Differences in Physical Fitness of Male and Female Recruits in Gender-Integrated Army Basic Training

RAN YANOVICH[1], RACHEL EVANS[2], ERAN ISRAELI[3], NAAMA CONSTANTINI[4], NURIT SHARVIT[5], DRORIT MERKEL[1], YORAM EPSTEIN[1], and DANIEL S. MORAN[1]

[1]Heller Institute of Medical Research, Sheba Medical Center, Tel-Hashomer, ISRAEL; [2]US Army Research Institute of Environmental Medicine, Natick, MA; [3]Division of Medicine, Department of Gastroenterology, Hebrew University-Hadassah Medical Center, Jerusalem, ISRAEL; [4]Department of Orthopaedic Surgery, Hadassah-Hebrew University Medical Center, Ein Kerem, Jerusalem, ISRAEL; and [5]Combat Fitness Center, Infantry and Paratroopers Command, Ground Forces Command

ABSTRACT

YANOVICH, R., R. EVANS, E. ISRAELI, N. CONSTANTINI, N. SHARVIT, D. MERKEL, Y. EPSTEIN, and D. S. MORAN. Differences in Physical Fitness of Male and Female Recruits in Gender-Integrated Army Basic Training. *Med. Sci. Sports Exerc.*, Vol. 40, No. 11S, pp. S654–S659, 2008. **Purpose**: To evaluate gender differences in physical fitness before and after a 4-month gender-integrated basic training (BT) course and to determine whether this program effectively narrowed the differences between male and female soldiers in physical fitness parameters. **Methods**: One hundred and thirty-seven soldiers (109 females and 28 males) successfully completed a 4-month BT course in the Israeli Defense Forces (IDF). The subject's physical fitness was evaluated pre- and post-BT by three laboratory tests [the maximal aerobic capacity ($\dot{V}O_{2max}$), the Leonardo Ground Reaction Force Plate, and the Wingate Anaerobic Test (WAnT)] and by the IDF physical fitness test (IDF-PT). **Results**: Females significantly improved their scores in the IDF-PT and laboratory aerobic tests, whereas males significantly improved only in the IDF-PT. After BT, gender differences narrowed by approximately 4% in all tests except upper body strength. Although fitness improvement after BT was marginally higher in females than males, resulting in a slight narrowing of the gender differences, a significant gender gap in physical fitness still exists after BT. **Conclusions**: There was only a small overlap in physical abilities at the beginning of BT, which indicated vast differences in physical fitness between the genders. As expected, integrated combat BT improved physical fitness. Although females demonstrated marginally higher improvement in aerobic capacity, basic physiological gender differences were still evident at the end of the training regimen. **Key Words:** MILITARY SERVICE, $\dot{V}O_{2max}$, GROUND REACTION FORCE PLATE, WINGATE ANAEROBIC TEST

For the past 10 yr, there has been a growing interest in the Israeli Defense Forces (IDF) to integrate women into combat positions that historically were male-dominated posts. This is in line with the increasing involvement of women in the armed forces worldwide (27). In 2001, 15% of the total US Army military force was female (9), in comparison with 1.6% in 1972 (20), and female involvement is expected to increase soon to 20% of the active duty force (27). In Israel, where military service is mandatory for both males and females, women constitute approximately 30% of total military force. Noteworthy, a demographic shift in the recruitment of women has forced the US Army to update its policies on acceptable roles and job assignments for women (27). In most militaries, women are excluded only from armor and infantry positions, where their combat effectiveness is questioned on both physiological and psychological grounds.

The physiological differences between men and women have limited the inclusion of female soldiers in combat units due to physical limitations related to their lower muscle mass, higher fat percentage, lower aerobic and anaerobic capacity, and higher susceptibility to stress fracture and other musculoskeletal injuries (18). However, several studies have demonstrated that proper training can narrow the gender differences; for example, a study comparing women and men undergoing a similar 8-wk training regimen reported a reduction from 22% to 8% in the aerobic power difference between men and women (6). Additionally, studies comparing male and female weights and lean body mass (LBM) have shown that with proper physical training, both women and men reduce their body fat percentage by up to 7.1% while increasing in total weight, signifying a marked increase in muscle tissue (22,24).

Interestingly, in a study conducted by the US Army Research Institute for Behavioral and Social Sciences, male soldiers in gender-integrated units demonstrated slightly

Address for correspondence: Ran Yanovich, Heller Institute of Medical Research, Sheba Medical Center, Tel-Hashomer 52621, Israel; E-mail: ranovich@sheba.health.gov.il.

