

Female Marine Recruit Training: Mood, Body Composition, and Biochemical Changes

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ABSTRACT

LIEBERMAN, H. R., M. D. KELLOGG, and G. P. BATHALON. Female Marine Recruit Training: Mood, Body Composition, and Biochemical Changes. *Med. Sci. Sports Exerc.*, Vol. 40, No. 11S, pp. S671–S676, 2008. **Purpose:** The US Marine Corps (USMC) is an elite military organization. Marine recruit training (RT) is a physically and psychologically intense 13-wk-long course designed to transform civilians into Marines through shared hardship and arduous training. Our laboratory conducted a study of female recruits in USMC RT that assessed the nature and the extent of cognitive, nutritional, and physical changes that occur during this unique period of structured mental and physical training. **Methods:** During RT, mood state was assessed every 4 wk with a standardized questionnaire, the POMS. Body composition was assessed with dual-energy x-ray absorptiometry every 4 wk, and blood samples were collected for assessing metabolic status at the start and at the completion of training. **Results:** At the beginning of RT, approximately 1 wk after arrival at the training facility, levels of several negative mood states assessed by the POMS, depression, anxiety, fatigue, anger, and confusion, were considerably higher than POMS norms for age-matched, female college students. However, over the course of RT, these mood states gradually declined until, by the completion of training, they were substantially lower than college norms. Body composition changed dramatically, with muscle mass increasing by 2.5 ± 0.2 kg on average and fat declining by 4.7 ± 0.4 kg. There were also significant changes in several biochemical parameters associated with nutritional and physical status, particularly LDL cholesterol, free fatty acids, and cortisol. Other factors, such as total cholesterol, HDL cholesterol, and glucose, were more stable. **Conclusions:** Over the course of USMC RT, mood and body composition improved substantially and dramatically, an indication of the effectiveness of USMC RT for altering the physical and the cognitive status of trainees. **Key Words:** MILITARY, DEPRESSION, FATIGUE, STRESS, CORTISOL, CHOLESTEROL

Basic combat training (BCT) is a unique military environment designed to rapidly produce substantial physical, cognitive, and social changes in trainees. At the start of BCT, individuals undergo a dramatic change in their external environment. Transitioning from civilian to military life requires adaptation to a novel way of life, which includes mandatory physical training, group living, institutional feeding, intense and continuous supervision, strict discipline, and development of a wide variety of new physical and mental skills. These challenges typically occur at times in life, late adolescence and early adulthood, of substantial psychosocial development and vulnerability (26). The standardized nature of the stressors of BCT provides a unique opportunity to examine cognitive, physical, and biochemical changes simultaneously occurring as individuals adapt to a new environment. Surprisingly, little quantitative information is available on the

cognitive, physical, and physiological changes that occur during BCT. A few classic studies have examined psychological adaptation to BCT (3,9), and several recent articles have addressed personality and mood changes during BCT (14,25,26). Martin et al. (14) found little indication of psychological distress in US Army BCT trainees regardless of sex or ethnicity, although initial levels of distress were slightly elevated. A study of changes in mood and cortisol levels during British Army BCT found that mood was relatively stable, but cortisol did vary over the course of the 11-wk course (2). Changes in overall physical fitness have also been examined during US Army BCT and significant improvements occur (10). Substantial changes in body composition, consistent with improved fitness, have also been documented during Marine and US Army BCT (4,5).

The US Marine Corps (USMC) is an elite fighting force that emphasizes discipline, esprit de corps, loyalty, and dedication to the organization. Female enlisted recruits attending USMC recruit training (RT), a 13-wk BCT course conducted at Marine Corps Recruit Depot, Parris Island, SC, participated in the current study. The stated purpose of USMC RT is to transform recruits into Marines through shared hardship and intense, arduous training (8). Marine RT is designed to aggressively initiate the process of acculturation to the USMC ethos as well as to rapidly develop the high level of physical fitness required of Marines. Because it is mentally, emotionally, and physically stressful

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(5), USMC RT is considered to be one of the more intense and challenging BCT courses in the US Department of Defense. Recruits participate in rigorous physical and mental training, including loaded road marching, obstacle courses, swim survival training, confidence courses, and 3 to 5 d·wk⁻¹ of physical training. Classroom training includes military courtesy, USMC history, and first aid. Although not gender integrated, training for males and females is similar.

This current study assessed mood, body composition, and several markers of physiological and nutritional status in female recruits attending USMC RT. We are not aware of any published studies that have concurrently assessed changes in cognitive, physical, and biochemical parameters in either males or females in an environment such as Marine RT, where young individuals are exposed to a relatively brief but extremely intense and highly structured period of physical and mental training.

