Abstract 2
Purpose: To determine the association between sickle cell trait (SCT) as a binary variable and 25 hemoglobin S percentage as a stratified
categorical variable on aerobic and anaerobic fitness. 26
Methods: This retrospective cohort study included all recruits who entered U.S. Air Force basic 27 training between January 2009 and December
2014. Fitness parameters among recruits with and 28 without SCT were compared using a standardized fitness assessment of a 1.5-mile timed run,
one 29 minute of push-ups, and one minute of sit-ups. Performance was further compared by stratifying 30 those with SCT by their hemoglobin S
percentage (20-29.99%; 30-39.99%; and ≥40%). 31
Results: Of all recruits (N=210,442) who entered training during the surveillance period, 2,161 32 (1.0%) had SCT. After adjusting for age, sex,
body mass index, and ambient temperature while 33 conducting the fitness assessment, recruits with SCT were slower on their initial run than their

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Introduction

Sickle cell trait (SCT) is a hemoglobinopathy that results from inheriting one copy of the normal $H^A$ gene and one copy of the $H^S$ variant. Although a benign carrier state in most cases, SCT is associated with malaria and sickle cell disease, which can be fatal. However, in settings of extreme altitude and prolonged exertion, such as athletic competition and military training, the increased risk is thought to be mitigated, but not eliminated, by adequate hydration, proper work-rest balance, and safe acclimatization to the environment and activity level.

Methods

Screening is required by the National Collegiate Athletic Association for student-athletes and by the U.S. military services for enlisted recruits—with the exception of the U.S. Army, which selectively screens recruits entering special operation occupations. The survival advantage conferred by hemoglobin S (HbS) during infection with $P$. falciparum malaria is well-established. Evidence for a performance advantage with SCT or HbS, however, is indirect at best. It is widely observed that soldiers with West African ancestry, where malaria and SCT are highly prevalent, have dominated modern Olympic sprint competitions. On the other hand, many elite endurance runners are of East African heritage (e.g., from Kenya and Ethiopia), where falciparum malaria is less common. Efforts to isolate genetic markers for sprinting or endurance running performance have been relatively unsuccessful. One evolutionary hypothesis is that the reduced oxygen-carrying capacity associated with high HbS led to preferential development of anaerobic energy systems and preponderance of fast-twitch muscle fibers.

Acetid and anaerobic exercise discrepancies between those with and without SCT have been reported in several small trials, but their results are contradictory. These contradictory findings may be explained by the known heterogeneity of high HbS percentage within the SCT population, although a correlation between high HbS percentage and fitness has not been established. If it were, warfighters and athletes may be better aligned with sprinting or endurance activities. The current study investigates this question by evaluating the independent association of SCT and HbS percentage on various physical fitness measures among a large population of U.S. Air Force recruits.

Results

Of all recruits (N = 210,442) who entered training during the surveillance period, 2161 (1.0%) had SCT. After adjusting for age, sex, body mass index, and ambient temperature while conducting the fitness assessment, recruits with SCT were slower on their initial run than their peers without SCT by a mean (standard error) of 33.7 (2.5) seconds (p < 0.001). Baseline physical fitness was largely consistent across states of hemoglobin S percentages: increased percentages were modestly correlated with faster run times ($R^2 = 0.296$) and fewer push-ups ($R^2 = 0.330$) and sit-ups ($R^2 = 0.126$). As compared to their peers, recruits with SCT had inferior aerobic fitness and superior anaerobic fitness at the outset of basic training, but those gaps were small and narrowed over six weeks of training. Stratifying recruits by their hemoglobin S percentage did not dramatically change the strength or direction of association.

Discussion

We queried the Trainee Health Squadron’s SCT database for hemoglobinopathies, military training, sprinting, aerobic fitness, anaerobic fitness, and hemoglobin S percentage, and obtained data on aerobic and anaerobic fitness from the U.S. Air Force Fitness Assessment, which includes a 1.5-mile timed run, one minute of push-ups, and body composition measurements (height, weight, and abdominal circumference). In order to pass the assessment, recruits were required to pass each component and achieve a minimum total score, based on age- and sex-specific cutoffs.

Conclusions

This retrospective cohort study included all recruits who entered U.S. Air Force Basic Military Training (Joint Base San Antonio–Lackland, Texas) between January 2009 and December 2014 and was included in this popular study. The findings suggest that SCT is associated with reduced aerobic fitness and improved anaerobic fitness among U.S. Air Force recruits.

Keywords

Sickle cell trait, hemoglobin S percentage, physical fitness, aerobic fitness, anaerobic fitness, endurance, sprinting, military training, West African ancestry, East African ancestry.