Sleep and Infantry Battle Drill Performance in Special Operations Soldiers

Janna Mantua; Joseph D. Shevchik; Sidhartha Chaudhury; Hannah P. Eldringhoff; Carolyn A. Mickelson; Ashlee B. McKeon

BACKGROUND: Although multiple studies have documented the impact of insufficient sleep on soldier performance, most studies have done so using artificial measures of performance (e.g., tablet or simulator tests). The current study sought to test the relationship between sleep and soldier performance during infantry battle drill training, a more naturalistic measure of performance.

METHODS: Subjects in the study were 15 junior Special Operations infantry soldiers. Soldiers wore an actigraph and reported their subjective sleep duration and quality prior to close quarter battle (CQB) drills. Experienced leaders monitored each iteration of the CQB exercise and recorded the number of errors committed.

RESULTS: The number of errors committed during the live ammunition iterations was negatively correlated with subjective number of hours slept and subjective sleep efficiency/quality during the month prior. Soldiers with subjective sleep duration ≥7 h had a significantly lower number of errors than soldiers with subjective sleep duration <7 h (1.71 vs. 0.63 errors), and soldiers with sleep quality <85% committed more errors than those with sleep quality ≥85% (1.50 vs. 0.40 errors).

DISCUSSION: These data preliminarily suggest that sleep quality and duration may influence subsequent performance on infantry battle drill training, particularly for soldiers with limited experience in battle drill conduction who have not yet perfected battle drill techniques. Future studies should enact sleep augmentation to determine the causal influence of sleep on performance in this setting.

KEYWORDS: sleep, special operations, live fire, infantry exercises, performance.

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Sleep is critical for maintenance of health and performance. The characteristic poor sleep of military service members and its deleterious consequences have been well documented through numerous research efforts. Specifically, insufficient sleep (i.e., short sleep duration or poor sleep quality) commonly reported by U.S. Army soldiers is related to impaired cognitive performance,[13] degraded physical performance,[11,16] and poor psychosocial outcomes.[9,10,12] The results from this body of research collectively suggest that insufficient sleep lowers military readiness in this population. However, due to the inherent difficulties of quantifying realistic soldier performance in a naturalistic setting (i.e., actual operational performance), many previous studies have used simulations, such as "shooting" enemies in a high-fidelity simulator or on a low-fidelity electronic tablet. Focusing on the relationship between sleep and actual operational performance is critical, as there may be important, consequential factors intrinsic to an operational scenario (e.g., adrenaline) that are not present during simulated military operations.

Accordingly, we sought to test the relationship between sleep and a more realistic and meaningful operational measure: soldier operational performance during infantry battle drill training. Battle drills are defined by the U.S. Army as "a collective action executed by a platoon or smaller element without the

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application of a deliberate decision-making process."[3] Battle drills are taught to infantry soldiers early in their career and are continually practiced with the rationale that repeated trainings must be performed so that drills can be automatically executed during a chaotic combat scenario. Battle drills are considered such a foundational cornerstone of infantry performance that military leaders have directly credited infantry battle drills for combat successes in Iraq and Afghanistan.[7] Battle drills, therefore, present researchers with a promising opportunity to capture accurate measures of military-relevant performance. Here, we explore sleep as a possible factor impacting battle drill training.

METHODS

Subjects

This study was approved by the Walter Reed Army Institute of Research Scientific Institutional Review Board. It was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki. All subjects provided written informed consent.

Participating in the study, which was 7 d in duration, were 15 Special Operations infantry soldiers. In order to maximize the likelihood of detecting a relationship between sleep and performance, the research team focused on junior enlisted soldiers who were relatively inexperienced, as these soldiers may have frequent errors during trainings, while more experienced soldiers often have few to no errors.

Equipment and/or Materials

Insomnia Severity Index. The Insomnia Severity Index (ISI)[4] is a screening tool for insomnia that queries sleep quality from the month prior. It includes three items that query problems falling asleep, staying asleep, or waking too early, and four items that gauge how sleep issues are perceived to interfere with the soldier's life. These items are summed to make a total score, with a higher score indicating more symptoms of insomnia.

Subjective sleep items. Subjects were asked to estimate how many hours of sleep [total sleep time (TST)] and what sleep quality [sleep efficiency (SE); out of 100] they had on average during the month prior. These measures are respectively referred to as "subjective TST" and "subjective SE" to differentiate these measures from objectively (actigraphically) determined TST and SE.

