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Negative Mood Endures After Completion of High-Altitude Military Training

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ABSTRACT

Background: *Associations between physical and emotional stress and negative mood states have been documented in a variety of populations. In military personnel, more physical symptoms and decrements in ability to perform critical tasks have been shown to accompany such stress-induced negative mood. Most research in this area has focused on immediate effects of stress on mood.* ***Purpose:*** *We wondered what immediate mood effects strenuous training would have on Marines, what mood effects would endure 30 and 90 days after completion of training, and how mood scores would compare with normative data.* ***Methods:*** *Sixty male Marines (M age = 19 years, range = 18–28) completed the Profile of Mood States (POMS) at multiple time points before and after participating in a 30-day, cold weather, high-altitude field training exercise. Anthropometric measurements were taken at the same time points.* ***Results:*** *The Marines reported significant increases in POMS scores from baseline to completion of training, most of which endured up to 90 days. The anger and fatigue scores reported by the Marines were comparable to adult male psychiatric outpatient norms.* ***Conclusions:*** *Rigorous training in challenging environments may result in enduring negative moods that approach levels of clinical significance and may have implications for readiness for duty and performance of critical tasks. Behavioral medicine interventions may be helpful in military populations to reduce the impact of negative mood.*

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INTRODUCTION

The literature is replete with observations of negative mood in a range of populations experiencing various forms of physical and emotional stress. Several studies have documented negative mood in military and quasi-military populations undergoing stressful experiences involving rigorous training and challenging environments (1–11). For example, in one study, mood in army soldiers, as measured by the Profile of Mood States (POMS), was assessed shortly after beginning and immediately after completing a maximal effort 20-km road march while carrying a 40-kg load. The soldiers reported an 82% increase in fatigue and a 38% decrease in vigor between these two time points (2). Another study, examining mood in Navy Special Forces personnel engaged in basic training, showed increases in POMS anger and fatigue, and a decrease in POMS tension pre- to posttraining for those who completed training (7).

The assessment of changes in mood associated with strenuous training is of considerable interest in military populations for several reasons. In some studies, negative mood has been associated with increases in physical symptoms (1–3,9,12), thus having potential implications for readiness for duty. For example, one study reported that POMS tension and fatigue were positively associated with a number of physical health symptoms in Navy personnel engaged in Persian Gulf operations (6). In other studies, negative mood has been associated with decrements in the execution of critical military or quasi-military functions, thus having possible implications for quality of performance of duties. For example, Army personnel reporting elevated POMS fatigue and diminished POMS vigor experienced a significant decrease in marksmanship accuracy (2,4). Also, elevated levels of self-reported confusion accompanied augmented levels of fatigue in Air Force air traffic controllers working night shifts (2). Specific to high-altitude training, a number of researchers have observed negative mood states or increased physical symptoms or both at altitudes above 3,050 m (1,13–16). For example, Shukitt-Hale et al. (1998) observed decreased POMS vigor, increased POMS fatigue, and increases in seven physical symptoms at elevations as low as 3,080 m (16).

Previous studies in this area have been generally limited to the documentation of mood changes during episodes of stressful training or other operations. Thus, pretraining baseline measurements and longitudinal designs that would include posttraining follow-up assessments are often lacking in these studies. In addition, several of the cited studies involve sample sizes of 12 or less.

In this study, we focused on assessing mood changes in young Marines participating in a strenuous, 30-day, high-altitude, cold temperature field training exercise (FTX). Employing a longitudinal design that began with a pretraining baseline assessment, we were interested in determining whether mood would be more negative at the completion of training, if mood would remain at such levels at 30 and 90 days after completion, and how mood scores would compare with normative data.

METHODS

Study Participants

Sixty active-duty male Marines stationed at the Marine Corps Air Ground Combat Center at Twentynine Palms, California, volunteered to participate in a 5-month longitudinal study. The study was approved by the Naval Health Research Center Institutional Review Board. Before admission into the study, each Marine read and signed an informed consent document. Prior to signing the informed consent, each Marine was polled individually as to his understanding of the study and was given ample opportunity to ask questions concerning his participation.