METHODS

Marine RT. The 13 wk of USMC RT consist of three phases preceded by a week when trainees report and are assigned to a training unit. Phase 1 of USMC RT includes training weeks 1 to 4 and focuses on general military subjects; phase 2 includes training weeks 5 to 8 and focuses on basic combat tasks and includes a week when recruits work as teams; and phase 3 includes training weeks 9 to 12 and focuses on proficiency tests and inspections. A highlight of phase 3 is the “crucible” exercise during which recruits participate in a 54-h rigorous field training exercise. To graduate, recruits must successfully complete the “crucible,” pass a physical fitness test, and meet weight-for-height allowances and/or body composition (percent body fat [%BF]) standards.

The length of a recruit’s training day typically does not exceed 10 h, with the exception of weapons and field/combat training conducted during training weeks 6 and 7. A typical training day consists of waking up in the early morning, three 20-min meals, classes, tests, and physical, combat, and marksmanship training. Recruits have only 1 h of free time each evening, Monday through Saturday, while in garrison. Each Sunday, recruits may attend religious services and have 4 h of personal time. Drill instructors continuously supervise, monitor, and track the performance of recruits.

Volunteers. Participants were recruited from female recruits beginning the USMC RT course in May and June 2001. Female recruits with a BMI ≥ 19 kg·m⁻² and willing to add study requirements to their training schedule were eligible to participate. Sixty-six female recruits were enrolled in the study and 51 completed it. Fifteen volunteers withdrew from the study due to protocol time requirements, being reassigned to another training cycle, or for being deemed unfit for Marine Corps service and discharged. The mean age of volunteers completing the study was $19.7 \pm$

2.1 yr, and the mean height was 165.0 ± 4.8 cm. Most volunteers were either Caucasian ($n = 32$) or African American ($n = 10$). The US Army Research Institute of Environmental Medicine Human Use Review Committee, the Human Subjects Research Review Board, Office of the [Army] Surgeon General, and the Bureau of Navy Medicine Institutional Review Board reviewed and approved the protocol. Volunteers gave free and informed consent before study participation. An ombudsman was present at the time of consent to ensure that volunteers were not coerced to participate.

Procedures. The study was conducted during a standard cycle of RT at the USMC Recruit Depot, Parris Island, SC. Volunteers completed the POMS questionnaire (as described below) in the morning at the start of training week 1 and every 4 wk thereafter. The first week of training starts about 1 wk after recruits arrive on base, and so they would have already been exposed to the training environment, including intense discipline and supervision by drill instructors, before participating in the first mood assessment session. Volunteers also reported to study personnel during week 1 and subsequently every 4 wk for a urine pregnancy test and assessment of body composition by DEXA. A blood sample was collected at the start and at the completion of training.

POMS questionnaire. The POMS is a widely used, standardized, computer or paper-and-pencil inventory of mood states (16). Volunteers rated a series of 65 mood-related adjectives on a five-point scale in response to the question, “How are you feeling right now?” The individual adjectives factor into six mood subscales: tension, depression, anger, vigor, fatigue, and confusion.

Body composition. Dual-energy x-ray absorptiometry (DEXA; model DPX-L, software versions 4.6c and 4.7e; LUNAR Radiation Corp, Madison, WI) was used to measure weight, percent body fat (%BF), and bone mineral density. Fat mass was calculated as (body weight \times %BF). Fat-free mass was calculated as (body weight $-$ fat mass).

Laboratory measurements. Venous blood samples were obtained after an overnight fast. Samples were centrifuged at 3000 rpm for 10 min, and the serum was separated, aliquoted, and frozen at -80°C until analyzed at the Pennington Biomedical Research Center, Baton Rouge, LA. Total cholesterol and HDL cholesterol were analyzed on a Synchron CX7 (Beckman Coulter, Brea, CA) with a cholesterol esterase/oxidase/peroxidase (Beckman Coulter), a homogeneous assay (Trinity Biotech, Jamestown, NY), and a blanked timed end point method, respectively. LDL cholesterol was calculated with the Friedewald equation (LDL cholesterol = total cholesterol $-$ HDL cholesterol $-$ [plasma triglycerides / 5 mg·dL⁻¹]). Free fatty acids (FFA) were measured on a Beckman Coulter Synchron CX5 with Waco reagents (Waco Inc., Richmond, VA). Cortisol was measured on the DPC 2000 (Diagnostic Products Corporation, Los Angeles, CA), an automated immunoassay instrument that uses chemiluminescent detection.

