Influence of Training Frequency on Fitness Levels and Perceived Health Status in Deployed National Guard Soldiers

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Abstract

Warr BJ, Scofield DE, Spiering BA, and Alvar BA. Influence of training frequency on fitness levels and perceived health status in deployed National Guard Soldiers. *J Strength Cond Res* 27 (2): 315–322, 2013–While studies have examined changes in body composition, fitness, and other measures pre- and post-deployment, it is more difficult to characterize physical training practices during deployment. The purpose of this study was to evaluate the association between training frequency during deployment and changes in physical performance, body composition, and perceived health. Eighty-eight Soldiers (men, 76 and women, 12) from the National Guard performed 1 repetition maximum (1RM) bench press, 1RM back squat, and $\dot{V}O_2$peak testing within 30 days before and 10 days after deployment to Iraq or Afghanistan. Soldiers completed a questionnaire pertaining to aerobic and strength training frequency, as well as perceived changes to health. Soldiers experienced significant ($p \leq 0.05$) improvements in upper (11%) and lower body strength (14%), declines in body fat percent (−16%), but no change in $\dot{V}O_2$peak. About 57% of Soldiers reportedly performed aerobic training ≥3 times per week, whereas 67% performed strength training ≥3 times per week. Soldiers performing aerobic training ≥3 times per week responded differently than those who conducted aerobic training <3 times per week in $\dot{V}O_2$peak values (2 vs. −8%, $p = 0.016$). About 42% of Soldiers reported that their health improved, 36% reported no change to their health, and 22% reported that their health had declined. There was a significant association between training frequency and perceived health. About 50–58% of Soldiers who trained ≥3 times per week reported improvements in health during deployment, whereas only 21–24% of Soldiers who trained <3 times per week reported improvements in health for the same period of time. It seems that Soldiers who train ≥3 times per week experience a more advantageous response in terms of fitness levels and perceived health during deployments.

Key Words soldiers, deployment, training frequency, perceived health, fitness

Introduction

Soldiers are often expected to perform exhaustive physical work during perilous combat situations. Challenges faced by Soldiers on combat deployments include environmental demands of operating in harsh and austere environments, as well as the psychological demands of coping with unusual and often unpredictable surroundings. Additionally, combat deployments may last for extended periods up to or more than 12 months, and Soldiers are expected to maintain their fitness level during this time. Maintaining fitness during deployment may be achieved by the physical requirements and demands of the soldier's occupation, through the implementation of structured physical training (PT), or both. Despite the known benefits of moderate physical activity in the civilian population, it is not well understood how much activity is needed for Soldiers to maintain or improve in physical performance, body composition, and perceived health status while deployed (7,11,15).

Because of the extended duration of most combat deployments, Soldiers cannot rely on their predeployment fitness level to carry them through a deployment. It is vitally important that Soldiers continue to conduct some form of PT during this time, otherwise detraining will occur. How Soldiers conduct structured PT in the deployed environment can be influenced by a number of factors such as equipment and resources, command climate, the requirement of 24-hour operations, and safety. Moreover, under the current deployment circumstances, most deployed Soldiers maintain significant autonomy in terms of their PT. This autonomy is largely due to a combination of continuous operations and the individual Soldier's duty requirements, thus making it difficult for military leaders to provide direct supervision during fitness training.

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There are currently a number of publications assessing physical activity, including both occupational tasks and fitness training in a variety of military training settings ranging from basic training to U.S. Army Ranger School (4,6,9). However, there is limited research assessing the frequency and duration of physical activity in deployed Soldiers. Although the physical demands of specific military tasks have been established, there is a paucity of descriptive data for the overall physical activity levels and physical requirements of Soldiers who are deployed in a combat setting. Sharp et al. (11) in 2008 and Lester et al. (7) in 2010 published data showing that the amount of PT during deployment among individual Soldiers was highly variable, even though they were in the same Army unit. The variation reported within these 2 studies is likely because of the fact that different occupations represented within a single deployed Army unit tend to require different levels of physical activity (7,11). Determining the impact of the type and frequency of PT in deployed Soldiers has not been previously examined.

It has been reported that 20–26% of all military service members who have deployed to the Middle East report a decline in their health over the course of the deployment (2). There are variations between the different services and by active or reserve components. Army reserve component Soldiers, which consists of Army Reserves and National Guard (NG), had the highest percentage of soldiers reporting a decline in health at 32% (2). The potential relationship between physical fitness training frequency and perceived changes in health during a combat deployment hereto for has not been examined.

The primary purpose of this study was to evaluate the association between reported PT frequency and changes in physical performance and body composition during a military deployment in NG Soldiers. Additionally, the association between training frequency and perceived changes in health was evaluated.

