Reported Back Pain in Army Aircrew in Relation to Airframe, Gender, Age, and Experience

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INTRODUCTION: Back pain has remained an issue of significance among aircraft crewmembers for decades, occurring in the majority of military helicopter pilots with potential deleterious effects on performance, safety, and operational readiness. This exploratory, correlational survey study was designed to evaluate the presence of patterns and relationships that may require further examination to understand causal factors.

METHODS: The study population consisted of U.S. Army aviation crewmembers. Subjects (467) completed an anonymous survey, including questions regarding demographics, airframes, experience, pain history and severity, ergonomics, mitigation strategies, and duty limitations.

RESULTS: Overall, 84.6% of participants reported back pain at some time during their flying career, with 77.8% reporting back pain in the last calendar year. Age was found to significantly correlate with earlier time to pain during flight, higher pain rating after flight, and occurrence of grounding. A stepwise linear regression model was used to explore the relationships between age, flight hours, and years of aviation experience, demonstrating age to be the significant variable accounting for the observed variance. Aircrew reported wear of combat-related survival equipment and poor lumbar support to be the most notable contributors.

DISCUSSION: Back pain rates were consistent with previous studies. The relationship of age to back pain in this study may highlight unique pathophysiological pathways that should be further investigated within an occupational context to better understand the etiologic role. Enhanced seated lumbar support and combat-related survival equipment remain relatively low-cost/high-yield topics worthy of further investigation for exploiting efficient means to improve health, safety, and operational performance.

KEYWORDS: gender, flight experience, rotary-wing aviators.

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The objective of this study was to evaluate back pain affecting military aircrew with respect to aircraft type, demographics (gender, age), physical duty position of crewmembers within type (cockpit or cabin), onset and intensity of pain, hours flown within type, and crew perceptions of potential exacerbating factors, mitigating strategies, and ergonomic design. This was an exploratory, correlational survey study designed to evaluate the presence of patterns and relationships that may require further examination to understand the causal factors contributing to back pain in aircrew.

Back pain has remained an issue of significance among rotary-wing aircraft crewmembers for decades. Studies indicate that back pain occurs in the majority of military helicopter pilots with potential deleterious effects on performance, safety, and operational readiness.[11,22] Although often minimized or underreported, back pain is targeted as one of the most common symptoms experienced by military aircrew members across all aviation platforms, suggesting a variety of potential causal factors, including maladaptive posture and ergonomics,[3,20,21] whole body vibration,[5,14,15] inadequate lumbar support in aircraft seating,[12,26,27] aircrew-borne combat and survival kits,[6,19] and others. Furthermore, back pain remains an exceptionally common and pervasive malady among the adult working population in general[8,9] and many other factors may be related, including age, family history, previous back

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injury, smoking, obesity, physical fitness, stress and workload, anxiety and depression, leisure activities, and many others.[7,18,23] Among a host of potential physical, occupational, and psychosocial confounders, identification and quantification of clear lines of causation can be exceptionally difficult.[11]

With respect to rotary-wing aircrew, in many cases it remains unclear exactly what modifications to aircraft design, and more specifically to which aircraft types, could potentially alleviate back pain and/or improve long-term occupational outcomes in military pilots and crewmembers.[2,10,19] Historically, many important factors such as airframe and seat design, cockpit ergonomics, control geometry, personal life support equipment, and other engineering specifications have been driven primarily by airworthiness requirements and crash performance rather than concerns for crewmember health and comfort. For newer aircraft, there remains a paucity of data within the U.S. Army to correlate back pain with any particular seat design, aircraft type, or amount of time that crewmembers fly while constrained within such type.

Back pain and its relationship to age have been well documented in this subpopulation as well as in the general population. However, any gender differences or differences with respect to flying duties specific to the four main operational platform types used within the U.S. Army (UH-60 Blackhawk, AH-64 Apache, OH-58D Kiowa Warrior, and CH-47 Chinook) have not yet been reported in the literature. To address these gaps, this study employed a survey-based instrument including feedback on crewmember demographics, flight hours, history of back pain, approaches to management, and possible nonoperational contributors to back pain. Subjects were also asked to provide narrative feedback on their perceptions of aircraft seating and quality of cockpit ergonomics.

