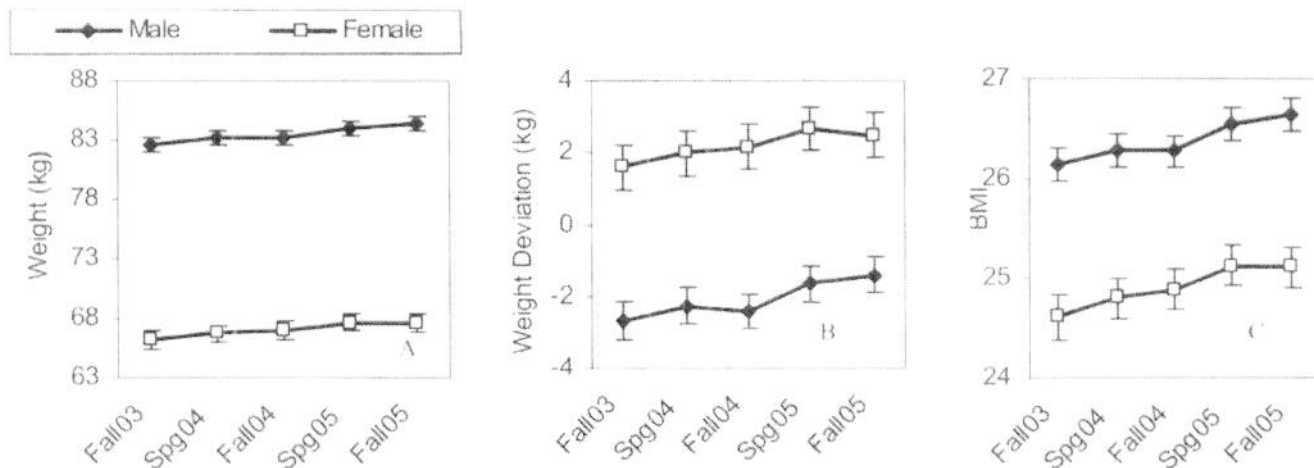


FIGURE 4. (A) Least square mean of weight (kg) over time by gender. (B) Least square mean of weight deviation (kg) over time by gender. (C) Least square mean of BMI (kg/m^2) over time by gender. The sample included 423 men and 261 women. Figure B summarizes the same information, expressed as a deviation from the maximum allowable screening weight. This approach corrects for gender and changes in age. Figure C summarizes the same information, expressed as mean body mass index (BMI).

Anonymity of assigned personnel was maintained. The study was approved and granted exempt status by the Institutional Review Board, Pennington Biomedical Research Center, Baton Rouge, LA and the U.S. Army Medical Research and Materiel Command's (USAMRMC) Human Subjects Research Review Board, Fort Detrick, MD and is part of a USAMRMC grant entitled *The Military Health Behaviors: Promotion of Healthy Weight and Fitness in Career Personnel*. Longitudinal data of soldiers for whom data were collected at least three, but as many as five times were analyzed to assess changes in body weight, %BF (if applicable), and APFT scores.

Statistical Methods

Longitudinal data of body weight, deviation from AR 600-9 maximum allowable weight, compliance with body fat standards, body mass index (BMI), and APFT scores were evaluated using a repeated measure ANOVA. The proc mixed procedure was used to manage missing data using the raw maximum likelihood method. Analyses were performed using Statistical Analysis Software (SAS) version 9.1 and a p -value of <0.05 was assumed significant.

RESULTS

A total of 1,710 records were recorded in the MSFD during the 2.5-year data collection period. Data were collected on 684 soldiers (423 men and 261 women) for at least three iterations of the APFT and mandatory weigh-in. Table 1 summarizes the demographic data for the participants.

Weight and Body Fat Measures

Weight gain for both men and women occurred during the study, [$F(4, 1795) = 9.90, p < 0.0001$] (Fig. 4A) along with a corresponding increase in BMI (Fig. 4C). Mean weight gain for men was 0.85 kg (1.9 lb)/year and 0.7 kg (1.5 lb)/year for

women. On average, men were 1.4–2.7 kg (3.1–5.9 lb) under their weight-for-height allowance and women were 1.6–2.5 kg (3.5–5.5 lb) over their weight-for-height allowance (Fig. 4B).

The distribution of "deviation scores" (a soldier's actual weight minus the weight-for-height allowance) of fall 2003 compared to fall 2005 is shown for men (Fig. 5A) and women (Fig. 5B). The distributions were normal (nonskewed). The average body weight deviation of the sample increased by ~ 1 kg (2.2 lb) from fall 2003 to fall 2005. Men moved closer to their weight-for-height allowance, and women moved further above their weight-for-height allowance [$F(4, 1801) = 6.7, p < 0.0001$]. In fall 2005, 36% of men ($n = 88$) and 57% of women ($n = 96$) exceeded the weight-for-height allowance, requiring measurement of %BF.