Table 1 shows characteristics of the participants at baseline. The Marines ranged in age from 18 to 28 years, with a mean age of 19.8 years (standard error of the mean [*SEM*] = .26 years), height of 179.2 cm (*SEM* = .84 cm), and weight of 81.38 kg (*SEM* = 1.22). On average, the Marines had a mean body mass index (BMI) at the high end of the normal range, but with relatively low percentage of body fat, high fat-free mass, and a low ratio of body fat to lean body mass. All participants had been members of the Marine Corps for at least 6 months. Each Marine participating in the study was given a physical exam by the battalion medical officer and deemed to be in good health and free from taking any prescription medication.

Experimental Design

This study employed a prospective repeated measures design. Using the POMS, mood was evaluated on two occasions prior to and three occasions after completion of a deployment to the Marine Corps Mountain Warfare Training Center (MWTC), Bridgeport, California, where the Marines participated in a 30-day high-altitude FTX. All 60 Marines completed the FTX. Data were collected at the Marines' home of record at Twentynine Palms, California, 23 days prior to arrival at MWTC and within 1 day after the Marines arrived at the MWTC base camp. Because POMS scores did not differ significantly at these two time points, they were averaged to provide a single estimate of baseline functioning (baseline). The POMS was administered again at the conclusion of the FTX—1 day before the Marines returned to Twentynine Palms (post-FTX). In addition, participants completed the POMS at 30 (30-post-FTX) and 90 (90-post-FTX) days after completion of training to provide an estimate of mood recovery from the training episode. All POMS questionnaires were administered between 1300 and 1500 hr for each assessment period.

Various anthropometric measurements were taken at multiple time points using standard measurement techniques. At baseline, each Marine's height was measured in centimeters. At baseline and 30- and 90-days post-FTX, body weight was measured in kilograms, percentage body fat was assessed using standard Navy circumference equations (17), and fat-free mass, fat-to-lean ratio, and BMI (kg/m^2) were calculated.

Military Training Activities

Table 2 shows a day-by-day breakdown of FTX activities. Winter military operations at MWTC consisted of continuous physical activities encompassing both night and day patrols using cross-country skiing, telemarking, and snowshoeing. Additional training included land navigation, acquiring survival skills, as well as live-fire training. On arrival at MWTC, the Marines received orientation on the military activities while at base camp (altitude 2,053 m) for approximately 3 days. At the conclusion of the base camp training, company size units hiked to their respective training ranges, which ranged in altitude from 2,546 m to 3,600 m. The initial military training exercises lasted approximately 9 days, at which time the Marines returned to base camp for 2 days. The Marines then hiked to different training ranges for the remainder of the FTX (approximately 2 weeks). While in the field, the Marines typically bivouaced in four-man tents. The winter military operations took place between mid-February and mid-March. The average snow level during this time ranges from about 2 m to 4.5 m. Nighttime tem-

TABLE 1
Participant Characteristics by Time Point

	Baseline	*Post*	*30 Post*	*90 Post*
Age	19.80 (.26)	—	—	—
Body mass index	25.33 (.33)$^{a**, b**}$	24.85 (.30)$^{a**, c**}$	24.69 (.39)$^{b**, d*}$	25.86 (.40)$^{c**, d*}$
% body fat	16.52 (.56)	16.23 (.48)	15.57 (.56)	17.29 (.64)
Fat-free mass	67.66 (.78)^{a**}	67.07 (.77)^{a**}	67.14 (.86)	68.84 (1.20)
Ratio: fat/lean	.20 (.01)^{b*}	.20 (.01)	.19 (.01)^{b*}	.21 (.01)

Note. Values are mean (standard error of the mean). FTX = field training exercise.
[a]Significant baseline to post-FTX differences. [b]Significant baseline to 30-post-FTX differences. [c]Significant post-FTX to 90-post-FTX differences. [d]Significant 30-post-FTX to 90-post-FTX differences.
$^*p < .05$. $^{**}p < .01$.