Methods

Experimental Approach to the Problem

Primary outcomes for this study were the measurements of individual body composition, muscular strength, and cardiorespiratory fitness. Additionally, self-reported aerobic training frequency, strength training frequency, and perceived levels of health were assessed. There were no formal PT requirements for Soldiers enrolled in this study. Soldiers were simply encouraged to train in accordance with their respective unit requirements while deployed. Performance measures and body composition were assessed at predeployment and postdeployment using the standardized methodology described below.

Subjects

Eighty-eight Soldiers, which included 76 men (26.6 ± 6.3 years, 176.7 ± 6.4 cm, 86.9 ± 14.9 kg) and 12 women (32.1 ± 11.7 years, 163.5 ± 4.6 cm, 66.2 ± 10.1 kg), from the Arizona NG completed predeployment and postdeployment testing after having been cleared for deployment by the NG medical providers. Before testing, all volunteers read and signed an informed consent and were screened using the American College of Sports Medicine (ACSM)/American Heart Health/Fitness Facility Preparticipation Screening Questionnaire (12). The study was approved by the institutional review board at Arizona State University, as well as by the Arizona NG State Surgeon's Office.

Both sexes were eligible for this study. Per ACSM risk stratification, men older than 45 years and women older than 55 years, or anyone having severe physical limitations that would prevent successful completion of testing, or uncontrolled chronic disease (i.e., hypertension, diabetes, sleep apnea, and asthma) were not eligible for this investigation. Soldiers were recruited from 5 different companies or detachments (infantry, communications, transportation, explosive ordinance disposal, and military police). Multiple occupations were represented within each of these units (Figure 1). These Soldiers were required to perform a variety of missions while deployed to include explosive ordinance disposal, convoy operations, provincial reconstruction, security, and establishing and maintaining theater communications. The variety of occupations represented provided a sample that could be considered "typical" of operations occurring at the time of the study.

Procedures

Pre- and postdeployment physical fitness testing included measurements of body composition, muscular strength, and cardiorespiratory fitness. All data were collected using standard methods, while taking into consideration the required military training and duties of the participating

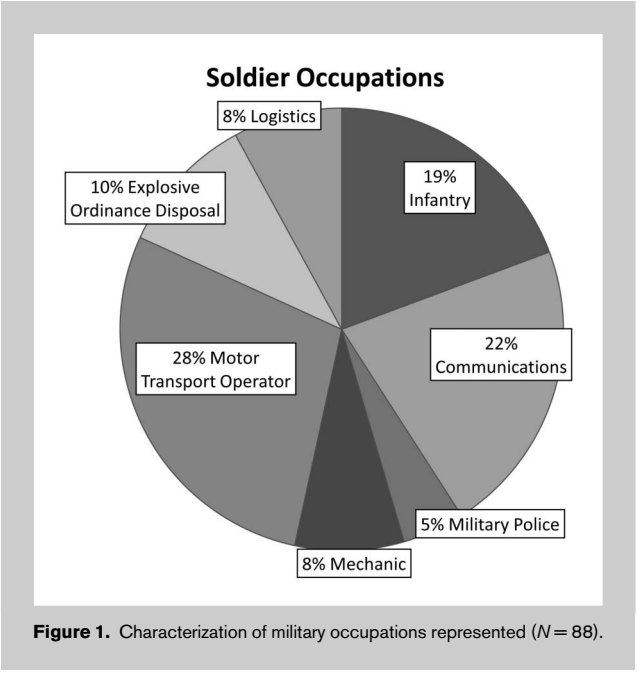

Figure 1. Characterization of military occupations represented ($N = 88$).

Table 1. Mean ± *SD* of pre- and postdeployment measures.

	Combined ($n = 88$)		Men ($n = 76$)		Women ($n = 12$)	
	Pre	Post	Pre	Post	Pre	Post
Weight (kg)	84.1 ± 15.9	82.0 ± 14.1*	86.9 ± 14.9	85.0 ± 12.5	66.2 ± 10.1	62.7 ± 7.0†
Body mass index ($kg \cdot m^{-2}$)	27.4 ± 4.6	26.7 ± 3.8*	27.8 ± 4.6	27.2 ± 3.8	24.7 ± 3.8	23.5 ± 2.6†
Fat free mass (kg)	64.0 ± 10.5	65.5 ± 10.7*	66.9 ± 8.2	68.5 ± 8.3	46.9 ± 4.7	48.1 ± 4.7†
Fat mass (kg)	20.2 ± 9.8	16.5 ± 7.6*	20.3 ± 10.2	16.9 ± 8.0	19.3 ± 7.5	14.6 ± 4.9
Percent body fat (%)	23.2 ± 8.5	19.6 ± 7.2*	22.3 ± 8.4	19.1 ± 7.3	28.4 ± 7.7	22.9 ± 6.0†
Bench (kilogram lift per kilogram body mass)	0.96 ± 0.27	1.07 ± 0.29*	1.02 ± 0.23	1.14 ± 0.25	0.57 ± 0.08	0.67 ± 0.11†
Squat (kilogram lift per kilogram body mass)‡	1.25 ± 0.30	1.43 ± 0.33*	1.33 ± 0.24	1.51 ± 0.30	0.78 ± 0.17	1.02 ± 0.15†
$\dot{V}O_2$peak ($ml \cdot kg^{-1} \cdot min^{-1}$)	46.9 ± 8.1	45.7 ± 8.1	48.3 ± 7.4	46.7 ± 8.0	38.8 ± 7.5	40.0 ± 6.6†