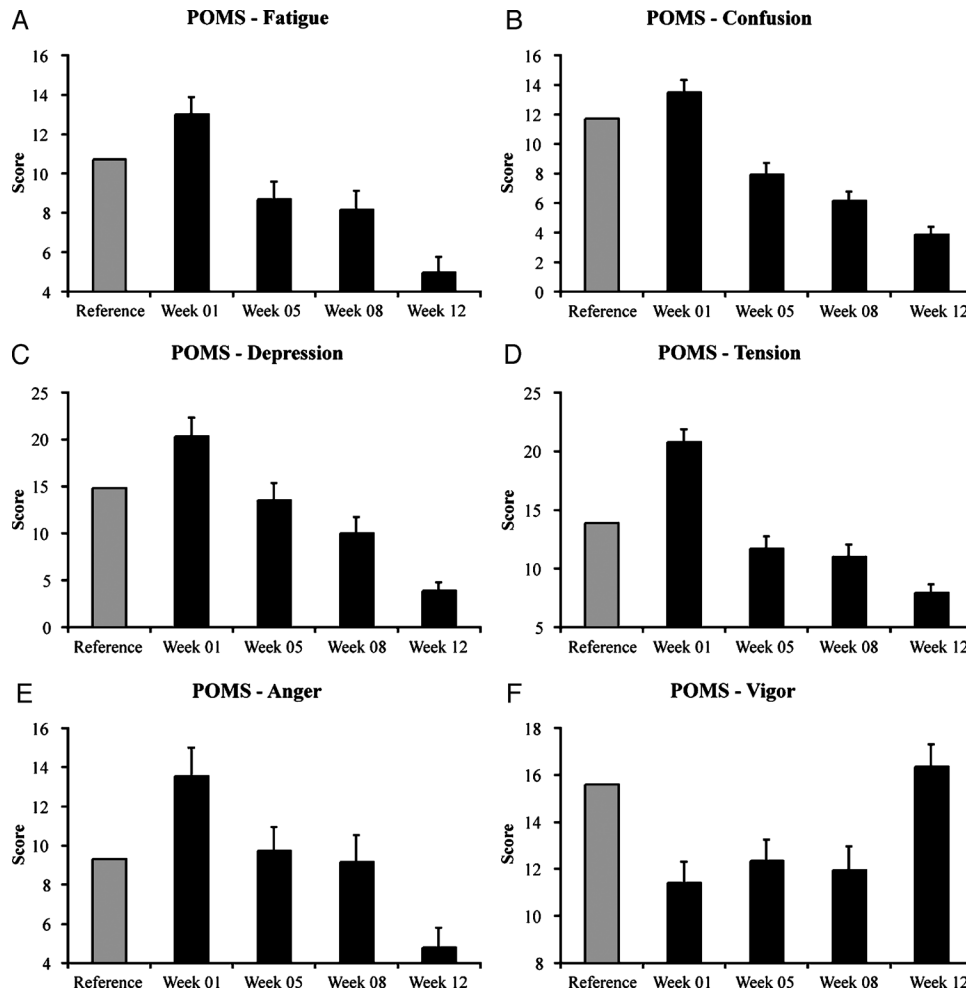


FIGURE 1—Mean \pm SEM changes in POMS during the 13-wk USMC RT Course of 50 female recruits. Age-matched norms are presented for comparison and labeled on the abscissa as “reference” (16). Changes in all POMS subscales were significant ($P < 0.001$).

Data analysis. The data were grouped by test week, and descriptive statistics (mean \pm SEM) were derived. Repeated-measures ANOVA were performed on the mood and the biochemical parameters assessed, with test week as a within-subject factor. The Greenhouse–Geisser correction was used for any measure that did not meet the sphericity assumption. *Post hoc* differences were determined with the least significant difference pairwise multiple comparison test. Paired-sample *t*-tests were used to evaluate changes in biochemical parameters at the start and at the completion of testing. The $P < 0.05$ level of significance was used to determine statistical difference for all analyses. One volunteer did not complete the POMS on one occasion and another missed a DEXA scan, so their data were excluded from the respective analyses.