0195-9131/08/4011S-S654/0
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/MSS.0b013e3181893f30

reduced physical performance after basic training (BT) in comparison with male soldiers in all-male units. In contrast, female soldiers in those integrated units demonstrated marked improvements in performance after BT in comparison with female soldiers in all-female units (21).

In comparison with males engaged in similar activities (14), women are known to be more susceptible to overuse injuries such as stress fractures. Some studies have shown a stress fracture incidence ranging from 12% to 30% among female army recruits in comparison with only 7% to 10% among male soldiers (4,18). Despite the high incidence of injury among female soldiers, Reynolds et al. (23) showed that women athletes who have undergone regular strength training and running programs exhibited a significant reduction in stress fracture incidence, with only 2 out of 45 (4.4%) participants dropping out of a training program due to injury. Moreover, Knapik (17) showed that a carefully controlled physical training program produced a lower overall injury rate in basic combat training. Although those injuries were not specifically stress fractures, one should consider that incidences of stress fractures should decrease in response to a controlled training program. Noteworthy, military standards in combat units were set for male soldiers. The point in question is whether women soldiers can adapt to the physical demands by the implementation of proper military-relevant training programs.

A unique situation of a male–female mixed combat unit exists in the IDF. This unit comprises 70% female soldiers and 30% male soldiers. All soldiers, regardless of their gender, are required to serve under the same environmental conditions and to participate equally in all duties, for example, patrols, pursuits, ambushes, and surveillance. In this unit, the physical requirements for female and male soldiers are supposed to be equal.

In view of the increased interest for a deeper integration of women into specific military positions, this study was conducted to estimate gender differences in physical fitness before and after a 4-month BT course and to determine whether the course was effective in narrowing those differences.

MATERIALS AND METHODS

Subjects. One hundred and seventy-six new recruits (129 females and 47 males; 19 ± 1 yr) who were assigned to an integrated combat infantry battalion of the IDF participated in a 4-month BT regimen. Both genders were positioned in integrated platoons and classes with similar training duration and requirements. The physical training program consisted of an average of 4 h running, 3 h marching, 10 h combat training, and 5 h continuous standing per week. One hundred and thirty-seven soldiers (109 females and 28 males) completed the 4-month course.

The procedures performed in the present study were within the framework and restrictions of the IDF Medical Corps Type Protocols for Human Research Studies of Thermal Stress and Exercise and were also approved by the surgeon general's Human Subjects Research Review Board. This committee approved the study in accordance with the 1964 Helsinki declaration. Baseline measures were taken within 3 d of arrival to the recruit training unit (pre) and upon completion of the 4-month training program (post). Before participating in the study, all potential participants were briefed by the study investigators and signed an informed consent form before commencing the testing.

Anthropometric measurements. Changes in body weight, percent body fat, body mass index (BMI), and lean body mass (LBM) were evaluated by anthropometric measures. Height (cm) was measured using a stadiometer (±1 cm), and weight (kg) was determined with a metric scale (±100 g). Percent body fat was estimated according to Durnin and Rahaman (7) from a four-site skinfold thickness (biceps, triceps, subscapula, and suprailiac) using Lange skinfold calipers (Beta Technology, Santa Cruz, CA). To reduce operator variability the same investigator performed all skinfold measurements. Body fat percentage was calculated according to Siri (25), and body density (BD) was calculated according to Durnin and Womersley (8).

Laboratory tests. Physical fitness was evaluated by three laboratory tests and the IDF physical fitness test (IDF-PT). For aerobic fitness, maximal oxygen uptake ($\dot{V}O_{2max}$, $mL \cdot min^{-1} \cdot kg^{-1}$) was measured using the modified Bruce treadmill protocol (12). Oxygen uptake was measured breath by breath by a metabolic cart (SensorMedics Corp., Yorba Linda, CA). Peak oxygen uptake ($\dot{V}O_{2max}$) was considered according to accepted criteria (5).

For anaerobic fitness, the Wingate Anaerobic Test (WAnT) was an all-out 30-s cycling bout performed on a cycle ergometer (Monark Ergomedic 894 Ea®, Monark Exercise AB, Vansbro, Sweden) using the protocol of Bar-or et al. (1). The subjects cycled against a resistance that was proportional to 8.5% of their body weight and were measured for their peak anaerobic capacity ($W \cdot kg^{-1}$).

