A Survey of Fatigue in Army Aviators

Amanda M. Kelley; Kathryn A. Feltman; Ian P. Curry

INTRODUCTION: Fatigue plays a critical role in mission success due to its effect on a number of performance variables. The purpose of this study was to gauge the extent to which U.S. Army aviators experience subjective fatigue on a regular basis presently as well as their perceptions of their own sleep quality, quantity, and daytime sleepiness. This information is valuable for prioritizing future research lines with respect to injury prevention and fatigue management as well as updating policy.

METHODS: An anonymous, 125-item questionnaire was completed by 214 U.S. Army aviators. A subset of those items (15 questions related to fatigue) are reported in this study. Subjects were primarily male and the mean age was 33 yr.

RESULTS: Results suggest that the majority of subjects sleep less than the recommended 8 h per night and nearly half of them report sleeping less than their own preferred amount of sleep. Approximately 40% of the sample indicated that they believed fatigue to be a widespread problem in the U.S. Army aviation community.

DISCUSSION: Overall, the findings identified factors contributing to fatigue and performance degradation currently experienced by those sampled in this study. Specifically, inconsistent shiftwork, less than optimal levels of rest, and poor sleep quality in the field were identified. Compared to past research, the extent to which fatigue is perceived to be a widespread problem is significantly lower than reported 15 yr prior.

KEYWORDS: fatigue, sleep quality, sleep quantity, military.

Kelley AM, Feltman KA, Curry IP. *A survey of fatigue in army aviators*. Aerosp Med Hum Perform. 2018; 89(5):464–468.

Advancements in technology and engineering continue to enhance safety in military aviation, leading to significant reductions in mishaps over the decades. Unfortunately, several prominent concerns in aviation continue to be problems that have existed for years despite considerable research efforts into these areas. Fatigue continues to remain a significant concern, with the Naval Safety Center reporting fatigue as the second highest causal factor of Class A aviation mishaps, behind spatial disorientation, and as the highest cited cause for total number of mishaps between 1990–2011.[5] Fatigue plays a critical role in mission success due to its effect on a number of performance variables, including reaction time, accuracy, attention, and executive decision.[1,3,12] Additionally, numerous studies have shown fragmented sleep or reduced time spent in slow wave sleep can negatively impact performance measures compared to undisturbed sleep,[4,9] suggesting multiple sleep-related factors that may contribute to the likelihood of accidents.

Fatigue can be challenging to study in naturalistic environments given the large number of factors influencing sleep quality and quantity. It is particularly challenging to study fatigue and its role in mishaps given that variables such as hours slept are typically self-reported, if reported at all, after an incident and are thus subject to bias on the part of the individual. Further, self-reported sleep following an incident may not be completely accurate in order to shift the accident culpability from the individual for fear of consequences. Thus, evaluating sleep outside of accidents and incidents may provide some insight regarding the quantity and quality of sleep aviators are obtaining. Further, while fatigue is deleterious in any military setting, it is especially significant in aviation operations where the impact of a lapse in attention or decision making can result in costly errors with little time for correction. Fatigue increases the likelihood of mishaps that can potentially lead to loss of life and financial losses over 10 million dollars for a single accident.

From the Aircrew Health and Performance Division, U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL.

This manuscript was received for review in November 2017. It was accepted for publication in February 2018.

Address correspondence to: Amanda M. Kelley, Ph.D., Aircrew Health and Performance Division, U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL 36362; akelley1981@gmail.com.