TABLE 2
Thirty-Day Field Training Exercise (FTX) Activities

Segment	*Activity*	*Location (Distance Traveled)*	*Altitude*
Day 1–4	Orientation (Baseline data collection Day 1)	Base camp—none	2,053 m
Day 5	Company movement (hiking)	Training ranges I—11 km	2,800 m
Day 6	Establish bivouac area	Training ranges I—none	2800 m
Day 7–8	Nighttime patrolling	Training ranges I—5–8 km	2,800– 3,100 m
Day 9–10	Cross-country skiing, telemarking, snowshoeing orientation	Training ranges I— 5–10 km/day	2,800—3,100 m
Day 11	Critique/break down bivouac area	Training ranges I—none	2,800 m
Day 12	Company movement (hiking)	Back to base camp—11 km	3,100–2,053 m
Day 13–15	Equipment cleaning/repair	Base camp—none	2,053 m
Day 16	Company movement (hiking)	Training ranges II—9 km	3,200 m
Day 17	Establish (new) bivouac area	Training ranges II—none	3,200 m
Day 18–20	Company attack/night firing	Training ranges—2–5 km	3,200 m
Day 21	Planning/operations order	Training ranges II—none	3,200 m
Day 22–26	Tactical operations (company)	Training ranges II—2–5 km/day	3,200–3,650 m
Day 27	Critique/break down bivouac area	Training ranges II—none	3,200 m
Day 28	Movement to base camp (hiking)	Base camp—9 km	2,053 m
Day 29	Equipment loading/repair (end-FTX data collection)	Base camp—none	2,053 m
Day 30	Movement to Twentynine Palms (bus)	Twentynine Palms—720 km	427 m

Note. All Marines involved with training carry a 40-kg pack and weapon.

peratures ranged from –2° C to –20° C and daytime temperatures ranged from 2° C to –7° C.

Mood Assessment

The POMS is a self-administered measure of current mood or affective states, consisting of 65 adjectives rated on a 0 to 4 scale. One of the most widely used mood scales (18), this instrument is easily understood by persons having at least a seventh-grade education. POMS data can be consolidated into six factor analytically derived mood variables (Tension–Anxiety, Depression–Dejection, Anger–Hostility, Vigor–Activity, Fatigue–Inertia, and Confusion–Bewilderment) as well as a global distress variable (total mood disturbance). Higher scores indicate greater levels of mood symptoms except for vigor, where lower scores indicate greater symptomatology. Internal consistency (Cronbach's α) ranges from .84 to .95, indicating excellent reliability (19).

The POMS has been shown to be valid in studies of emotion-inducing conditions, sports, and exercise (19), and in studies assessing mood and fitness in military personnel before and after basic training (11) and other strenuous maneuvers and training (1–3,5–7,9,10). More specifically, the POMS has been used repeatedly to assess mood in military and quasi-military populations experiencing stressful situations involving high altitude and extreme cold temperatures (1,3,9,10). At each administration of the scale, participants were instructed to indicate how they felt "right now."

Normative data for the POMS is available for many populations. We chose norms for adult men from the U.S. general population (ages 18–65), men attending college (because of the similarity to the Marines in terms of age range), and adult male psychiatric outpatients. The latter group was included to provide a rough estimate of whether negative mood observed in the Marines approached a level comparable to that of a psychiatric population.

Statistical Analysis

Data were analyzed using SPSS 11.0.1 *t* tests, Pearson correlations, and repeated measures analysis of variance (ANOVA) and covariance. *T* tests were used to compare the Marines' baseline POMS subscale scores with the norms. Repeated measures ANOVAs were conducted to determine the significance of changes in mood and anthropometric variables over time. When significant main effects were noted, individual time points were compared to baseline values. Pearson correlations were conducted to determine relations between POMS subscale scores and anthropometric variables.

RESULTS

Repeated measures ANOVAs indicated that there was a significant decrease from baseline to post-FTX in body weight ($p < .001$) and BMI ($p < .001$), which was maintained at 30-post-FTX. This was followed by significant increases in body weight ($p = .012$) and BMI ($p = .013$) from 30- to 90-post-FTX, which amounted to a return to baseline levels (Table 1). The baseline to post-FTX body weight and BMI decrease can be explained by a significant decrease in fat-free mass ($p = .003$) during this period. In addition, there was a significant decrease in the fat-to-lean ratio from baseline to 30-post-FTX ($p = .047$). No significant changes in indexes of fat or lean mass occurred after 30-post-FTX. Taken together, these data suggest that the decreases in body weight and BMI were due to decreases in both fat and lean mass.