METHODS

Subjects

Subjects ($N = 467$) were rated ($N = 417$) or nonrated ($N = 50$) U.S. Army aviation crewmembers (active duty, Army Reserve, National Guard, and retired) over the age of 18. Recruitment occurred at the U.S. Army Aviation Center of Excellence (Fort Rucker, AL) from multiple aviation brigades, professional aviation military courses, and aviation organizational meetings. Of the subjects, 24 were women and the mean age was 35.5 (SD = 6.47). The response rate was 97.9% (477 surveys distributed). Full descriptive statistics on the demographics of the sample are provided in **Table I** and **Fig. 1**. Prior to data collection, the study received Institutional Review Board approval and was granted a waiver of written informed consent.

Materials

The anonymous, paper-and-pencil administered, 20-question survey was adapted from the occupational back pain epidemiological questionnaire published in 1994.[1] In this study, the "back" was defined as the region from the shoulder blades down to the lower region of the buttocks (consistent with the definition provided in the original survey version[1]). The instrument included questions regarding crewmember demographics, flight experience, history of back pain, approaches to managing back pain, and possible nonoperational confounders of back pain. Subjects were also asked to provide narrative feedback on their perceptions of aircraft seating and quality of cockpit ergonomics. The key outcome variables describing pain were Likert scale ratings of back pain severity both prior to and following a flight, the duration of the pain following flight, the prevalence of pain (yes/no), and the onset of pain in flight.

Procedure

At the start of each recruitment session, research staff administered an orientation briefing to potential subjects lasting approximately 15 min describing the study's purpose and opportunity for participation. After the briefing, military leadership personnel were asked by research staff to exit the study room (those individuals were afforded a separate opportunity to participate outside the group setting), and then all individuals received the 20-question survey. Volunteers who wished to participate were given the opportunity to complete and return the anonymous, written survey to a sealed collection box placed by research staff at a designated location inside the room; individuals choosing not to participate in the survey were instructed as well to turn in the blank/uncompleted survey to the collection box in order to help maintain complete anonymity and determine response rate. The survey instrument required approximately 30 min to complete.

Statistical Analysis

Data entry accuracy for the paper-and-pencil questionnaire was assessed using a 10% sample. Statistical analyses were

Table I. Descriptive Statistics for Demographic Data.

	MINIMUM	MAXIMUM	MEDIAN	MEAN (SD*)
Overall (N = 467)				
Age (years)	21	58	34	35.5 (6.47)
Height (in)	57	77	71	70.6 (3.16)
Weight (lb)	115	255	190	188 (24.7)
Beginning of aviation career (calendar year)	1976	2014	2006	NA
Women (N = 24)				
Age (years)	22	45	30.5	31.8 (5.72)
Height (in)	58	70	65	65.0 (2.93)
Weight (lb)	115	190	135	142 (20.0)
Beginning of aviation career (calendar year)	1995	2013	2007	NA
Men (N = 443)				
Age (years)	21	58	34	35.7 (6.45)
Height (in)	57	77	71	70.9 (2.86)
Weight (lb)	120	255	190	190.6 (22.95)
Beginning of aviation career (calendar year)	1976	2014	2006	NA

* SD denotes standard deviation.