Actigraphy. Philips Respironics (Murrysville, PA, USA) Actiwatch Spectrums were used to capture objective sleep measures. Sleep/wake activity was sampled in 1-min increments. All default settings were used. TST and SE were calculated using standard metrics in the accompanying Philips Respironics Actiware Software. TST is defined as hours spent asleep in the 24-h period (i.e., sleep duration). SE is defined as the percent of time spent in bed that the soldier was asleep (i.e., sleep quality). The outcome measures of interest for close quarter battle (CQB) performance were: 1) average number of errors committed across the three iterations with UTM ammunition; and 2) average number errors committed across the three iterations with live ammunition.

Procedures

On the first day of the study, soldiers completed a survey on their recent sleep habits (described below). Soldiers were given an actigraph (a device with an accelerometer that provides an objective measure of the sleep/wake cycle) and were asked to wear it on their nondominant wrist continuously until the end of the exercise period.

Six days later, the soldiers completed infantry battle drill training in the form of CQB drills. CQB drills are a type of infantry training that emphasize close range combat scenarios. In this particular type of CQB exercise, in accordance with U.S. Army standard infantry procedures, soldiers entered a room in teams of three to five soldiers and executed a number of milestones in a particular order to ensure the room was "clear" from danger.[5] The milestones of each soldier were predetermined depending on the position that they entered the room (e.g., soldier 1 must check the left corner of the room, then scan the left side of the room, then scan the center of the room, etc.). After all soldiers entered the room and executed their duties, the soldiers communicated verbally that the milestones had been completed, and the iteration concluded. Speed is emphasized during this type of training, and each iteration could happen quickly (e.g., 20 s).

Each team of soldiers performed six iterations: three using ultimate training munitions (UTM; i.e., nondeadly rounds that can be shot out of a weapon with minimal impact on the target) and three with live ammunition. Experienced leaders monitored each iteration and recorded errors on scorecards that are regularly used by the unit during CQB trainings. The scorecards included common types of errors (e.g., pointing muzzle of weapon in wrong direction, scanning the wrong sector of the room, etc.). Feedback about errors was verbally provided to each soldier by leaders after each iteration. Soldiers cycled through different positions between each iteration. Soldiers received feedback on their own performance and witnessed feedback provided to other members of the unit after each iteration. The CQB exercise lasted roughly 3 h.

Statistics

Descriptive statistics (averages) were calculated to summarize the frequency of errors for each iteration and to summarize both the subjective and objective sleep parameters of the subjects. Pearson's correlations of sleep measures with battle drill performance (errors) were performed. It is noteworthy that objective sleep measures represent 1 night and an averaged 7 nights prior to the exercise while the subjective sleep measures represent the month prior to actigraphy use.

Table I. Relationship Between Sleep Measures and Close Quarter Battle Performance.

	ISI	TST (Sub. mo prior)	SE (Sub. mo prior)	TST (Ob. wk prior)	SE (Ob. wk prior)	TST (Ob. night prior)	SE (Ob. night prior)
UTM							
r	0.45	0.30	0.17	−0.49	−0.19	0.03	−0.28
P	0.11	0.30	0.56	0.08	0.52	0.97	0.31
Live							
r	0.25	−0.67	−0.55	0.05	0.21	0.04	0.02
p	0.37	0.006	0.03	0.85	0.43	0.88	0.77

UTM = ultimate training munitions (nonlethal ammunition rounds); Live = live ammunition rounds; ISI = Insomnia Severity Index; TST = total sleep time; SE = sleep efficiency; Sub = subjective; Ob = objective; *r* = *r*-value; *P* = *P*-value.

Where there was a relationship between TST (both subjective and objective) and performance, the number of errors were compared between those sleeping < and ≥7 h per night, which is the minimum amount of sleep per 24 h suggested by U.S. Army doctrine.[4] Where there was a relationship between SE (both subjective and objective) and performance, the number of errors were compared between those with SE <85% and those with SE ≥85%. Student's *t*-tests were used for these comparisons.

Given that there was a relationship between both subjective sleep duration and quality (from the month prior) with performance, a linear regression was used to determine the relative contribution of sleep duration and quality in predicting performance. Number of errors was used as the dependent variable and subjective sleep duration and quality were entered into the model simultaneously.

RESULTS

Participating soldiers were 24.3 ± 3.82 yr old. By design, soldiers were junior in rank and relatively inexperienced. Specifically, 5 soldiers were Privates (Enlisted 3; E-3) and 10 were Specialists (Enlisted 4; E-4). They had been in the unit for 16.3 ± 7.7 mo.