Table 3 shows mean POMS scores for the Marines at each time point and data for the three normative groups. *T* tests were used to compare the Marines' baseline POMS subscale

TABLE 3
Profile of Mood States Subscale Norms and Scores by Time Point

	Norms[a]			*Marines*			
	College Men	*Adult Men*[b]	*Male Psychiatric Outpatients*[c]	*Baseline*	*Post*	*30 Post*	*90 Post*
Tension	10.70[d**]	12.30[d**]	18.4	7.42 (.57)[e**, f**, g*]	9.55 (.73)[e**]	9.80 (.93)[f**]	9.77 (.94)[g*]
Depression	8.60	8.30	22.3	7.24 (1.08)[e**, f*, g**]	10.41 (1.30)[e**]	10.67 (1.63)[f*]	11.61 (1.57)[g**]
Anger	8.90	9.20	13.5	9.11 (.96)[e**, f**]	13.31 (1.20)[e**, h]	12.51 (1.57)[f**, h]	11.68 (1.47)[h]
Vigor	16.90[d**]	16.30[d**]	11.3	13.08 (.77)	14.29 (.85)[h]	12.82 (1.07)[h]	14.73 (.80)
Fatigue	9.00[d**]	7.00	10.1	6.07 (.64)[e**, f**, g*]	9.95 (.74)[e**, h,i*]	10.53 (1.06)[f**, h, j*]	7.91 (.84)[g*, i*, j*]
Confusion	7.10[d*]	6.70	12.4	5.91 (.48)[e*, f**, g*]	6.79 (.58)[e*]	7.64 (.73)[f**]	7.09 (.69)[g*]
Total	27.50	27.20	65.4	22.66 (3.42)[e**, f**, g*]	35.72 (4.10)[e**]	38.33 (5.59)[f**]	33.34 (5.23)[g*]

Note. Values are means, with standard error of the mean in parentheses. FTX = field training exercise.
[a]Norms from McNair, Lorr, and Droppleman (1992) (see 19). [b]Age ranged from 18 to 65. [c]Norms for male psychiatric outpatients differed significantly from means for Marines on all subscales at all time points, except those marked with [h]. [d]Norm versus baseline Profile of Mood States subscale scores. [e]Significant baseline to post-FTX differences. [f]Significant baseline to 30-post-FTX differences. [g]Significant baseline to 90-post-FTX differences. [h]Mean scores for Marines did not differ from norms for male psychiatric outpatients. [i]Significant post-FTX to 90-post-FTX differences. [j]Significant 30-post-FTX to 90-post-FTX differences.
$*p < .05$. $**p < .01$.

scores with scores for each normative group. Compared with adult male norms, the Marines reported 40% less tension ($p < .001$) and 23% less vigor ($p < .001$); however, the Marines' scores did not differ from adult men on POMS Depression ($p = .331$), Anger ($p = .924$), Fatigue ($p = .150$), Confusion ($p = .105$), or total mood disturbance ($p = .189$). Compared with norms for college men, at baseline, the Marines had 33% less fatigue ($p < .001$), 31% less tension ($p < .001$), 23% less vigor ($p < .001$), and 17% less confusion ($p = .016$). Marines' baseline scores did not differ from the college norms for POMS Depression ($p = .213$), Ager ($p = .829$), or total mood disturbance ($p = .162$). The Marines reported significantly better baseline mood on all POMS subscales compared with the adult male psychiatric outpatients ($p = .023$ for vigor; $p < .001$ for all other subscales).

Results of repeated measures ANOVAs revealed significant time effects for five of the six POMS subscales ($p < .001$ to .031) and POMS total mood disturbance ($p = .001$); however, only a trend was observed for Vigor ($p = .079$). Post hoc analyses of these significant time effects revealed that the Marines reported more negative mood at post-FTX compared with baseline, and except for fatigue, these levels were maintained at 30- and 90-post-FTX. Fatigue scores declined significantly from 30- to 90-post-FTX (10.53 to 7.91, $p = .022$) and were significantly lower than post-FTX scores (9.95 vs. 7.91, $p = .020$) but nonetheless remained significantly elevated above baseline (7.91 vs. 6.07, $p = .032$).