*Denotes significant differences between pre- and postdeployment.
†Denotes significant differences between sexes.
‡Denotes sex × deployment interaction.

Soldiers. Predeployment testing was performed within 30 days of deployment, and postdeployment testing was conducted within the first 10 days of a Soldier's return to the United States. The physical performance testing methods used in this study have previously been described in detail (13). Body composition (fat mass [FM] and fat-free mass [FFM]) was measured using air displacement plethysmography (Bod Pod, COSMED, Concord, CA, USA) (8). One-repetition maximum (1RM) strength was determined for the bench press and the back squat exercise in accordance with

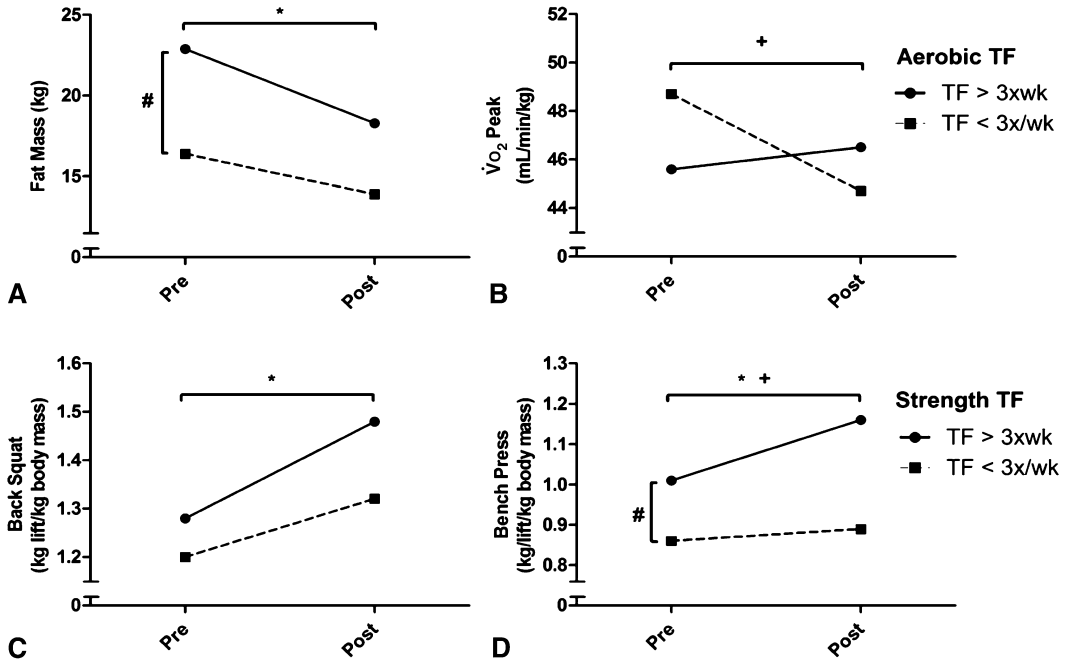

Figure 2. A, B) Comparison of improvements in FM and $\dot{V}O_2$peak between Soldiers who performed aerobic training ≥3 times per week vs. <3 times per week during deployment. C, D) Comparison of relative upper and lower body strength between Soldiers who performed strength training ≥3 times per week vs. <3 times per week during deployment. "#" denotes significant differences between training frequency groups, "*" denotes significant differences from pre- to postdeployment, "+" denotes training frequency × deployment interaction; TF, training frequency.

the guidelines set forth by the National Strength and Conditioning Association and the ACSM (1,12). The absolute value of the 1RM lift was then divided by the Soldier's weight to determine relative strength (1RM kilogram lift per kilogram body mass). Soldiers' aerobic fitness ($\dot{V}O_2$peak) was measured using indirect calorimetry while completing an incremental treadmill test. Criteria for adequate testing included the following: respiratory exchange ratio >1.00 or heart rate ± 10 beats per minute of age predicted maximum heart rate (11).

During postdeployment assessments, Soldiers completed a questionnaire that inquired about aerobic and strength training frequency, as well as perceived changes to health. The questionnaire has been previously used in populations of deployed Soldiers (7,11,14).