Figure 6 summarizes the proportion of soldiers who (1) met weight-for-height allowance (no tape test required), (2) failed weight-for-height allowance but passed (met) %BF, (3) failed both weight-for-height allowance and %BF, and (4) failed weight-for-height allowance but, for some unknown reason, were not taped as required by AR 600-9. For the purpose of this study, the latter group is categorized as "possible fail." Approximately 65% of men met the weight-for-height allowance. Of the 35% who were over weight-for-height allowance, 4–8% exceeded %BF (Fig. 6A). Although more women than men exceeded weight-for-height allowance (Fig. 6B), the proportion of soldiers exceeding body fat standards was comparable for women and men (5.9% and 6.4%, respectively). The failure rate for soldiers exceeding %BF was consistently $<10\%$, even when including the "possible fail" category.

Fitness Measures

A significant interaction between gender and time [$F(4, 1277) = 2.56, p < 0.05$] was observed for APFT scores (Fig. 7).

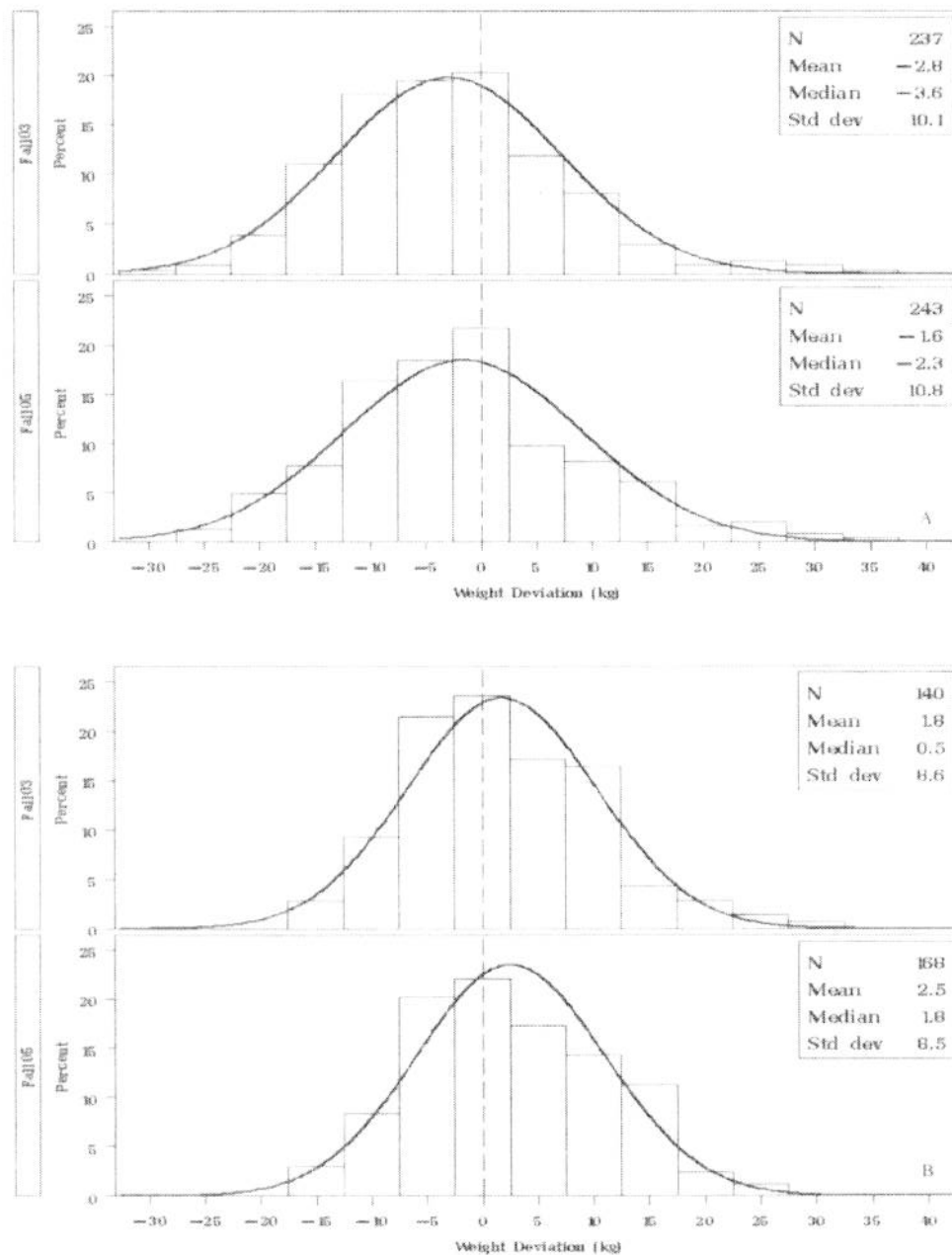


FIGURE 5. Distribution of "deviation scores" (soldier's actual weight minus the gender and age-specific weight for height allowance) at fall 2003 (top panel) and fall 2005 (bottom panel) for men (A) and women (B). Underweight (under the weight for height allowance) vs. overweight (over the weight for height allowance) status is represented by having scores to the right or left, respectively, of the dashed line that transects the histograms.