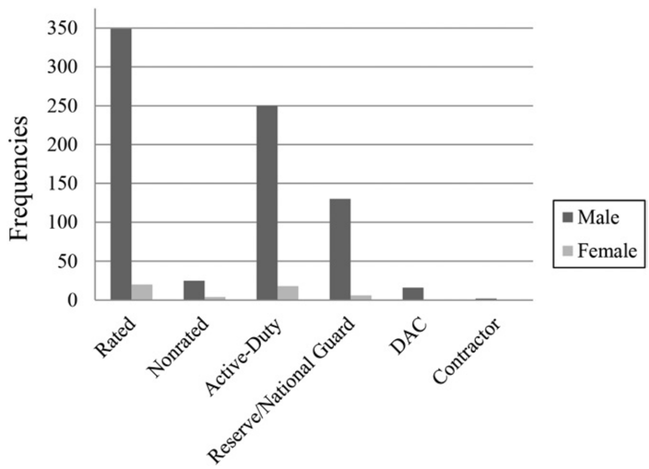

Fig. 1. Frequencies of rated/nonrated crewmembers and military affiliation. Note that data were missing for 69 male subjects for rated/nonrated and 45 male subjects for military affiliation. DAC denotes Department of the Army civilian.

performed using the statistical software package SPSS release 19.0.0. Prior to analysis, subjects were categorized into groups reflecting which aircraft/airframe they flew primarily using the reported flight hours for each aircraft. For example, a subject who reported 2000 h in the UH-60 and 500 h in the AH-64 would be categorized as reporting flight duties primarily in the UH-60. Subjects were categorized using this method with respect to the four main operational platform types used within the U.S. Army (UH-60 Blackhawk, AH-64 Apache, OH-58D Kiowa Warrior, and CH-47 Chinook).

Descriptive statistics, nonparametric tests (Mann-Whitney *U*, Wilcoxon ranked sum test), and Spearman's rank correlation coefficients were used to explore the data. Specifically, to evaluate the relationship between gender and back pain, nonparametric comparison tests were used given the large difference in sample size between men and women (Chi-squared tests of independence and Mann-Whitney *U*-tests). To evaluate the relationships between age, experience (flight hours), and back pain, stepwise linear regression models were conducted. Finally, to assess the relationships between aircraft types and pain, nonparametric tests (Spearman's rank correlation coefficients and the Kruskall-Wallis test) were used given the large differences between sample sizes in each category. Open-ended responses were reviewed for trends. Significance testing criterion was set at $P = 0.05$.

RESULTS

The survey used in the present study was designed to describe and explore potential relationships between crewmember demographics, including gender, age, and experience; aircraft type; consequences associated with crewmember personnel afflicted by back pain; and self-reported metrics of back pain as related to flying duties. Subjects' reported flight hours in the cockpit, cabin, and in combat were summarized and are presented in **Table II**. Note that combat hours are a subset of overall hours in the cockpit or cabin.

Collapsing over aircraft type, 395 out of 467 subjects (2 missing data; 84.6%) reported having back pain at some time during their flying career, with 361 subjects (3 missing; 77.8%) reporting pain during the calendar year preceding the survey and 40 (no missing; 8.6%) reporting that they had back pain issues before starting their flying career. The mean reported time in flight before back pain began was 67.52 min (89 missing data; SD = 54.88, median = 60). Of the 387 responses regarding durations of pain after cessation of a flight, the most frequently reported were "less than 2 hours" [$N = 114$ (29.46%)], "greater than 2 hours" [$N = 95$ (24.55%)], and "more than 24 hours" [$N = 92$ (23.77%)].

For female respondents, 22 out of 24 (91.7%) reported having back pain at some time during their flying career. Likewise, 21 female subjects (87.5%) reported pain during the calendar year preceding the survey and 2 (8.3%) reported having back pain before starting their flying careers. The mean reported time in flight before back pain began was 55.81 min (3 missing; SD = 40.56, median = 45). Chi-squared tests for independence yielded nonsignificant results for these pain variables between men and women. The most frequently reported durations of pain after cessation of a flight for women (3 missing data) were similar to those for men: "less than 2 hours" [$N = 8$ (33.3%)] and "more than 24 hours" [$N = 7$ (29.2%)].

The most frequently reported activities affected are sitting, standing, and stooping (bending over) for both men and women (**Fig. 2**). Both men and women reported the amount of

Table II. Descriptive Statistics of Cockpit, Cabin, and Combat Hours by Aircraft Type.