For lower extremity force and power, the Leonardo Ground Reaction Force Plate (Orthometrix, Inc., White Plains, NY) was used to assess lower extremity force and power. The subjects were positioned on the force platform according to manufacturer's guidelines and were asked to use both legs to jump three times as high as possible. They were then asked to perform three one-legged vertical jumps on each leg to calculate force per kilogram ($N \cdot kg^{-1}$) and power per kilogram ($W \cdot kg^{-1}$).

IDF-PT test. The IDF physical fitness test (IDF-PT) consisted of a 2-km run (time) and the number of maximal push-up and sit-up repetitions performed until exhaustion or until the recruits stopped for more than 2 s. Instead of weighing all results into one final score, we present the absolute results of the different subtests.

Statistical analysis. To compare between sample means of the male and the female groups pre- and post-BT, we used a 2 × 2 factorial repeated-measures ANOVA (gender and time; $\alpha < 0.05$). Fisher *post hoc* tests were used to further analyze significant interactions. Two-sample Kolmogorov–Smirnov (KS) test (26) was used to compare the empirical results division and to determine whether the two gender distributions differ in all the fitness tests that were implemented. The KS analysis is depicted by a box figure whereas the exterior lines represent the variable range between 0% and 100% while the 25 to 75 percentiles are shown as a box. The dots in the figures symbolize individuals who are more than 2.5 SD away from the mean value. The asymptotic *P* value for the KS test was considered at 0.0001.

RESULTS

A total of 109 females and 28 males successfully completed the 4-month BT course. This represented an overall survivability (the ratio between the number of recruits that successfully completed BT and the number entering BT) of 78% in the integrated BT course: 85% survivability rate among females and 60% among males. Preliminary anthropometric measurements revealed expected physiological differences. On average, females were 6.9% shorter, weighed 12.8% less, had 0.9% higher BMI, and their percent body fat was 64.4% higher than the males (Table 1).

Over the course of BT, an average increase in body weight and BMI was evident in the female group (0.7 kg and 0.2 $kg \cdot m^{-2}$, respectively) while percent body fat decreased by 3.5%. A 5.9% decrease in body fat also occurred in the male group but was accompanied by an average decrease of 0.8 kg in body weight and 0.5 $kg \cdot m^{-2}$ in BMI (Table 1). The increase in the body weight and BMI of the women, as well as the reduction in their body fat percentage, contributed to a 2.6% increase in lean body mass (LBM) after the training program. To note, all intragender anthropometric changes between pre- and post-BT did not reach a statistical significance. Although both sexes exhibited a decrease in percent body fat, the gender difference statistically increased ($P < 0.05$) from 64.4% to 73.6%.

Aerobic capacity differed significantly between both groups as exhibited by a small overlap in $\dot{V}O_{2max}$—10% of the top females overlapped with the lower 10% of the males ($P < 0.0001$; Fig. 1A). Over the 4-month BT, females significantly improved $\dot{V}O_{2max}$ by an average of 12.3% (35.8 ± 6.4 to 40.8 ± 6.0 $mL \cdot min^{-1} \cdot kg^{-1}$; $P < 0.05$), and