DOI: https://doi.org/10.3357/AMHP.5044.2018

The purpose of this study was to gauge the extent to which U.S. Army aviators experience subjective fatigue on a regular basis presently as well as their perceptions of their own sleep quality, quantity, and daytime sleepiness. In order to develop the survey instrument for this protocol, as well as facilitate informal comparisons, published surveys of similar populations regarding fatigue were reviewed. Of particular interest was a survey regarding fatigue in which Caldwell and Gilreath[2] administered a 64-item (including subquestions, a total of 93 possible data points per respondent) survey to 401 U.S. Army aviators and aircrew members. Respondents in this study reported inadequate amounts of sleep and reduced sleep quality in the field compared to at home. Also, 73.4% of pilots responded that they perceived fatigue to be a widespread problem in U.S. Army aviation. Overall, the authors concluded that the results supported continued research efforts on fatigue-reduction strategies. A subset of the questions in this instrument was modified for use in the present study. Similarly, Sexton and colleagues[8] administered the Cockpit Management Attitudes Questionnaire to pilots from major airlines.[6] The findings suggested that aviators indicated acknowledgment of the limitations brought upon performance and alertness from fatigue and subsequently were motivated to report sleepiness to their fellow crewmembers. The present study aimed to update previous study findings specific to U.S. Army aviators to allow for prioritizing future research lines with respect to fatigue management and updating policy. The design of this study consisted of a descriptive survey research design that employed a questionnaire which was administered to U.S. Army aviators.

METHODS

Subjects

The study was reviewed and approved by the U.S. Army Aeromedical Research Laboratory's Regulatory Compliance Office. Data supplied by U.S. Army Human Resources Command shows that the population of U.S. Army rotary-wing pilots is 6927. The respondents of this survey were a convenience sample, a nonprobability based sample accessible to the research team, of 214 U.S. Army (active duty and reserve) and National Guard rotary-wing pilots who had performed flight duties in the previous 6 mo, approximately 3.1% of the population. Of the 214 respondents, 69 completed the survey electronically and 145 completed it with paper and pencil. An invitational email was sent to approximately 650 U.S. Army active-duty aviators, 69 of which responded, yielding a response rate of approximately 10%. While a 10% response rate is typical for an online survey, it did not yield a sample size sufficient for the purpose of the overall survey. Thus, the hardcopy version of the survey was distributed to eligible participants through briefings given to aviation units at Fort Rucker, AL, without leadership present. A total of 187 aviators were asked to complete the hardcopy survey and 146 chose to participate (response rate = 77.5%). Those who chose not to participate typically reported not having time to complete the survey. Participation was voluntary. Respondents were primarily men (*N* = 203, 95.3%; 1 missing response); women (*N* = 10, 4.7) were slightly underrepresented [approximately 5.2% of U.S. Army aviators are women; personal communication, Human Resources Command; 2016]. The mean age of respondents was 33.03 yr (SD = 8.22). Levels of experience are summarized in **Table I**. All subjects had at least 50 flight hours.

Respondents provided a list of the type of aircrafts that they have flown throughout the duration of their military career as well as the approximate hours and periods of operation (**Table II**). A total of 211 respondents listed at least 1 type of aircraft, 158 listed 2 types, 76 listed 3 types, 18 listed 4 types, and 8 listed 5 types.

Materials

A subset of 15 questions (**Fig. 1**) regarding fatigue from an anonymous, 125-question survey instrument covering fatigue, sleep quality and quantity, workload, technology/automation, spatial disorientation, hypoxia, nutrition, and health habits are reported here. The purpose of the full survey was to assess aviator's perception of current issues (e.g., automation) and health-related behaviors (e.g., supplement use). The survey items, excluding those modified from prior published studies, were developed by the research team composed of research psychologists, U.S. Army aviators, medical personnel, and subject-matter experts in the field of aviation. All items in the survey instruments were reviewed by additional subject-matter experts not involved in the development of the survey for relevance, clarity, an appropriate reading-level, and overall length.

Procedure

Subjects were recruited either by receiving an invitational email from the principal investigator distributed by the U.S. Army Aviation Center of Excellence to aviation units or were recruited locally, outside the chain of command, at Fort Rucker to participate in a paper-and-pencil survey. The invitational email contained a link and instructions on how to access the survey as well as a password required to access the survey. The paper-and-pencil format of the questionnaire was proctored by a member of the research team. All potential volunteers were briefed and were provided a copy of the questionnaire. All

Table I. Summary Statistics for Reported Levels of Experience.

	N	MEDIAN	MEAN	SD
Flight time in last year	208	110.00	147.04	92.99
Flight time in last 90 d	191	30.00	38.12	30.13
Flight time in last 30 d	189	15.00	15.38	13.99
Total h pilot-in-command	192	741.02	0.00	1485.51
Total hours of instrument flight – actual	196	20.00	45.80	84.31
Time since last instrument flight – actual (weeks)	189	8.00	18.72	76.62
Total hours of instrument flight – simulated	200	30.00	93.38	240.75
Time since last instrument flight – simulated (weeks)	195	9.00	12.72	13.88

Table II. Summary Statistics of Hours Reported by Airframe (9 Missing Responses).