Statistical Analyses

Potential sex differences in physical performance and body composition were analyzed using a Sex × Time (pre- and postdeployment) analysis of variance (ANOVA), with Time being a repeated-measures factor. Subsequently, the effects of training frequency on physical performance and body composition were analyzed using a Training Frequency (dichotomized as either ≥3 sessions per week or <3 sessions per week) × Time ANOVA, with Time being a repeated-measures factor. Next, we sought to determine if changes in perceived health were associated with measurable changes in physical fitness and body composition. This was accomplished by categorizing changes in perceived health responses as either "improved," "unchanged," or "declined" and then analyzing physical performance and body composition data using a Perceived Health Change × Time ANOVA, with Time being a repeated-measures factor. For all ANOVAs, data that were not normally distributed were logarithmically transformed and then retested for normality before statistical analysis. Significant main effects and interactions were further analyzed using *t*-tests and applying the Bonferroni correction. Finally, the association between training frequency and changes in perceived health were analyzed using a chi-squared test. All data were analyzed using SPSS 19.0. The criterion for statistical significance was $p \leq 0.05$.

Results

Effects of Sex and Deployment on Body Composition and Performance

Measures obtained before deployment demonstrated significant differences between men and women for weight, FFM,

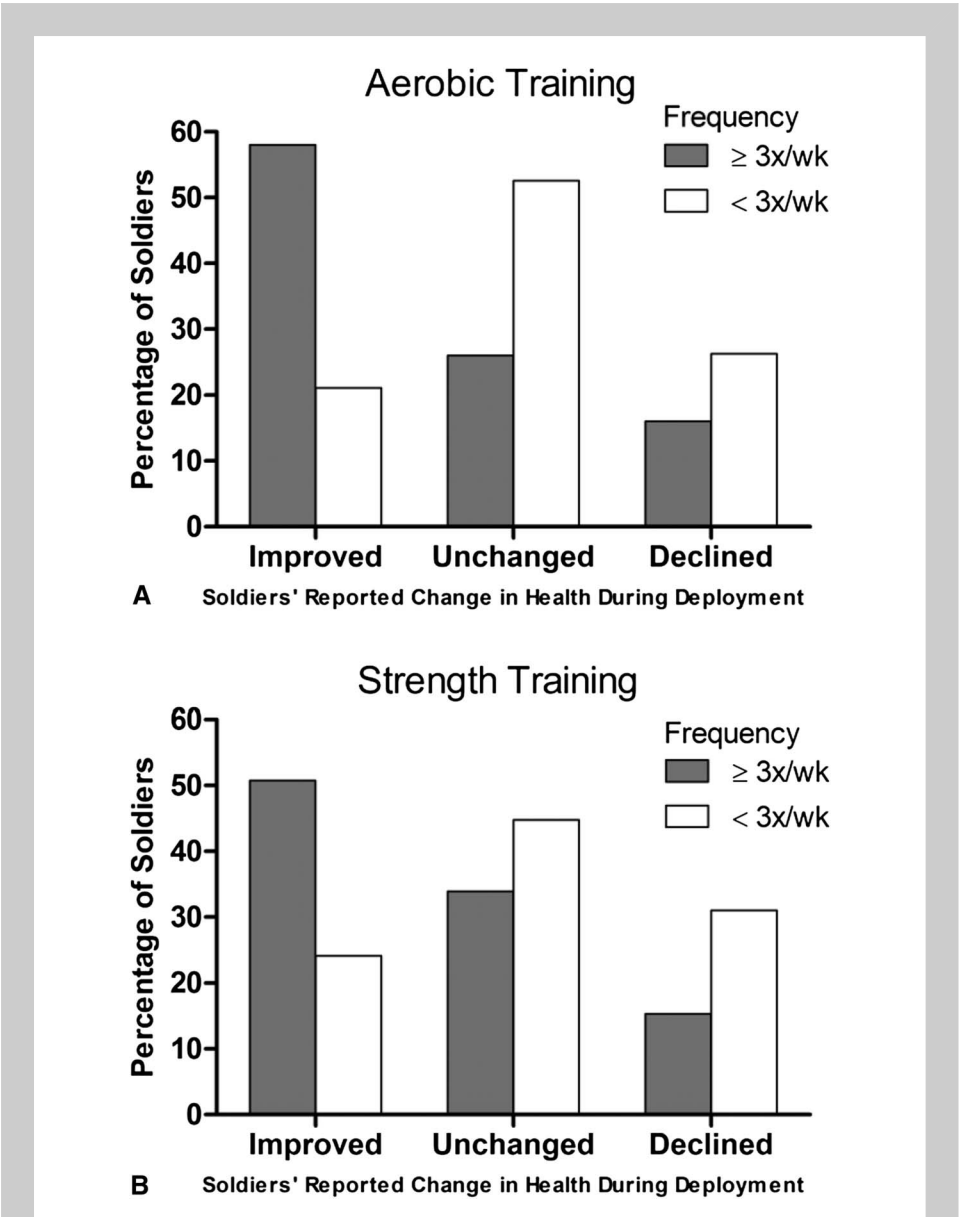

Figure 3. A) A comparison of aerobic training frequency (≥3 times per week vs. <3 times per week, $p = 0.002$) vs. reported change in health during deployment. B) A comparison of strength training frequency (≥3 times per week vs. <3 times per week, $p = 0.043$) vs. reported change in health during deployment.