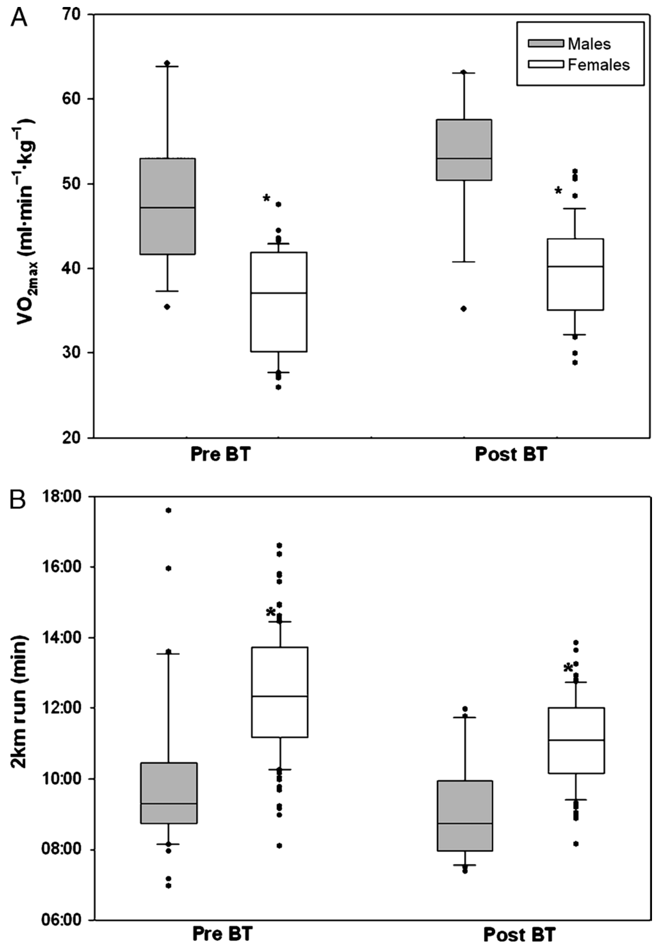

FIGURE 1—Distribution of $\dot{V}O_{2max}$ (A) and 2-km run (B) results before and after a 4-month BT regimen measured from 109 females and 28 males. The boxes represent 50% of the subjects. In the boxes: midline = median; bottom line = first quartile (Q1); upper line = third quartile (Q3). Individuals who are more than 2.5 SD away from the mean value; * $P < 0.0001$ between genders.

their male soldier counterparts improved $\dot{V}O_{2max}$ by an average of 9.3% (45.9 ± 7.9 to 50.6 ± 7.0 $mL \cdot min^{-1} \cdot kg^{-1}$; $P < 0.05$; Fig. 1 and Table 2). Females also improved their 2-km run time by an average of 10% (69 s) in comparison with the 5% improvement in the male group (28 s; $P < 0.05$). As can be seen in Figure 1B about the 2-km run, only the highest 90th percentile females overlapped the scores of the lowest 10th percentile males at the beginning of BT ($P < 0.0001$).

TABLE 1. Anthropometric measures (mean ± SD) before and after a 4-month BT regimen.

	Female (n = 108)		Male (n = 28)		Female/Male Difference (%)[a]	
Phase (in BT)	Before	After	Before	After	Before	After
Weight (kg)	60.5 ± 10.0	61.2 ± 9.1	69.4 ± 12.6	68.6 ± 11.7	−12.8*	−10.8*
Height (cm)	162.3 ± 6.3	162.5 ± 6.1	174.3 ± 6.8	174.7 ± 7.1	−6.9*	−7.0*
BMI ($kg \cdot m^{-2}$)	23.0 ± 3.4	22.8 ± 4.0	23.7 ± 4.1	22.3 ± 3.0	2.9	2.2
Body fat (%)	28.6 ± 4.2	27.6 ± 4.1	17.4 ± 4.9	15.9 ± 4.5	64.4*	73.6*

Differences intragenders pre- or post-BT were not statistically significant.
[a] Female/male % difference = (female − male) / male × 100.
* Significant gender differences at the same time point, $P < 0.05$.

TABLE 2. Laboratory and PT test results (mean ± SD) before and after a 4-month BT regimen.

Phase (in BT)	Female (n = 108) Before	Female (n = 108) After	Male (n = 28) Before	Male (n = 28) After	Female/Male Difference (%)[a] Before	Female/Male Difference (%)[a] After
Aerobic $\dot{V}O_{2max}$ ($mL \cdot min^{-1} \cdot kg^{-1}$)	35.8 ± 6.4	40.8 ± 6.0*	45.9 ± 7.9	50.6 ± 7.0*	−22†	−19.4†
Ground reaction force plate ($N \cdot kg^{-1}$)	46.1 ± 9.2	42.7 ± 7.2	49.9 ± 12.9	44.6 ± 8.3	−7.6	−4.3
WAnT power ($W \cdot kg^{-1}$)	4.85 ± 0.90	4.89 ± 0.80	6.79 ± 0.90	6.59 ± 2.30	−28.6†	−25.8†
PT						
2-km run (min)	12:23 ± 0:32	11.14 ± 0.24*	9:43 ± 0:21	9:15 ± 0:18*	21.5†	17.7†
Push-ups (repetitions)	37.2 ± 2.6	47.8 ± 6.9*	42.8 ± 8.5	67.8 ± 9.1*	−13.1†	−29.5†
Sit-ups (repetitions)	63.6 ± 18.6	85.5 ± 18.3*	65.4 ± 19.9	85.9 ± 9.9*	−2.7	−0.5

[a] Female/male % difference = (female − male) / male × 100.
* Significance between pre- and post-BT, $P < 0.05$.
† Significant gender differences, $P < 0.05$.