AIRCRAFT	TOTAL HOURS	*N*	MEAN	SD
UH-60 (A/L)	64,604.7	87	742.6	938.2
UH60M	22,599.2	42	538.1	979.1
TH67	11,600.7	127	91.3	96.1
TH55	105.0	2	52.50	3.5
OH58	25,380.1	103	246.4	786.1
UH72A	1768.0	16	110.5	77.7
UH72	2083.0	23	90.6	21.1
HH1	12,770.0	16	798.13	1040.03
CH47F	6754.4	5	1351.5	816.4
CH47	22,387.2	10	2238.7	1804.4
OH6	470	3	156.7	211.3
AH64E	29,213.8	17	1718.5	1373.4
AH64	18,039.2	13	1387.6	1144.6
Other	100	1		

subjects were informed that their participation was completely voluntary and anonymous.

Statistical Analysis

Responses submitted using the web-based system were outputted in a spreadsheet and reviewed by a member of the research team for validity. Responses from hardcopy surveys were entered by two members of the research team in order to minimize data entry errors. Data entry accuracy was assessed using a 10% sample. Statistical analyses were performed using the statistical software package SPSS release 19.0.0. Descriptive statistics including frequencies, percentages, means, and standard deviations were calculated for all survey items where appropriate.

RESULTS

The majority of subjects reported flying primarily during the day [$N = 164$ (84.9%)], whereas a subset reported flying primarily at night with night-vision goggles [$N = 29$ (15.0%)]. With respect to scheduling consistency, 60.5% agreed that their work and rest schedules were about the same day-to-day, whereas 22.8% disagreed with this statement (16.7% were neutral). Similarly, 20.9% and 26.2% responded that their rest and wake times varied day to day, respectively. The mean number of hours slept per night reported was 6.8 (SD = 0.9), whereas the mean number of hours of sleep needed to feel rested was 7.2 (SD = 1.3). Of those who reported the typical number of hours slept per night and the number of hours needed to feel rested ($N = 197$), 48.7% reported sleeping less than necessary. For this subset of participants, the mean difference between their actual and desired amount of sleep was 1.5 h (SD = 1.1). Approximately 80% of subjects reported typically sleeping less than 8 h a night. When questioned about the quality of sleep at home vs. in the field, the majority responded sleep quality was good at home [$N = 138$ (64.5%)], whereas only 26.3% ($N = 55$) agreed that the sleep in the field was "good."