body mass index (BMI), percent body fat, relative strength (bench press and back squat), and $\dot{V}O_2$peak (Table 1). There were no difference between men and women in FM. With deployment, both male and female Soldiers experienced reductions in body mass, BMI, FM, and percent body fat concomitant with increases in the mean FFM. Additionally, with deployment, both male and female Soldiers significantly improved their relative upper body strength as measured by the bench press. There was a significant sex × deployment interaction for the back squat, indicating that female Soldiers improved their relative strength of the lower extremity significantly more than men (31 vs. 14%, respectively, $p = 0.005$). There was no significant change in $\dot{V}O_2$peak from pre- to postdeployment for men, women, or the combined group (Table 1).

Effects of Training Frequency and Deployment on Body Composition and Performance

In the present study, 57% of all Soldiers reported that they performed aerobic training at least 3 times per week (≥3 times per week) and 67% reported that they performed strength training ≥3 times per week. Female Soldiers were more likely than male Soldiers to perform aerobic training ≥3 times per week (83 vs. 53%, respectively, $p \leq 0.05$). There was no significant difference between men and women Soldiers in reported strength training frequency ≥3 times per week (68 vs. 58%, respectively).

Significant ($p \leq 0.05$) reductions in FM were seen between pre- and postdeployment regardless of reported aerobic training frequency (Figure 2A). For $\dot{V}O_2$peak, there was a significant ($p = 0.016$) aerobic training frequency × deployment interaction, indicating that the response of Soldiers performing aerobic training ≥3 times per week was different than those who conducted aerobic training <3 times per week (2 vs. −8%, Figure 2B).

A statistically significant ($p < 0.001$) improvement in relative lower body strength was seen between pre- and postdeployment, regardless of strength training frequency (Figure 2C). When analyzing relative upper body strength, we observed that the response of Soldiers performing strength training ≥3 times per week (15%) was different than those who conducted strength training <3 times per week (3%), as indicated by a significant ($p < 0.001$) strength training frequency × deployment interaction (Figure 2D).

Perceived Health

Forty-two percent of all Soldiers in the present study reported that their health had improved over the course of the deployment, whereas 37.5% reported no change to their health and 20.5% reported their health had declined. There was no significant relationship between sex and perceived health. Chi-square analysis revealed significant relationships ($p \leq 0.05$) between Soldiers' perceived health and reported aerobic and strength training frequency during the deployment.