	HOURS IN COCKPIT		HOURS IN CABIN		COMBAT HOURS	
AIRCRAFT TYPE	***N****	**MEAN (SD)**	***N***	**MEAN (SD)**	***N***	**MEAN (SD)**
AH-64 Front seat	101	637 (530)	NA	NA	59**	781.1 (456)
AH-64 Back seat	86	732 (94)	NA	NA	NA	NA
OH-58	146	921 (1038)	12	36 (34)	64	941 (579)
OH-58D	74	1296 (1050)	0	NA	57	986 (579)
UH-1	52	625 (921)	10	360 (351)	3	406 (168)
UH-60 A/L	246	1057 (881)	111	358 (509)	185	541 (368)
UH-60 M	88	522 (492)	23	166 (279)	46	437 (256)
UH-72	40	302 (306)	5	135 (114)	0	NA
TH-67	200	101 (105)	41	58 (40)	0	NA
CH-47	46	1035 (692)	21	358 (569)	42	561 (360)
C-12	37	1127 (1124)	8	66 (52)	19	544 (335)
C-21	4	1024 (1303)	0	NA	1	NA
Other	57	1007 (1055)	12	510 (867)	16	662 (390)

* *N* denotes the number of respondents who reported greater than 0 h.
** Overall values for AH-64 collapsed over front and rear seat.
The OH-58 A/C was used in combat during the Bosnia conflict and Desert Storm.
The CH-47 data is not broken out by model type given that the seat design has not been altered, but a new seat cushion was implemented in the CH-47 F model.
All values have been rounded to whole numbers.

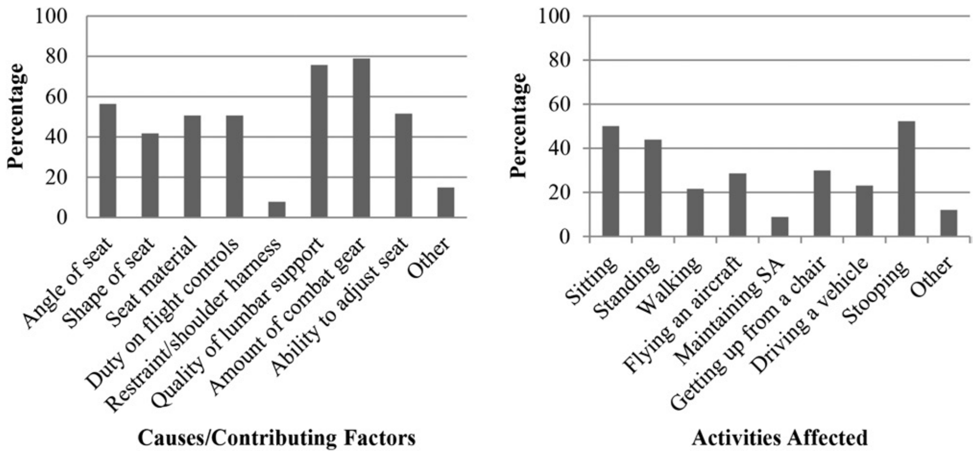

Fig. 2. Percentage of total affirmative responses of back pain causes/contributing factors and activities affected. Data were missing from 69 respondents.

combat gear most frequently as a cause of back pain followed by quality of lumbar support and angle of seat (Fig. 2). The patterns in frequencies of responses for men were similar to that for women.