Analysis of the WAnT results revealed that both genders did not improve their anaerobic abilities throughout BT. Whereas females maintained their anaerobic fitness, anaerobic fitness in men declined by an average of 0.2 $W \cdot kg^{-1}$, although not statistically significant. Nevertheless, the anaerobic fitness differences between females and males remained statistically significant ($P < 0.05$) both pre- and post-BT (1.94 and 1.7 $W \cdot kg^{-1}$, respectively). The distribution comparison showed that at the beginning of BT only 25% of the females scored better than the lower 5% of the males ($P < 0.0001$), and it increased to 45% of the females at the end of BT as shown in Figure 2.

Lower extremity force production tended to decrease in both groups during BT, but the changes were not statistically significant (49.9 ± 12.9 to 44.6 ± 8.3 $N \cdot kg^{-1}$ in males and 46.1 ± 9.2 to 42.7 ± 7.2 $N \cdot kg^{-1}$ in females) as shown in Table 2. Noteworthy, this decline was slightly lower (not significantly) in females (8%) than in males (11%).

The gender difference in push-up performance was 13.1% at baseline. After training, both men and women improved; however, gains were considerably lower for women (28% vs 54% for females and males, respectively). In contrast, there was no significant gender difference in sit-up performance either before or after BT, although both genders significantly improved their scores ($P < 0.05$).

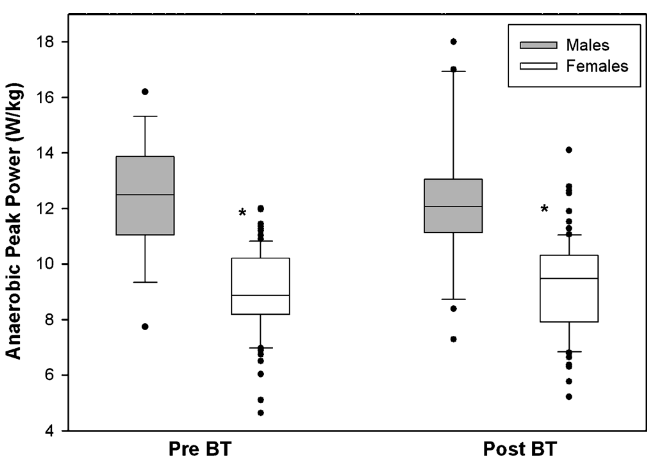

FIGURE 2—Distribution of anaerobic peak power ($W \cdot kg^{-1}$) results before and after a 4-month BT regimen measured from 109 females and 28 males. The boxes represent 50% of the subjects. In the boxes: midline = median; bottom line = first quartile (Q1); upper line = third quartile (Q3). * $P < 0.0001$ between genders.

In summary, before BT, male achievements in all the tests were higher than those of the females as shown in Table 2. After BT, these differences were narrowed by up to 4% ($P < 0.05$) in every category with the marked exception of push-up performance, where the gap increased by 16.6% ($P < 0.05$), and the abdomen endurance, which showed a lack of gender difference.

DISCUSSION

This study examined gender differences in physical fitness parameters before and after BT in an infantry battalion consisting of gender-integrated companies of 70% females and 30% males. This gender ratio in the battalion was dictated by the Army Ground Forces Headquarters according to the unit assignments. This unit is unique because female and male soldiers are required to participate in the same combat assignments and act under the same conditions and at the same combat standards. In general, the study results emphasize the differences between female and male soldiers in their physical capabilities, which could not be bridged during the 4-month BT.

The results presented are in accordance with those presented by the US Army Research Institute for Behavioral and Social Sciences findings of improvement in female soldiers' physical abilities in comparison with their male counterparts of the same integrated unit (21). It is obvious that as women initially had a lower aerobic capacity than men, they benefit more than males from the physical fitness program.

This study is the first to demonstrate gender-distribution differences during BT using the KS test for distribution differences analyses (26). Initially, males had 22% higher aerobic fitness, 28.6% higher anaerobic fitness, and 13.1% higher upper extremity endurance than females. At the beginning of BT, only 25% of the females scored equivalent to the lower 5% of their male counterparts in the $\dot{V}O_{2max}$ test. During the IDF-PT test, the slowest male ran faster than 75% of the females, and 90% of the females achieved a total score similar to the lower 5% of the males.