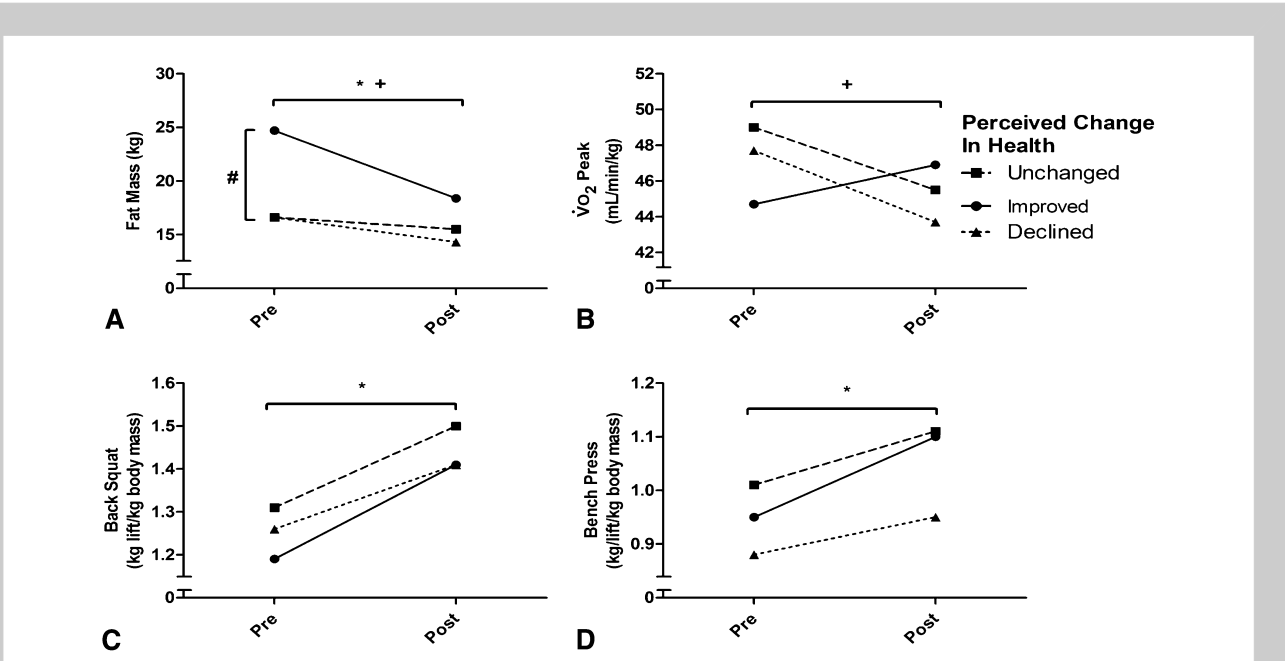

Figure 4. A–D) Comparison of change in FM, $\dot{V}O_2$peak, and upper and lower body strength between Soldiers who reported improved, unchanged, or declined health over the course of the deployment. "#" denotes significant differences between perceived health groups, "*" denotes significant differences between pre- and postdeployment, "+" denotes perceived health × deployment interaction.

Nearly 3 times as many Soldiers, who performed aerobic training ≥3 times per week, also reported that their health improved during the deployment compared with Soldiers who performed aerobic training <3 times per week (Figure 3A). A similar pattern in perceived health changes during deployment can be seen with strength training frequency (Figure 3B).

The self-perceived improvement in Soldier health is supported by the measured fitness variables. There was a significant perceived health × deployment interaction for FM and $\dot{V}O_2$peak ($p \leq 0.05$). A post hoc *t*-test confirmed that Soldiers who reported improved health demonstrated a significantly greater decline in FM (−23 vs. −2 vs. −13%, $p \leq 0.05$, Figure 4A) concomitant with improvements in $\dot{V}O_2$peak (9 vs. −6 vs. −8%, $p \leq 0.05$, Figure 4B) vs. Soldiers who reported their health was unchanged or declined, respectively. Regardless of a perceived health change, there was a significant improvement from pre- to postdeployment for both relative upper and lower body strength ($p \leq 0.05$, Figures 4C,D).

Discussion

These data begin to establish baseline anthropometric and physiological measures across sexes at pre- and postdeployment in Army NG Soldiers. A novel aspect of this study was the evaluation of the association between reported training frequency and changes in physical performance and body composition during a military deployment. Additionally, we were able to evaluate the association between training frequency and perceived health.

Although the male and female NG Soldiers in this study started the deployment with different physical characteristics, both responded similarly during deployment. Female NG Soldiers had a lower weight, BMI, FFM, greater percent body fat, and similar FM. Additionally, they demonstrated less relative upper and lower body strength compared to the male NG Soldiers. However, both the men and women improved similarly in all outcomes, with the exception of $\dot{V}O_2$peak and relative lower body strength. Neither the male nor female NG Soldiers improved their mean $\dot{V}O_2$peak with deployment. Although there was no significant difference between the male and female NG Soldiers in their reported strength training frequency, female NG Soldiers increased their relative lower body strength more than the male NG Soldiers. This finding may be because this small population of women had little previous experience in strength training and lower absolute strength at the beginning of the study. Anecdotally, a higher percentage of the NG men reported previous strength training experience.

Soldiers who reported strength training <3 times per week had improvements in relative lower body strength similar to Soldiers who reported strength training ≥3 times per week. Similarly, Soldiers who reported aerobic training <3 times per week decreased their FM similar to Soldiers who reported aerobic training ≥3 times per week. Significant differences were observed between the 2 categories of strength training frequency when analyzing the improvements in relative upper body strength. Although both groups improved, those who reported strength training ≥3 times per week improved 12% more despite having significantly higher baseline strength than those who reported strength training <3 times per week (1.01 vs. 0.86 kg lift kg^{-1} body mass, $P < 0.001$).

As expected, Soldiers who performed aerobic training <3 times per week experienced declines in their cardiorespiratory function during deployment, whereas those who reported aerobic training ≥3 times per week experienced slight gains. Although increases in strength may improve Soldier performance and the ability to perform military tasks, there have been more published reports in support of the association between cardiorespiratory function and injury/illness in Soldiers (3–5,10). For example, lower levels of aerobic capacity have previously been shown to be associated with higher prevalence of musculoskeletal and heat-related injuries (3,5). Furthermore, previous research has also shown that the Soldiers who suffer the greatest declines in cardiorespiratory function use medical resources at more than twice the rate of Soldiers who minimize their declines or improve their cardiorespiratory function during deployment (15). Therefore, it may be in the best interest of Soldiers deployed in hot climates, such as the Middle East, to at least maintain their predeployment levels of cardiorespiratory fitness.