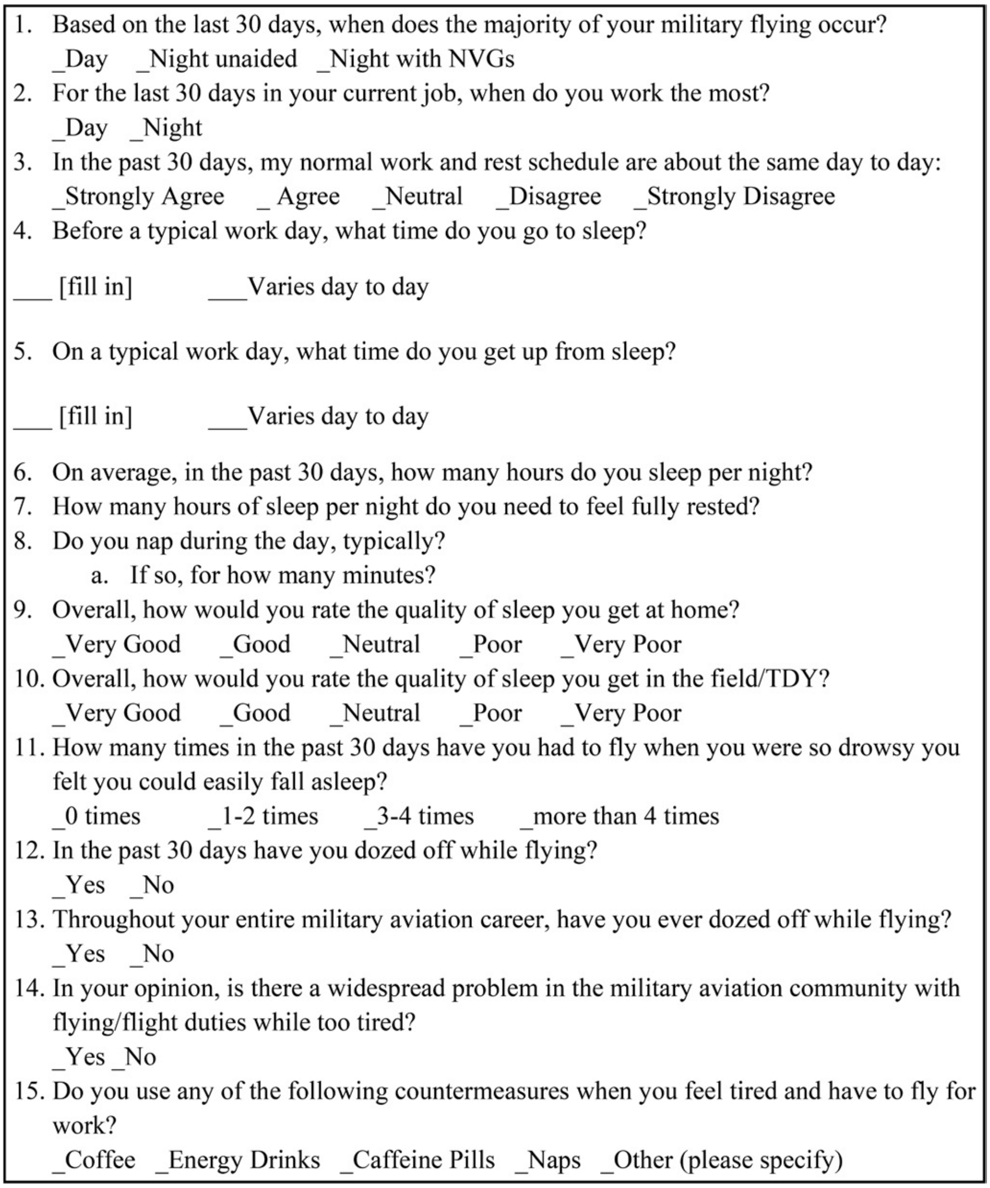
Overall, subjects' responses did not indicate excessive daytime sleepiness currently. Specifically, with respect to the past 30 d, a majority of subjects did not report feeling excessively drowsy during a flight [$N = 157$ (74.8%)], nor did they report dozing off during a flight [$N = 212$ (99.0%)]. However, when asked whether they had ever dozed off during a flight over the course of their military aviation career, 21.0% reported that they had ($N = 45$).

With respect to countermeasures, subjects most frequently reported drinking coffee to combat fatigue [$N = 153$ (81.34%)], with smaller proportions of the sample reporting use of energy drinks [$N = 77$ (40.9%)], naps [$N = 60$ (31.9%)], caffeine pills [$N = 8$ (4.3%)], and other countermeasures [$N = 15$ (7.9%)], including soda, exercise, and chewing tobacco, to combat fatigue. A majority of participants did not report taking naps on a regular basis [$N = 166$ (79.8%)], but of those who did report naps, the mean number of minutes typically slept was 44.1 ($N = 42$, SD = 30.86). Finally, 42.3% ($N = 85$, 13 missing responses) of the respondents agreed that they felt fatigue was a widespread problem in the military aviation community.

DISCUSSION

Execution of the study faced a number of challenges with respect to sampling and response rate. A thorough discussion of these limitations is presented following an overview of the findings. Overall, the results suggest that fatigue is a prevalent and important concern for the aviators sampled. The results indicate that roughly one-fifth of the participants reported inconsistent work schedules (as well as dynamic wake/rest times day-to-day), a factor which has been shown across many occupations to be a safety concern. Multiple U.S. military branches have attempted to address this concern by developing tools to assist in the scheduling of training, shift hours, and blocks of time reserved for sleep.[7] Currently, there are no known studies that have examined if these mitigation strategies have had any impact on relative risk associated with fatigue in an Army aviation operational setting. Although policy and doctrine outline strategies for facilitating adequate rest cycles and provide important information to soldiers for optimizing sleep and recovery,[10,11] the policies generally provide broad guidance and allow leadership flexibility so that the fatigue avoidance strategy can be tailored to support individual mission goals. This allows for a large degree of flexibility in policies, which can be difficult to monitor and enforce. Additionally, mission needs and conflicting policies to meet requirements may result in lower prioritizing of crew rest policies.