Although gender differences narrowed throughout BT, the low overlap in physical abilities between genders was consistent throughout training and showed a similar pattern at the end of BT. Nevertheless, in this specific battalion, all soldiers, regardless of their gender, are expected to perform equally in their missions. These ability gaps are reduced by performing the tasks as an integrated unit with both genders performing according to their physical abilities.

Gender differences were demonstrated in similar studies that emphasized the basic physiological advantage of males as expressed by greater physical abilities (3,6,13,16). Apparently, those differences resulted not only from the basic physiological anthropometric differences between genders, which indicated that females had 64.4% higher body fat percentage than males, but also from different gender-specific lifestyle activities in the year before recruitment. These findings were similar to those described in prior studies (2,11).

Adherence to the prescribed training regimen, calculated from planned versus performed hours of activity, was 98%, but the program lacked sufficient anaerobic exercise training. Thus, gender differences in anaerobic measures, which narrowed by 3%, are not related to greater improvement in the females' abilities but rather to a decrease in anaerobic capability in the men over the course of BT. We believe that the decrease in anaerobic power affected also leg force, which decreased after BT by about 10% in both groups.

The only physical parameter that did not differ between the genders was the abdomen endurance as measured during the IDF-PT test by performing sit-ups. Although it is not unusual for women and men of the same age to perform similarly on sit-ups (10,15), this study's results are skewed by the IDF-PT protocol, which awards maximal points to those who can perform 86 continuous sit-ups, providing no incentive to perform more.

Military training is a systematic process during which soldiers, in a process that is similar to competitive athletic training, improve their fitness to meet the dictated demands. Planning for training programs must be according to known guidelines and principles, such as overload, specificity, and variety (19). Training reversibility emphasizes that no improvement in fitness will occur if loading levels are not stimulating enough. In this specific battalion, the physical demands for male soldiers were the same as those for female soldiers. Because at baseline male soldier fitness was higher than that of female soldiers, it is likely that female soldiers benefited more than the male soldiers from the scheduled training program, which for males was not strenuous enough to elicit a positive training response. This is in accord with previous studies in which female soldiers who trained in gender-integrated units dramatically improved their performance in comparison with female soldiers who trained in all female units (21).

Although their initial physical fitness was higher, male survivability during BT was 25% lower in comparison with their female counterparts. We speculate that this may be due in part to lower motivation levels of men, whose first choice may have been to be selected for a more prestigious all-male infantry battalion. Females in this battalion are voluntarily recruits, whereas recruitment of males is according to army manpower needs. Therefore, *a priori*, female motivation to serve in this particular battalion is much higher than that of the males.

In conclusion, gender-integrated BT improves most fitness elements in both male and female recruits. Although females demonstrated marginally higher improvement in aerobic capacity, basic physiological differences between the sexes were still evident. To note, we found a small overlap in physical abilities at the beginning of BT, which indicates vast differences in physical fitness between the genders (Figs. 1 and 2). Among many ethical and physiological questions associated with the integration of women into combat units, three practical issues require further investigation: 1) whether a better prerecruitment sorting process would bridge the inherent physiological differences between genders; 2) whether a pre-BT course for females would be helpful in further narrowing gender differences in physical capacity; and 3) whether a basic selection based on performance, regardless of gender and solely assignment dependent, would decrease the physical fitness differences between the battalion's soldiers.

The opinions and assertions in this article are those of the authors and do not necessarily represent official interpretation, policy, or views of the US Department of Defense or the Israeli Defense Forces.