Of particular note are the levels of scores for POMS Anger, Fatigue, and Vigor. As a reminder, at baseline, Marines' Anger scores did not differ from either of the nonpatient norms, Fatigue was significantly lower than college males, and Vigor was significantly lower than both nonpatient norms. However, POMS Anger scores were significantly higher than norms for college men at post-FTX (13.31 vs. 8.9, $p = .001$) and at 30-post-FTX (12.51 vs. 8.9, $p = .026$). Marines' Anger scores did not differ from norms for adult male psychiatric outpatients at post-FTX, 30-post-FTX, and 90-post-FTX (13.31, 12.51, and 11.68 vs. 13.5; all nonsignificant; see Figure 1). In addition, Marines' scores did not differ from male psychiatric outpatients at post-FTX and 30-post-FTX for Vigor (14.29 and 12.82 vs. 11.3; both nonsignificant) and Fatigue (9.95 and 10.53 vs. 10.1; both nonsignificant; see Figure 2).

We assessed the anthropometric variables in relation to the POMS subscales. To this end, we examined baseline Pearson correlations between these sets of variables. With the exception of Vigor, the POMS subscales were not significantly associated with any of the anthropometric variables. POMS Vigor, however, was significantly negatively correlated with baseline weight ($r = -.322$, $p = .012$), fat mass ($r = -.259$, $p = .045$), and fat-free mass ($r = -.299$, $p = .020$). We also divided baseline anthropometric variables into high or low categories (using median splits) and used

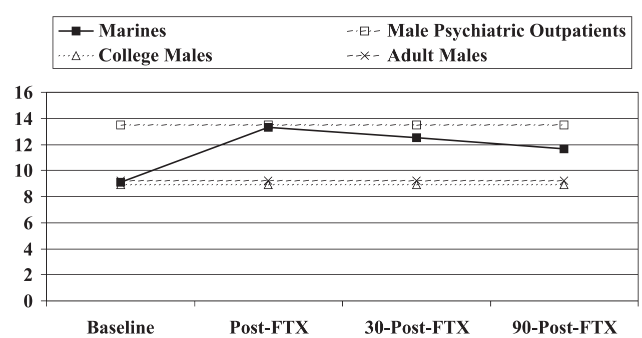

FIGURE 1 Comparison of mean POMS Anger scores for Marines versus normative groups. Marines' POMS Anger scores were significantly lower than male psychiatric outpatient norms at baseline ($p < .001$) but did not differ at post-FTX, 30-post-FTX, or 90-post-FTX (all *ns*). FTX = field training exercise; post-FTX = at completion of FTX; 30-post-FTX = 30 days after completion of FTX; 90-post-FTX = 90 days after completion of FTX.

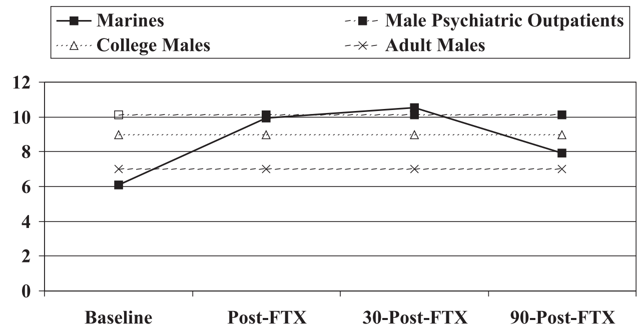

FIGURE 2 Comparison of mean POMS Fatigue scores for Marines versus normative groups. Marines' POMS Fatigue scores were significantly lower than male psychiatric outpatient norms at baseline ($p < .001$) and 90-post-FTX ($p = .013$) but did not differ at post-FTX or 30-post-FTX (both *ns*). FTX = field training exercise; post-FTX = at completion of FTX; 30-post-FTX = 30 days after completion of FTX; 90-post-FTX = 90 days after completion of FTX.

these as grouping variables in repeated measures ANOVAs with POMS subscales as the repeated variable. None of the Time × Anthropometrics group interactions were statistically significant.

DISCUSSION

Because of potential implications for readiness for (1–3,6,9,12) and performance (2,4) of duty, understanding the mood effects of stressful activities and harsh environments is of particular importance in military populations. This study was designed to determine changes in mood associated with a rigorous, 1-month, cold temperature, high-altitude FTX. This study is a significant addition to this literature in that it included preexercise baseline characterization of mood and anthropometrics, a longitudinal design that involved 30- and 90-day follow-up assessments of these variables, and a larger sample size than many previous studies. Thus, we were able to report not only on the immediate effects of such rigorous training but on mood patterns up to 3 months after completion.