RESULTS

All mood states assessed by the POMS changed substantially over the course of RT. Figure 1 presents the normative data for each subscale of the POMS for

comparison with the data of this study. As demonstrated by ANOVA, significant decreases in fatigue, confusion, depression, tension, and anger ($P < 0.001$ for each subscale) occurred gradually and systematically over the course of basic training (Fig. 1). Self-reported vigor increased over the course of training ($P < 0.001$), consistent with the changes in the other mood states assessed (Fig. 1). As shown in Figure 1, the differences between the initial and the final administration of the POMS were the largest. On *post hoc* testing, all comparisons were significant, $P < 0.001$ (mean difference \pm SEM): fatigue (8.0 ± 1.0),

TABLE 1. Changes in body composition as assessed by DEXA in 50 female recruits attending the 13-wk RT course.*

	Week 1	Week 5	Week 8	Week 12
Weight (kg)	63.9 \pm 0.8	61.8 \pm 0.8	61.4 \pm 0.8	61.7 \pm 0.7†
Fat mass (kg)	19.5 \pm 0.6	16.2 \pm 0.6	15.2 \pm 0.5	14.7 \pm 0.5†
Fat-free mass (kg)	41.7 \pm 0.5	42.7 \pm 0.5	43.3 \pm 0.5	44.1 \pm 0.5†
%BF	30.2 \pm 0.7	26.1 \pm 0.7	24.6 \pm 0.7	23.7 \pm 0.7†
Bone mineral mass (kg)	2.8 \pm 0.1	2.8 \pm 0.1	2.8 \pm 0.1	2.9 \pm 0.1

* Values are presented as mean \pm SEM.

† Significantly different from training week 1, $P < 0.001$.

TABLE 2. Changes in selected biochemical markers of 51 female recruits attending the 13-wk USMC RT course.*

	Week 1	Week 12
Cholesterol (mg·dL ⁻¹)	143.2 ± 3.2	139.1 ± 3.3
LDL cholesterol (mg·dL ⁻¹)	83.6 ± 2.9	64.9 ± 2.3†
HDL cholesterol (mg·dL ⁻¹)	51.5 ± 1.2	53.4 ± 1.6
FFA (mmol·L ⁻¹)	0.70 ± 0.1	0.08 ± 0.01†
Cortisol (μg·dL ⁻¹)	13.2 ± 0.7	10.4 ± 0.7‡
Glucose (mg·dL ⁻¹)	93.4 ± 2.2	97.5 ± 2.6

* Values are presented as mean ± SEM.

Significantly different from training week 1: † $P < 0.001$; ‡ $P < 0.003$.

FFA, free fatty acids.

confusion (9.6 ± 0.9), depression (16.4 ± 2.0), tension (12.8 ± 1.1), anger (8.8 ± 1.5), and vigor (4.9 ± 1.1). The recruits began RT reporting higher scores for adverse symptoms than is typical of age-matched females, but by the time they had completed training, their scores were lower than the norms, with the exception of the vigor score which, as would be expected, was higher (Fig. 1) (16).

Over the course of RT, the women lost 2.3 ± 0.4 kg of body weight ($P < 0.001$) with a concomitant loss of 4.7 ± 0.4 kg of body fat ($P < 0.001$) and gain of 2.5 ± 0.2 kg of muscle mass ($P < 0.001$, ANOVA and *post hoc* testing) (Table 1). There was no change in bone density ($P < 0.3$).

As shown in Table 2, there were substantial decreases in several biochemical parameters, including LDL cholesterol ($P < 0.001$) and free fatty acids (FFA; $P < 0.001$). Cortisol, a marker for stress, declined significantly ($P < 0.003$) over the course of RT (Table 2). Other biochemical markers such as total cholesterol ($P = 0.1$), HDL cholesterol ($P = 0.2$), and glucose ($P = 0.2$) remained stable over the 12 wk of RT.

DISCUSSION

Compared with POMS norms of female college students, the initial mood state of the recruits was unusually poor and comparable in many respects to the mood of individuals suffering from various psychiatric illnesses or severe military operational stress (12,13,16,19). This may have resulted from the week-long period of initial exposure to the Marine training environment before administration of the first POMS. It is also possible that trainees reported for BCT with abnormally poor scores on the POMS. However, over the course of 12 wk of training, many mood factors gradually and consistently improved until, after USMC RT, overall mood was better than that of female college students (16). Several factors, notably anger and vigor, improved more substantially from weeks 8 to 12, perhaps because the recruits were approaching graduation. In studies of male British Army and US Army basic trainees, substantial changes in mood state were not observed (2,14). The mood states of US Army female basic trainees fell within expected norms at the start and at the completion of BCT and resembled the mood of male basic trainees, not the extremes seen in female USMC recruits (14). Therefore, it

does not appear that sex differences account for these disparities but rather the nature of USMC RT, although until studies are conducted with male Marines during BCT, sex differences cannot be ruled out.