This group of NG Soldiers reported changes in health similar to previous reports that have shown that more than 1 of every 4 Soldiers returning from deployment reported a decline in health (2). When we evaluated the relationship between perceived health and measurable changes to fitness in this present study, we found that cardiorespiratory function may be the variable that influences perceived health changes. Relative upper and lower body strength improved among all 3 groups regardless of the perceived health change during deployment. All 3 groups also experienced a mean decline in FM. Soldiers who perceived an improvement in their health did experience greater declines in FM than those who were unchanged or declined, but this is partly explained by the significantly higher FM at predeployment (24.7 vs. 16.6 vs. 16.6 kg, $p < 0.001$).

Cardiorespiratory function was the most notable difference observed between the 3 distinct groups of perceived health (improved, unchanged, and declined). There were no significant differences at baseline between those who reported an improvement in perceived health vs. those who reported no change or a decline in perceived health. However, those reporting improvements in health demonstrated improvements in their cardiorespiratory function, whereas those who reported no change or a decline in health both experienced a decline (9 vs. −6 vs. −8%, $p \leq 0.05$). In this study, it seems that cardiorespiratory function had the largest influence on perceived health from the perspective of physical fitness levels. Regardless of perceived

change in health during the deployment, the 3 groups responded similarly with reductions in FM coupled with gains in upper and lower body strength. Only Soldiers who reported an improvement in health demonstrated an improvement in their cardiorespiratory function, whereas Soldiers who reported that their overall health was unchanged or declined both demonstrated declines in their cardiorespiratory function. This finding would indicate that the improvement in cardiorespiratory function is partly responsible for the delineation between Soldiers who perceive an improvement in their health and those who perceive a decline or no change in their health during deployment.

This study sought to investigate the relationship between reported training frequency and perceived health. Our findings clearly demonstrate that Soldiers who reported performing aerobic and/or strength training ≥3 times per week were more likely to perceive improvements in their health during the duration of the deployment. This observed improvement in perceived health was supported by measurable physical performance and body composition improvements (Figure 2A,B). Conversely, Soldiers who reported a decline in health were more likely to only have trained <3 times per week during the deployment. Additionally, Soldiers training <3 times per week did not attain the improvements in performance and body composition as those conducting training more frequently. More importantly training <3 times per week yielded decrements in cardiorespiratory function. These data suggest that the amount or type of physical requirements associated with these Soldiers' occupational tasks were not adequate in maintaining cardiorespiratory function unless they also performed aerobic training ≥3 times per week. It remains unclear as to the exact causes of why Soldiers may report a decline in perceived health during deployment. Further research is therefore needed to delineate the true cause of the deleterious effects of deployment on perceived health relative to training frequency.

This study supports the notion that a decline in cardiorespiratory function may be related to a perceived decline in health. This decline in cardiorespiratory function is more likely to be observed in Soldiers who reported aerobic training frequency <3 times per week. By continuing aerobic training ≥3 times per week, predeployment cardiorespiratory function may be maintained and thus a perceived decline in health may be prevented.

The present study differs from reports of previously deployed active duty Soldiers in that deployed Army NG Soldiers demonstrated significant changes in their body composition and physical performance (7,11). Soldiers in this study maintained their cardiorespiratory function, increased strength, and decreased their FM, which is in contrast to previous studies conducted in 2008 and 2010 that both reported significant declines in cardiorespiratory function and increases in FM in deployed active duty Soldiers. Furthermore, these previous studies reported either no change or only a modest improvement in strength (7,11).

The observed differences in physical fitness may be partly explained by reported frequency of exercise. In this study, 57% of the Soldiers performed aerobic training ≥3 times per week and 67% performed strength training ≥3 times per week. These percentages exceed those previously reported by Lester et al. (7) in 2010 and Sharp et al. (11) in 2008 (i.e., 29 and 35% performed aerobic training ≥3 times per week, respectively; and 45 and 55% performed strength training ≥3 times per week, respectively). These 2 previous studies reported declines in cardiorespiratory function, whereas we observed that the mean $\dot{V}O_2$peak for the NG Soldiers in this study was maintained during the course of the deployment. Our data suggest that that the maintenance of cardiorespiratory function was accomplished by performing a higher frequency of aerobic training sessions.

This hypothesis is further supported by the reported frequency of strength training and the improvements in muscular strength. While the 2 previous studies noted above reported no change or modest gains (7–8%) in strength with 45–55% of the Soldiers performing strength training ≥3 times per week, we observed 12–14% increases in relative strength with 67% of the Soldiers performing strength training ≥3 times per week. The improved strength gains associated with increased frequency of training may indicate a dose-response relationship is present. Further research is needed to evaluate the specifics of the strength and aerobic training programs being performed by deployed soldiers.