Another key finding is the less than optimal amounts of sleep reported. Specifically, the majority of subjects reported sleeping less than the recommended 8 h per night. While the typical adult needs 7–9 h of sleep to feel rested, nearly half of the subjects reported sleeping less than they felt they needed. The reasons for less than desired amounts of sleep are unknown, but regardless of the cause, insufficient rest is a well-documented contributor to fatigue and increased risk of a mishap. Conversely,



1. Based on the last 30 days, when does the majority of your military flying occur?
   _Day _Night unaided _Night with NVGs
2. For the last 30 days in your current job, when do you work the most?
   _Day _Night
3. In the past 30 days, my normal work and rest schedule are about the same day to day:
   _Strongly Agree _ Agree _Neutral _Disagree _Strongly Disagree
4. Before a typical work day, what time do you go to sleep?

___ [fill in] ___Varies day to day

5. On a typical work day, what time do you get up from sleep?

___ [fill in] ___Varies day to day

6. On average, in the past 30 days, how many hours do you sleep per night?
7. How many hours of sleep per night do you need to feel fully rested?
8. Do you nap during the day, typically?
   a. If so, for how many minutes?
9. Overall, how would you rate the quality of sleep you get at home?
   _Very Good _Good _Neutral _Poor _Very Poor
10. Overall, how would you rate the quality of sleep you get in the field/TDY?
    _Very Good _Good _Neutral _Poor _Very Poor
11. How many times in the past 30 days have you had to fly when you were so drowsy you felt you could easily fall asleep?
    _0 times _1-2 times _3-4 times _more than 4 times
12. In the past 30 days have you dozed off while flying?
    _Yes _No
13. Throughout your entire military aviation career, have you ever dozed off while flying?
    _Yes _No
14. In your opinion, is there a widespread problem in the military aviation community with flying/flight duties while too tired?
    _Yes _No
15. Do you use any of the following countermeasures when you feel tired and have to fly for work?
    _Coffee _Energy Drinks _Caffeine Pills _Naps _Other (please specify)

Fig. 1. Fatigue survey items.

subjects did not indicate excessive daytime drowsiness at present; however, more than 20% of the sample reported having dozed off while on flight controls at some point in their aviation career. One possible reason for this seemingly inconsistent finding between insufficient sleep and somnolence is the use of countermeasures such as coffee and caffeine.

Finally, a large proportion of the sample indicated perceiving fatigue to be a widespread problem in the aviation community. The rationale for this belief was not assessed in the survey, but one possible explanation is that aviators inform each other of being sleepy and witness performance changes in fellow crewmembers related to fatigue. Note that the percentage of subjects who agreed with this statement is substantially lower than that reported by Caldwell and Gilreath[2] (42.3% versus 73.4%). While there are many possible reasons for the inconsistent finding between these two studies, one possible, and optimistic, explanation is the success of policies and countermeasures implemented in the past 15 yr.

Interpretation of the study results is limited, partially due to the methodology employed, as well as logistical challenges with execution. First, self-report surveys are prone to a number of biases, including recall and social desirability. Maintaining anonymity, as was done with this study, may reduce the impact of social bias, but the extent to which the bias is reduced is unknown. The nature of the questions should have also eliminated some desire to answer questions in a biased way. Also, the voluntary nature of the survey introduces participant bias such that some individuals are more likely to participate than others. The extent to which this bias may have influenced the results is also unknown, but given the moderately high response rate (74%) of the hardcopy version of the survey, its potential impact is minimized. Finally, and possibly the most important limitation, is the representativeness of the sample. While the sample itself is relatively large, it is a fairly small percentage of all U.S. Army aviators and is limited to the convenience sample available. Expected response rates are very low with surveys, particularly online surveys. In the case of this study, very few subjects responded online and, thus, a paper and pencil method was employed. Given these conditions, it is not possible to generalize our results to the population of U.S. Army aviators. To do so, a future study employing a stratified sampling approach would increase the representativeness of the sample as well as allow for more definitive analyses to be conducted evaluating relationships and effects specific to demographics and aircraft platforms.