REFERENCES

1. Bar-Or O, Lamb DR, Clarkson PM, editors. *Perspectives in Exercise Science and Sports Medicine: Vol. 9. Exercise and the Female: A Life Span Approach*. Indianapolis (IN): Benchmark Press; 1996.
2. Bar-Or O. The Wingate Anaerobic Test: an update on methodology, reliability and validity. *Sports Med*. 1987;4:381–94.
3. Billaut F, Giacomoni M, Falgairette G. Maximal intermittent cycling exercise: effect of recovery duration and gender. *J Appl Physiol*. 2003;95:1632–7.
4. Cline AD, Jansen GR, Melby CL. Stress fractures in female army recruits: implications of bone density, calcium intake, and exercise. *J Am Coll Nutr*. 1998;17(2):128–35.
5. Clinical indications and uses of exercise testing. In: Pate et al., eds. Pate RR, Blaire SN, Durstein JL, Eddy DO, Hanson P, Painter P, Smith LK, Wolfe LA. *ACSM's Guidelines for Exercise Testing and Prescription*. 4th ed. Philadelphia (PA): Lea & Febiger; 1991.
6. Daniels WL, Kowal DM, Vogel JA, Stayffer RM. Physiological effects of a military training program on male and female cadets. *Aviat Space Environ Med*. 1979;50(6):562–6.
7. Durnin JV, Rahaman MM. The assessment of the amount of fat in the human body from measurements of skinfold thickness. *Br J Nutr*. 1967;21(3):681–9.
8. Durnin JVGA, Womersley J. Body fat assessed from total body density and its estimation from skinfold thickness: measurements

on 481 men and women aged from 16 to 72 years. *Br J Nutr*. 1974;32:77–97.
9. Elspeth CR. Issues for military women deployment: an overview. *Mil Med*. 2001;166:1033–7.
10. Evans R, Reynolds K, Creedon J, Murphy M. Incidence of acute injury related to fitness testing of U.S. Army personnel. *Mil Med*. 2005;170:1005–11.
11. Heled Y, Epstein Y, Shapiro Y, Moran DS. Thermoregulation in rest and exercise—gender differences. *Harefuah*. 2001;140(11): 1041–5.
12. Jones NL. *Clinical Exercise Testing*. 3rd ed. Philadelphia (PA): WB Saunders Co; 1988;152–5.
13. Kang J, Chaloupka EC. Physiological and biomechanical analysis of treadmill walking up various gradients in men and women. *J Appl Physiol*. 2002;86:503–8.
14. Kelly EW, Jonson SR, Cohen ME, Shaffer R. Stress fractures of the pelvis in female navy recruits: an analysis of possible mechanisms of injury. *Mil Med*. 2000;165:142–6.
15. Knapik JJ, Darakjy S, Scott SJ, et al. Evaluation of a standardized physical training program for basic combat training. *J Strength Cond Res*. 2005;19:246–53.
16. Knapik JJ, Sharp MA, Canham-Chervak M, Hauret K, Patton JF, Jones BJ. Risk factors for training-related injuries among men and women in basic combat training. *Med Sci Sports Exerc*. 2001; 33(6):946–54.
17. Knapik JJ. The Army Physical Fitness Test (APFT): a review of the literature. *Mil Med*. 2000;154(6):326–9.
18. Libster D, Heled Y, Shapiro Y, Epstein Y. Physiological aspects of women in combat. *Harefuah*. 1999;137(11):521–5.
19. McArdle WD, Katch VL, Katch LK. *Exercise Physiology: Energy, Nutrition, and Human Performance*. 5th ed. Philadelphia (PA): Lippincott Williams & Wilkins; 2001.
20. McNeary AM, Lomenick TS. Military duty: risk factor for preterm labor? A review. *Mil Med*. 2000;165:612–5.
21. Mottern JA, Simutis ZM. Gender integration of U.S. Army basic training. In: *Proceedings of the 36th Annual Conference of the International Military Testing Association*; 1994. pp. 24–9.
22. Patton JF, Daniels WL, Vogel JA. Aerobic power and body fat of men and women during army basic training. *Aviat Space Environ Med*. 1980;51(5):492–6.
23. Reynolds KL, Harman EA, Worshman RE, Sykes MB, Frykman PN, Buckus VL. Injuries in women associated with a periodized strength training and running program. *J Strength Cond Res*. 2001;15(1):136–43.
24. Sharp MA, Patton JF, Knapik JJ, Hauret K, Mello RP, Ito M. Comparison of the physical fitness of men and women entering the U.S. Army: 1978–1998. *Med Sci Sports Exerc*. 2002;34(2): 356–63.
25. Siri WE. *Advances in Biological and Medical Physics*. In: Lawrence JH, Tobias CA, editors. New York: Academic Press Inc; 1956.
26. Steck GP. The Smirnov two sample tests as rank tests. *Ann Math Stat*. 1969;40(4);1449–66.
27. Unwin C, Hotopf M, Hull L, Ismail K, David A, Wessely S. Women in the Persian gulf: lack of gender differences in long-term health effects of service in United Kingdom armed forces in the 1991 Persian gulf war. *Mil Med*. 2002;167:406–13.