We are not aware of any military, civilian, or clinical alteration in lifestyle or health associated with such dramatic changes in all mood states. Treatment with antidepressant medication or cognitive therapy of patients with depression does not produce changes in mood of the magnitude observed during USMC RT (17). In a randomized controlled study of clinically depressed patients for 12 wk, those treated with antidepressants showed a 55% reduction in self-reported ratings of depression and those treated with cognitive therapy showed a 66% reduction in depression ratings (17). In this study, USMC recruits' ratings of depression declined 81% after 12 wk (Table 3). It should also be noted that civilian physical training and weight loss regimes also do not produce such dramatic changes in mood (11,20). Given the high levels of depression, anxiety, anger, and fatigue of recruits at the start of USMC RT, normalization of mood was to be expected; however, the mood of recruits upon completion was substantially better than the norms for females of this age would have predicted. It seems likely that the nature of training, including the initial, presumably harsh, treatment of recruits in the week before the start of formal training as well as various techniques used to transform civilians into elite Marines, both psychologically and physically, produced these dramatic changes.

Little quantitative information is available regarding the psychological state that USMC drill instructors attempt to instill in new recruits, but it appears that USMC RT may be more intense and stressful than US Army BCT. USMC RT is longer, 13 versus 9 wk, and the physical performance and body fat standards for graduation are stricter. The maximum permitted %BF for females to graduate Marine BCT is 26%, but for army BCT it is 30% for soldiers aged 17 to 20 yr (6,7). Tougher, more stressful treatment by drill instructors on arrival at RT may account for the poor mood state of recruits on entry to USMC RT because these recruits are drawn from the same population as US Army basic trainees. In addition, the longer, more demanding, and intense nature of USMC RT may produce greater changes in mood state than army BCT over the course of training. Change in body composition over the course of BCT is also very different when female USMC recruits are compared

TABLE 3. Changes in subscales of POMS 50 female recruits attending the 13-wk USMC RT course.*

	Week 1	Week 12	% Change
Fatigue	13.0 ± 0.9	4.9 ± 0.8	62
Confusion	13.5 ± 0.8	3.8 ± 0.5	72
Depression	20.3 ± 1.9	3.9 ± 0.9	81
Tension	20.8 ± 1.1	7.9 ± 0.7	62
Anger	13.6 ± 1.4	4.8 ± 1.0	65
Vigor	11.5 ± 0.9	16.1 ± 1.0	40

* Values are presented as mean ± SEM.

with their army counterparts. Army female basic trainees have been reported to gain 0.8 kg of body mass and lose 3% of their body fat as assessed by DEXA (21). USMC female recruits in this study lost 2.3 kg of body mass and 6.5% of their pretraining body fat.

We observed substantial changes in several biochemical factors over the course of USMC RT. LDL fell significantly—a positive change as it is an important marker of cardiovascular risk associated with diet and exercise (24). Another positive metabolic change was a dramatic reduction in FFA. Reduced levels of FFA are associated with reduced lipid synthesis, gluconeogenesis, and insulin resistance (15). The changes in LDL cholesterol and FFA were consistent with the changing physiological and nutritional status of the trainees. The intense physical training may account not only for these biochemical changes but also for the substantial changes in body composition observed. The reduction in cortisol observed is consistent with the positive change in mood states over the course of RT, particularly the reduction in the tension score of the POMS (23). During training weeks 1 and 12, we assessed food consumption. There was a substantial increase from weeks 1 to 12 in total energy consumed, which is consistent with the increased levels of physical activity associated with BCT. There were only modest changes in the proportion of macronutrients consumed from weeks 1 to 12 with the proportion of protein intake in the diet decreasing somewhat and a modest increase in the proportion of carbohydrate

consumed. These changes are unlikely to be responsible for the changes in body composition and biochemical parameters observed.

The dramatic changes in mood observed in female recruits were associated with extensive changes in body composition and biochemical markers of overall health. Whether these substantial changes in both physical and mental state are related cannot be determined from this study; however, there are several studies that suggest that physical training and exercise and the associated change in body composition have positive effects on cognitive state, including mood (1,18,22). However, other studies and a systemic review of research conducted with children and adolescents are negative or inconclusive (11,20).

In conclusion, USMC RT, at least for females, appears to substantially modify both the mental and the physical state of trainees in a manner consistent with the aims of Marine RT doctrine (8).

The opinions or the assertions contained herein are the private views of the author(s) and are not to be construed as official or as reflecting the views of the Army or the Department of Defense. Human subjects participated in these studies after giving their free and informed voluntary consent. The investigators have adhered to the policies for protection of human subjects as prescribed in Army Regulation 70-25, and the research was conducted in adherence with the provisions of 32 CFR Part 219. Citations of commercial organizations and trade names in this report do not constitute an official Department of the Army endorsement or approval of the products or services of these organizations.

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