Despite the limitations of the study, the results provide insight into the current perception of fatigue among aviators. The findings suggest that future fatigue management research may need to include evaluation of implemented scheduling tools, for not only the efficacy but also the ways in which they are employed. Additionally, the optimal level of sleep required may need further investigation given that the survey results suggest that despite seemingly inadequate levels of sleep obtained, minimal somnolence is reported.

ACKNOWLEDGMENTS

The authors would like to acknowledge the dedication and professionalism of the research staff of the Aircrew Health and Performance Division, U.S. Army Aeromedical Research Laboratory, and of the U.S. Army Aeromedical Activity for their contributions to the success of this project.

The opinions, interpretations, conclusions, and recommendations contained in this report are those of the authors and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation. Citation of trade names in this report does not constitute an official Department of the Army endorsement or approval of the use of such commercial items.

Authors and affiliation: Amanda M. Kelley, M.S., Ph.D., Kathryn A. Feltman, M.A., Ph.D., and Ian P. Curry, BM, B.S., D.Av.Med., FAsMA, U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL.

REFERENCES

1. Banks S, Van Dongen HP, Maislin G, Dinges DF. Neurobehavioral dynamics following chronic sleep restriction: dose-response effects of one night for recovery. Sleep. 2010; 33(8):1013–1026.
2. Caldwell JA, Gilreath SR. A survey of aircrew fatigue in a sample of U.S. Army aviation personnel. Aviat Space Environ Med. 2002; 73(5): 472–480.
3. Durmer JS, Dinges DF. Neurocognitive consequences of sleep deprivation. Semin Neurol. 2005; 25(1):117–129.
4. Gildner TE, Liebert MA, Kowal P, Chatterji S, Snodgrass JJ. Associations between sleep duration, sleep quality, and cognitive test performance among older adults from six middle income countries: results from the Study on Global Ageing and Adult Health (SAGE). J Clin Sleep Med. 2014; 10(6):613–621.
5. Hartzler BM, Chandler JF, Levin CB, Turnmire AE. Predicting performance during chronic sleep loss: identification of factors sensitive to individual fatigue resistance. Dayton (OH): Naval Medical Research Unit, Wright-Patterson Air Force Base; 2015. Report No.: NAMRU-D-15-47.
6. Helmreich RL. Cockpit management attitudes. Hum Factors. 1984; 26(5):583–589.
7. Hursh SR, Redmond DP, Johnson ML, Thorne DR, Belenky G, et al. Fatigue models for applied research in warfighting. Aviat Space Environ Med. 2004; 75(3):A44–A53.
8. Sexton JB, Thomas EJ, Helmreich RL. Error, stress, and teamwork in medicine and aviation: cross sectional surveys. BMJ. 2000; 320(7237):745–749.
9. Tonetti L, Fabbri M, Filardi M, Martoni M, Natale V. Effects of sleep timing, sleep quality and sleep duration on school achievement in adolescents. Sleep Med. 2015; 16(8):936–940.
10. U.S. Army Combat Readiness Center. Leader's guide to crew endurance. 2015. [Accessed Sept. 2017.] Available at https://safety.army.mil/Portals/0/Documents/REPORTINGANDINVESTIGATION/TOOLS/Standard/LEADERS_GUIDE_TO_SOLDIER_CREW_ENDURANCE_15JAN2015.pdf.
11. U.S. Department of the Army. Temporary flying restrictions due to exogenous factors affecting aircrew efficiency. Army regulation 40-8. 2007. [Accessed Sept. 2017.] Available at https://wss.apan.org/3999/NCNG%20Aviation%20Documents/AR%2040-8%20Tep%20Flying%20Restrictions1.pdf
12. Van Dongen HP, Baynard MD, Maislin G, Dinges DF. Systematic inter-individual differences in neurobehavioral impairment from sleep loss: evidence of trait-like differential vulnerability. Sleep. 2004; 27(3):423–433.