Subjects provided ratings of their back pain before and after a flight on a scale ranging from 0 (no back pain) to 10 (worst pain). Data were missing for 74 subjects, resulting in 393 valid responses. The mean rating of pain before flight was 2.03 (SD = 1.74, median = 2) and the mean rating after flight was 5.20 (SD = 2.05, median = 5). A Wilcoxon signed rank test indicated that the median before-flight ratings were significantly less than median after-flight ratings ($Z = 16.65$, $P < 0.001$). Mann-Whitney U-tests did not support any differences in ratings between men and women (before-flight ratings, $U = 4262$, $P = 0.722$; after-flight ratings, $U = 3366$, $P = 0.152$). Of the 393 subjects who provided before-flight ratings, 391 also responded whether they had visited a health care provider about their back pain. Comparison of median values indicated that those who had seen a provider reported greater back pain before and after flight than those who had not ($U = 25{,}405$, $P < 0.001$, and $U = 25{,}003$, $P < 0.001$, respectively; **Table III**). Finally, of the 395 valid responses, 61 (15.44%) indicated that he/she had been grounded or missed work due to back pain (5 women, 56 men). The median length of time to have been grounded was 30 d, though the majority (58%) were grounded less than 1 mo, while some reported more extensive periods (e.g., two subjects reported a duration of 1 yr). Note that the mean age of those who had been grounded was 38 yr. Again, comparisons of the median values suggested that those who had been grounded/missed work rated their back pain as greater than those who had not both before and after flight ($U = 12{,}698.50$, $P < 0.001$, and $U = 12{,}229$, $P = 0.005$, respectively; Table III).

With respect to reported back pain and demographics, no difference was seen in a comparison of median values between rated and nonrated crew, though nonrated representation was small (approximately 10% of the subjects). Height and weight (self-reported; no anthropometric data) were not significantly correlated to back pain ratings, pain onset, pain duration, or medical outcomes (health care provider visit, grounded from flight). Age was weakly correlated with back pain ratings after flight [$r_s(395) = 0.147$, $P = 0.003$]; pain onset in flight [$r_s(378) = -0.128$, $P = 0.013$]; and experienced grounding for back pain [$r_s(395) = 0.210$, $P < 0.001$]. Given that age is strongly correlated with total flight hours [$r_s(461) = 0.507$, $P < 0.001$] and years of experience [$r_s(464) = 0.687$, $P < 0.001$], it is difficult to delineate the unique relationships between pain and each of these variables. Height and weight were not significantly correlated to back pain ratings, pain onset, pain duration, or medical outcomes (health care provider visit, grounded from flight). Thus, stepwise linear regression models were explored. The first model entered the age, total flight time, and years of experience as predictors and reported pain rating after flight as the outcome variable. The results suggest that age explained a statistically significant amount of the variance in after-flight pain ratings [$R^2 = 0.011$, $F(1, 387) = 4.12$, $P = 0.043$]. Likewise, age significantly predicted pain ratings after flight [$\beta = 0.033$, $t(387) = 2.03$, $P = 0.043$]. The second model used the same three potential predictors to model the amount of time into flight when pain begins and similarly found that age explained 1.5% of the variance [$R^2 = 0.015$, $F(1, 370) = 5.45$, $P = 0.02$]. Again, age was a significant predictor of pain onset in flight [$\beta = -1.03$, $t(370) = -2.33$, $P = 0.02$].

Subjects were asked to indicate methods/techniques used to reduce back pain (**Fig. 3**). The most frequently reported methods for both men and women were stretching/exercise

Table III. Descriptive Statistics for Before- and After-Flight Pain Ratings.

	N	MEAN	SD	MEDIAN
Before-flight pain ratings				
Visit to health care provider	210	2.50	1.83	2.00
Did not visit provider	181	1.50	1.44	1.00
After-flight pain ratings				
Visit to health care provider	210	5.72	2.03	6.00
Did not visit provider	183	4.63	1.88	5.00
Before-flight pain ratings				
Grounded/missed work	60	2.68	1.66	3.00
No work disruption	330	1.93	1.72	2.00
After-flight pain ratings				
Grounded/missed work	60	5.90	1.91	6.00
No work disruption	332	5.10	2.03	5.00