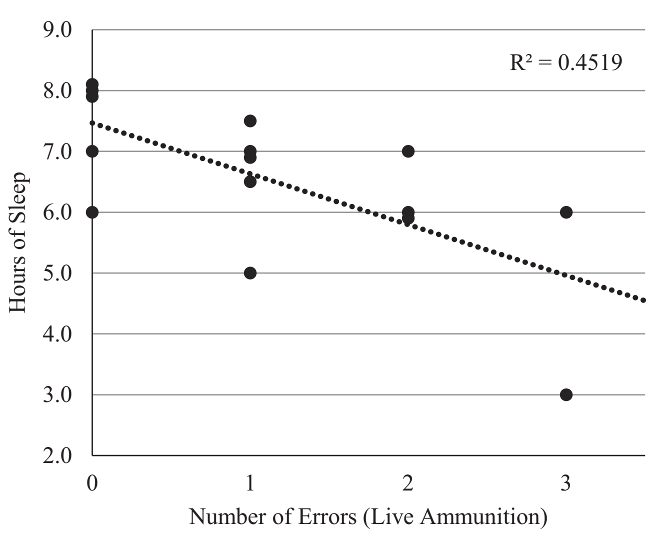

Fig. 1. Relationship between subjective sleep over the month prior and number of errors committed during the Close Quarter Battle drill iterations with live ammunition. R^2 = strength of the relationship.

The soldiers had an average ISI score of 4.6 ± 2.8, which is slightly lower (better) than comparable populations.[9] Soldiers had a subjective TST of 6.6 ± 1.3 h of sleep during the month prior and objective metrics of sleep similarly showed that subjects had an average TST 6.6 ± 1.2 h in the week leading up to the exercise. Soldiers reported an average subjective SE of 66.4% ± 22.6% during the month prior, while objective SE from actigraphy was 82.0% ± 5.3% in the week prior to the exercise.

The average number of errors committed during the UTM trials was 2.5 ± 1.9 per iteration, and the average number of errors during the live ammunition trials was 1.1 ± 1.1 per iteration. As shown in **Table I**, live ammunition performance was correlated with subjective TST (also depicted in **Fig. 1**) and SE. ISI scores and objective sleep were not related to performance, although there was a nonsignificant trend toward a relationship between objective SE and UTM errors.

Those with subjective TST ≥ 7 h had a significantly lower number of errors than soldiers with subjective TST < 7 h [$t(14) = 2.26$, $P = 0.04$; **Fig. 2**). Further, those with subjective SE ≥ 85% had a significantly lower number of errors than soldiers with subjective SE < 85% ($t = 2.11$, $P = 0.05$; Fig. 2)

The linear regression model assessed the relative contribution to subjective sleep duration and quality over the month prior in predicting number of errors. The omnibus model was significant [$F(2,12) = 5.15$, $P = 0.02$, $R^2 = 0.46$], but neither sleep duration (B = —0.45, $P = 0.08$) nor sleep quality (B = —0.01, $P = 0.59$) reached the threshold of statistical significance.

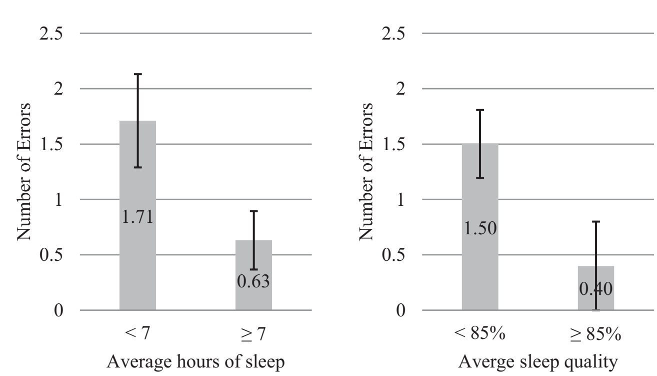

Fig. 2. Comparison between soldiers who reported < and ≥ 7 h of sleep per night during the month prior (left panel) and comparison between soldiers who reported < 85% and ≥ 85% sleep quality during the month prior (right panel) for number of errors during live ammunition iterations.

DISCUSSION

Enhancing infantry battle drill performance during training may directly translate to greater success in combat scenarios.[7] Here, the relationship between sleep and infantry battle drill performance was tested. In the present sample, junior infantry soldiers had poor SE (< 85%),[15] and soldiers were regularly objectively and subjectively sleeping less than the minimum 7 h per night that is recommended by the U.S. Army[6] and by the academic sleep research and sleep medicine community.[22] Soldiers with shorter/poorer subjective sleep during the prior month made more errors during the training. These data preliminarily suggest that sleep quality and duration impact subsequent performance on infantry battle drill training, particularly for soldiers with limited prior experience in conducting battle drills.