The Marines reported significant increases in negative mood from baseline to post-FTX, which were generally maintained for 3 months after completion of training. The baseline to post-FTX changes were consistent with previous observations of increased fatigue (2,7) and anger (7) immediately after completing military training. However, we are unaware of any studies that tracked mood up to 3 months postcompletion.

Regarding comparisons with normative data, the Marines reported better mood overall at baseline than has been reported for male college students and males from the general population (19). However, immediately after the exercise, the Marines reported levels of depression, anger, fatigue, and total mood disturbance that exceeded levels reported for these two normative groups. In addition, levels of anger, vigor, and fatigue equaled normative values for male psychiatric outpatients (the patient group for which the POMS was developed) (19) and, thus, could be of potential clinical concern.

The strenuousness of the exercise is suggested by the significant anthropometric changes observed in these Marines. BMI and percentage body fat decreased an average of 2% from baseline to the end of the exercise and 3% and 6%, respectively, by the 30-days-post-FTX time point. Fat-free mass declined 1% by 30 days post-FTX. However, because anthropometric variables were associated with only one POMS subscale—Vigor, which was the only POMS subscale not to show significant changes over time—the observed mood changes cannot be explained by changes in body habitus as a result of the exercise. It is possible that food quality or quantity or both could have been a factor influencing the anthropometric variables; however, we did not evaluate dietary factors per se, and diet was beyond the scope of this study.

This preliminary analysis raises questions about mechanisms for the persistence in negative mood up to 3 months after completion of the FTX. The literature has shown that exposure to stressful stimuli (e.g., cold, high altitude; physical activity; reduced oxygen) increases stress hormone levels (20), and elevations in stress hormones have been associated with negative mood states (21–23). However, the literature is not so clear on how rapidly adaptation to stress ablates after removal of the stressful stimuli. Further, in the case of these Marines, there were adaptations not only to stressful environmental stimuli but also to mild hypoxia. When the Marines returned to their home base, there was a physiological stimulus to readapt to a normoxic environment. It is possible that this readaptive process (affecting many physiological systems, including the endocrine system and the hypothalamic–pituitary–adrenal axis) manifests as prolonged psychological perturbations.

On the other hand, psychological distress (e.g., sleep deprivation, disruption of normal daily cycles, anxiety associated with deployment) evokes stress signals independent of the environmental stressors. Perhaps these psychologically induced stress signals drive physiological maladaptations or at least delay normal adaptive processes. Even when removing the novel environmental stressors (i.e., returning to Twentynine Palms), the central nervous system must again readjust to new circumstances. To our understanding, the psychological distress associated with the return to home base has not been well characterized. This may be of immediate relevance given the numbers of troops currently returning from deployment in the Middle East. Clearly there is a need to assess in more detail the interplay of physiological and psychological factors in humans in the weeks to months after prolonged exposure to harsh environmental circumstances.

Limitations

Because it was determined that assessment of mood *during* the FTX would be impractical due to the intensity of the training, we have no data on mood fluctuations while the FTX was in process. It is possible that mood levels assessed immediately before and at the completion of the FTX are not representative of levels during the FTX. For example, Shukitt-Hale et al. (1998) observed shifts in alertness, vigor, and fatigue at five time points during a climb to 3,630 m (16). Nonetheless, we believe the mood patterns observed at the study assessment points are of significant importance. In addition, although we know that the

Marines returned to the same military setting they were in prior to the FTX, we did not assess types and levels of stress experienced by the Marines in the period after the FTX. Future studies should include such assessment to determine changes in stressors in the Marines' normal work and home environments after participation in exercises such as the FTX described here.

CONCLUSION

These findings are in agreement with previous studies that observed elevated fatigue and anger along with decreased vigor immediately after experiencing stressful activities or environments. It is of significant interest that these augmentations in mood remained—some at levels observed in psychiatric outpatients—well beyond the completion of the stressful exercise. Rigorous military training in challenging environments may result in enduring negative mood that approaches a clinically significant level. Such mood patterns have been previously associated with increased physical symptoms and decrements in performance of critical tasks. Thus, military populations may represent new opportunities for further application of behavioral medicine techniques. Behavioral interventions involving stress-coping techniques could conceivably have a positive impact on readiness for duty and quality of performance during and after the execution of strenuous activities in stressful environments.

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