Overall, APFT scores for men and women did not differ from fall 2003 to fall 2005 and no differences in APFT scores were observed between men and women from fall 2003 to fall 2004. In 2005, women scored ~7 points higher than men (spring 2005, 244 vs. 237 points, $p < 0.05$; and fall 2005, 249 vs. 242 points, $p < 0.05$). Although men scored fewer points on the APFT from fall 2003 to spring 2005 (245 vs. 237 points, $p < 0.001$), the overall APFT failure rate was similar for both men and women, ranging from 1 to 2%.

DISCUSSION

To date, there is no tracking tool in use by the Army to monitor soldiers' compliance with the AWCP and the APFT regulations. The MSFD was designed to achieve this goal by automating and tracking height, weight, %BF, and fitness data longitudinally for efficient administration of the AWCP and the APFT. A pilot study at Womack Army Medical Center, Fort Bragg demonstrated that the medical companies using the MSFD successfully monitored and summarized population

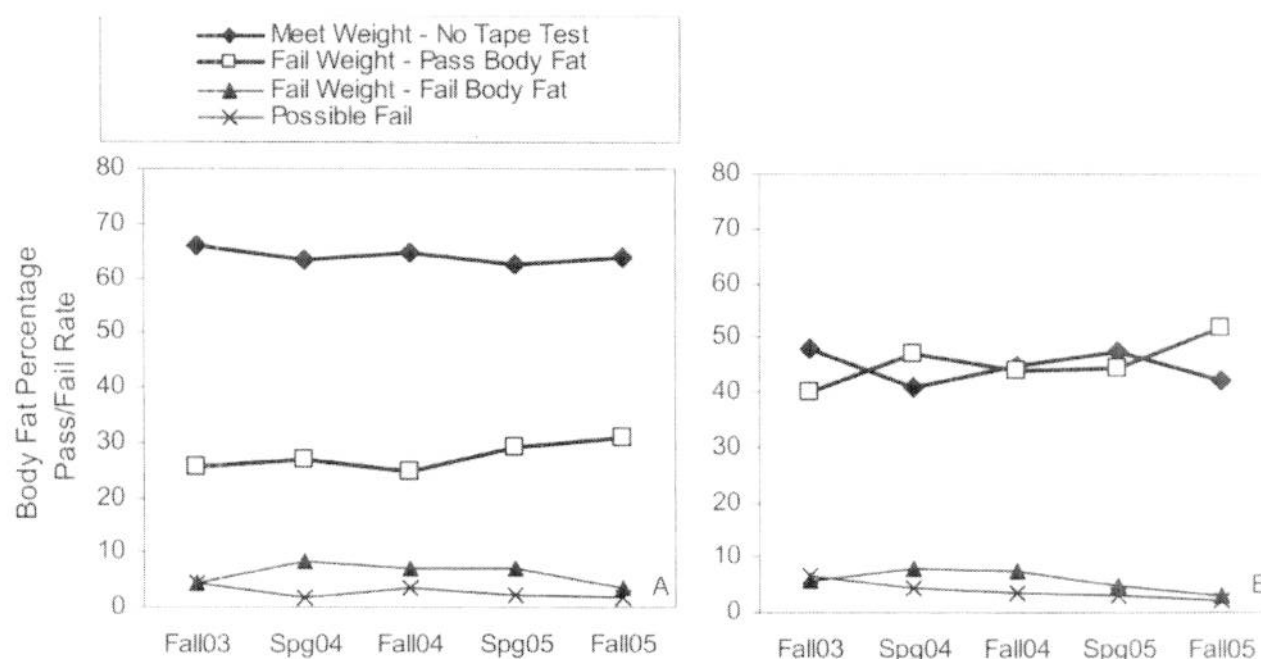


FIGURE 6. Body fat percent measurement and pass/fail rate for men (A) and women (B).