We are not aware of any previous studies in which the effects of sleep quality and duration on infantry battle drill performance were assessed, although there have been several studies on sleep and marksmanship (i.e., shooting at a distant target).[14,17–20] In those studies, marksmanship accuracy was consistently impacted by insufficient sleep. Further, additional components associated with marksmanship, such as discriminating between friend/foe targets[17] and "sighting time" (i.e., time between target appearance and trigger pulling)[10,18] were also negatively impacted by insufficient sleep. The present study extends those findings and suggests that battle drill execution (specifically CQB drills) is relatively degraded in those members of the unit who obtain less than 7 h of subjective sleep and those who have poor sleep quality. The present findings, in conjunction with previous findings related to marksmanship, demonstrate the broad impact of insufficient sleep on soldier infantry and combat-relevant performance.

Prior studies have shown insufficient sleep negatively impacts decision-making,[2] particularly when those decisions require updating based on feedback.[23] Further, previous studies have shown that even a single night of short sleep (e.g., 5 h[1]) can substantially impact vigilance (i.e., alertness, attentiveness), which is a core cognitive component that is the foundation of other higher-order cognitive abilities, such as executive functioning[8,21]). Insufficient sleep may have impacted aspects of cognitive performance that determine performance during CQB exercises. Soldiers in this sample who were habitually sleeping less than 7 h per night and those who had poor sleep quality may have unrecognized "sleep debt" that impaired decision-making (and the incorporation of feedback), vigilance, and executive functioning, culminating in more errors during the exercise. Given that performance during battle drills training is thought to generalize directly to performance during combat operations,[7] it can reasonably be surmised that the performance of junior soldiers who do not obtain adequate sleep will be similarly decremented in actual combat situations.

In this study, junior soldiers who subjectively slept less than 7 h committed roughly 1 more error during the live fire training than those who subjectively slept more than or equal to 7 h. Similar results were present for those who had less than and greater than or equal to 85% subjective sleep quality. Although the difference in errors may not seem large, we posit that the difference is indeed consequential. Given that the training exercise is intended to represent a realistic operational scenario, errors represent missed milestones that could be deadly errors in a real-world situation. For instance, if a soldier did not "clear" a corner of the room as they are intended to, or if they committed a safety error, that error could represent the difference between mission failure and mission success. Therefore, we believe the difference between these groups is not trivial.

It is noteworthy that subjective sleep during the month prior was related to performance, but objective sleep during the week and night prior to the exercise were not. There are three potential factors that could have led to this discrepancy: the time frame of sleep, the measurement of sleep, or statistical power. For example, it is possible that sleep during the month prior (rather than the week or night prior) had a greater influence on performance, as a month of subjective poor/short sleep may represent a weeks or months long accrual of sleep debt. On the other hand, the mode of sleep measurement may have accounted for this discrepancy. It is possible that self-reported sleep duration and quality also incorporate other factors (e.g., alertness upon awakening, mood, fatigue, etc.), while measures of objective sleep duration and quality do not. Lastly, it may simply be that low statistical power due to a small sample size prevented the detection of a link between objective measures of sleep and performance. Future studies should aim to determine the source of this discrepancy for a better understanding in this relationship.

It is important to interpret these findings in the context of the study limitations. Perhaps the most critical limitation was the correlational nature of this study. Sleep was not manipulated during this exercise, so it is not possible to determine whether sleep causally impacted performance. However, given that sleep is causally important for the maintenance of cognitive performance and causally impacts similar infantry skills that require higher order cognitive components (e.g., complex marksmanship tasks), it is nevertheless likely that insufficient sleep directly impacted performance. Still, future studies will be necessary to confirm the causal link between sleep and battle drill errors. An additional limitation is that this study had a small sample size, which may have led to Type II statistical error (false negatives). This type of error could explain why sleep parameters were related to some measures of performance but not others (e.g., subjective sleep was related to performance, but objective sleep was not). Future studies will be necessary to replicate and expand the present findings.

In conclusion, in Special Operations soldiers, subjective sleep duration and quality from the month prior were related to subsequent performance during infantry battle drills, a core component of junior infantry soldier competency. If these findings are replicated, military leaders should consider monitoring the sleep of their soldiers prior to infantry battle drill exercises and/or instituting curfews to help ensure adequate sleep.

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