In summary, training frequency was associated with changes in physical performance, body composition, and perceived health during deployment in NG Soldiers. Both sexes responded similarly to the deployment by improving relative strength, decreasing FM, and maintaining cardiorespiratory function. Soldiers who reported aerobic and/or strength training frequency ≥3 times per week experienced substantial improvements in upper body strength and cardiorespiratory function. Last, Soldiers who performed aerobic and/or strength training ≥3 times per week were more likely to report a perceived improvement in their health during deployment.

Practical Applications

This study demonstrated that a training frequency of ≥ 3 times per week during deployment not only improves physical fitness and body composition but also improves Soldiers' perception of health. Although strength is imperative to performing job related tasks, it would seem that improved levels of cardiorespiratory function not only benefit Soldiers' performance but also improve Soldiers' perception of their health. It may not always be possible to continually perform aerobic and/or strength training because of a unit's operation tempo, safety, or available facilities. However, when possible, we recommend that Soldiers continue to perform aerobic and strength training at least 3 days per week during

a deployment in an effort to improve, or at least maintain, predeployment fitness levels.

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References

1. Beachle, TR and Earle, RW. *Essentials of Strength Training and Conditioning.* Champaigne, IL: Human Kinetics, 2008.
2. Center AFHS. Update: Deployment health assessments, U.S. Armed Forces, April 2010. *MSMR* 17: 18–19, 2010.
3. Gardner, JW, Kark, JA, Karnei, K, Sanborn, JS, Gastaldo, E, Burr, P, and Wengner, CB. Risk factors predicting exertional heat illness in male Marine Corps recruits. *Med Sci Sports Exerc* 28: 939–944, 1996.
4. Jones, B, Manikowski, R, Harris, J, Dziados, J, Norton, S, Ewart, T, and Vogel, JA. *Incidence of and Risk Factors for Injury and Illness Among Male and Female Army Basic Trainees.* Natick, MA: US Army Research Institute of Environmental Medicine, 1988. pp. 1–43.
5. Knapik, J, Ang, P, Reynolds, K, and Jones, B. Physical fitness, age, and injury incidence in infantry soldiers. *J Occup Environ Med* 35: 598–603, 1993.
6. Knapik, J, Daniels, W, Murphy, M, Fitzgerald, P, Drews, F, and Vogel, J. Physiological factors in infantry operations. *Eur J Appl Physiol Occup Physiol* 60: 233–238, 1990.
7. Lester, ME, Knapik, JJ, Catrambone, D, Antczak, A, Sharp, MA, Burrell, L, and Darakjy, S. Effect of a 13-month deployment to Iraq on physical fitness and body composition. *Mil Med* 175: 417–423, 2010.
8. McCrory, MA, Gomez, TD, Bernauer, EM, and Mole, PA. Evaluation of a new air displacement plethysmograph for measuring human body composition. *Med Sci Sports Exerc* 27: 1686–1691, 1995.
9. Nindl, BC, Barnes, BR, Alemany, JA, Frykman, PN, Shippee, RL, and Friedl, KE. Physiological consequences of U.S. Army Ranger training. *Med Sci Sports Exerc* 39: 1380–1387, 2007.
10. Reynolds, K, Knapik, J, Hoyt, R, Mayo, H, Bremmer, J, and Jones, B. Association of training injuries and physical fitness in U. S. Army combat engineers. *Med Sci Sports Exerc* 26: S219, 1994.
11. Sharp, MA, Knapik, JJ, Walker, LA, Burrell, L, Frykman, P, Darakjy, SS, Lester, ME, and Marin, RE. Physical fitness and body composition after a 9-month deployment to Afghanistan. *Med Sci Sports Exerc* 40: 1687–1692, 2008.
12. Thompson, WR, Gordon, NF, and Pescatello, LS, eds. *ACSM Guidelines for Exercise Testing and Prescription.* Philadelphia, PA: Lippincott Williams & Wilkins, 2010.
13. Warr, BJ, Alvar, BA, Dodd, DJ, Heumann, KJ, Mitros, MR, Keating, CJ, and Swan, PD. How do they compare?: An assessment of predeployment fitness in the Arizona National Guard. *J Strength Cond Res* 25: 2955–2962, 2011.
14. Warr, BJ, Alvar, BA, and Sharp, MA. Self reported exercise during deployment correlates with measured fitness outcomes. *Med Sci Sports Exerc* 44: S701, 2012.
15. Warr, BJ, Heumann, KJ, Dodd, DJ, Swan, PD, and Alvar, BA. Injuries, changes in fitness, and medical demands in deployed National Guard soldiers. *Mil Med* 177: 1136–1142, 2012.