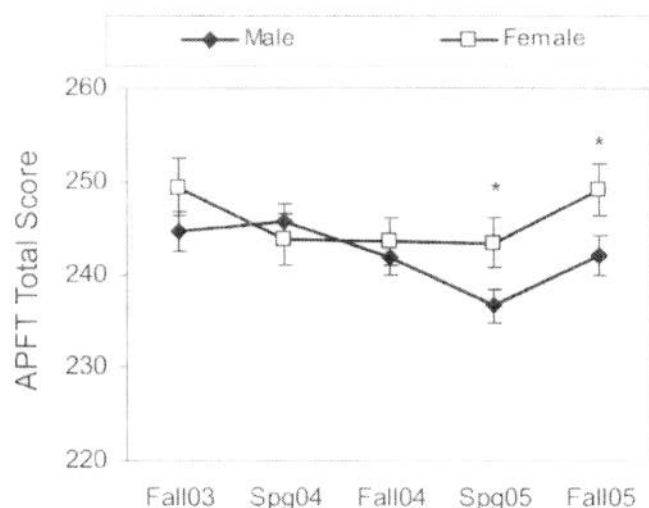


FIGURE 7. Least square means of APFT total score for 494 soldiers who had at least 3 APFT scores out of 5 observations over 2 years (324 male and 170 female) are shown. Asterisks (*) indicate males and females differed significantly ($p < 0.05$).

and individual trends of changing body weight, %BF, and fitness throughout the 2.5-year data collection period. Furthermore, the MSFD allowed users to efficiently manage soldier data with one database instead of multiple databases and computer programs, as was previously used at the hospital for administration of the AWCP and the APFT.

The MSFD's ability to store a soldier's previous information on height, weight, %BF (if required), and APFT scores,

alerted supervisors to potential misinformation such as inaccurate height, age, and circumference measures thereby improving accuracy of results for soldiers. Additionally, storage of soldiers' information and automated printouts of required DA forms reduced manpower time and improved efficiency in administering the AWCP and APFT.

The MSFD allowed the user to monitor soldiers for a variety of reasons related to compliance with the AWCP and the APFT such as those on medical profile, those who were on leave, temporary duty (TDY), or deployment status, and those who were repeatedly noncompliant or very close to being noncompliant with the regulations. Identification of "at risk" soldiers who may be close to exceeding weight and/or %BF or performing poorly on fitness standards provided supervisors with timely information which, if used appropriately, could prevent soldiers from being placed on the AWCP or remedial fitness programs. Ultimately, the early identification and monitoring of soldiers for compliance with weight and fitness standards could potentially reduce the number of soldiers discharged from service for failure to meet these standards. Furthermore, the capability to monitor weight and fitness data longitudinally has the potential to help identify the impact of specific situations (i.e., deployments, TDY, training, and medical profiles) on compliance with the AWCP and the APFT.

Investigations on civilian weight gain report an average gain of 0.90 kg (2.0 lb)/year over a 10-year period for men and women aged 25–35 years⁸ and 0.50–1.0 kg (1.1–2.2 lb)/year for American adults.^{10,11} In this study's 2.5-year evaluation period, active duty soldiers assigned to a medical unit reported an average weight gain that was lower than the nonmilitary population

[0.35–0.40 kg (0.8–0.9 lb)/year]. Corresponding to the increase in weight, the mean BMI for men and women also increased.

APFT scores for both men and women did not differ over the 2-year period indicating no significant change in fitness during this time. The failure rate for the APFT is lower than the failure rate for meeting percent body fat, suggesting that soldiers may have an easier time meeting fitness standards compared to weight and body fat standards.

It is important to avoid generalization of results from this medical unit to all military personnel. Nevertheless, the illustration with these data shows the potential for a computerized system, such as the MSFD, to provide the observational database needed to evaluate changes in weight, %BF, and fitness in a larger, more representative sample of military personnel.

In summary, the findings of this pilot study illustrate that a computer application such as the MSFD can efficiently monitor and summarize both population and individual trends of changing body weight, %BF, and fitness in a military population over time. Use of the MSFD demonstrated that Army personnel, from a selected sample of Army medical personnel, gradually gained body weight while fitness scores remained similar. Future efforts should focus on potential integration of this prototype into existing or planned automated computer tracking systems for the Armed Forces (active duty, reserves, and National Guard) to maintain continuity of weight and fitness data collection and allow for future comparisons.

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