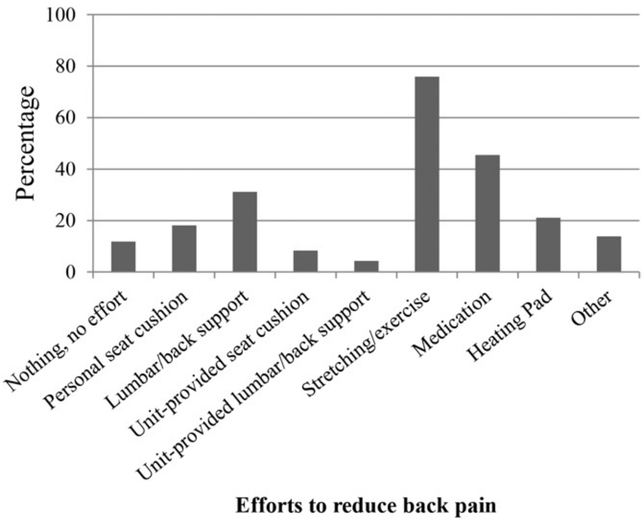

Fig. 3. Percentage of total affirmative responses of efforts to reduce back pain.

(75.88%), medication (45.47%), and lumbar/back support (31.16%).

To evaluate the potential relationships between aircraft types and reported back pain, Spearmen rank correlation coefficients were calculated between flight hours reported in an aircraft (hours in cockpit, cabin, and combat hours analyzed separately) and back pain ratings before and after flight (**Table IV**). Overall, these results suggest weak, yet statistically significant, positive relationships between the number of reported hours in the UH-60 and reported pain level both prior to and following flight. In other words, these results suggest that as reported hours in UH-60 aircraft increases, so does reported pain severity.

To compare reported presence and degree of pain between aircrew in the four main U.S. Army rotary-wing aircraft platforms, respondents were categorized according to the number of flight hours reported for each platform by cockpit, cabin, and combat hours. Respondents reported hours in multiple aircraft platforms and thus were categorized by the platform for which they had the most flight hours. For the purposes of categorization and to yield analyzable sample sizes, hours in different models (UH-60 A/L and UH-60 M) were summed to arrive at a total for each platform. As presented in Table III, cabin hours did not yield groups large enough for comparison. Given the large differences between sample sizes in each category, nonparametric tests were used to compare distributions and medians. The results show that the reported pain after flight was different among the aircraft platforms categorized using reported combat hours ($\chi^2 = 8.60$, $P = 0.035$). Pairwise comparisons ($P < 0.05$) show reported pain after flight is greater in AH-64 and CH-47 pilots than UH-60 and OH-58 pilots with respect to combat hours. Alternatively, reported pain after flight was different (marginally significant) among the aircraft platforms categorized using cockpit hours ($\chi^2 = 7.54$, $P = 0.056$). Inspection of the medians suggests greater pain in OH-58 pilots than the other platforms. All other comparisons were not significant. Rationale for this discrepancy is provided in the discussion.

Subjects responded to two open-ended questions at the end of the survey: 1) any other activities that may worsen/contribute to back pain (232 responses); and 2) opinions of the quality of aircraft ergonomics (310 responses). The most frequently reported activities that could have contributed to back pain were exercise (47 responses, 20.26%), weight lifting (47 responses, 20.26%), and running (30 responses, 12.93%). The most prevalent responses to ergonomic concerns were seating issues (188 responses, 60.65%). Specifically, 38 responses referenced a lack of lumbar support with the most complaints [$N = 14$ (5.53% of UH-60 pilot respondents)] being related to UH-60 A/L/M models. In addition, 31 responses were related to seat adjustability, with 2 positive reports on the adjustability of the CH-47 D/F seats (4.3% of CH-47 pilot respondents) and 1 positive report on the adjustability of the LUH-72A seats. However, most responses called for seats with better adjustability, with 15 complaints being leveled at the UH-60 A/L models (5.9% of respondents reporting cockpit hours in UH-60 A/L). In general, the UH-60 A/L models received the most complaints and were generally centered on seating [42 negative responses almost exclusively to UH-60 A/L models (17.1%) and 6 positive responses to UH-60 M (6.8%) seating]. Of note, 33 individuals (11% of respondents) specifically mentioned that equipment worn on the body (armor, helmets, survival vests, etc.) contributed to back pain during flight (i.e., weight, cube, shape, position). Of those complaints, 5 specifically named night vision goggles, 30 named body armor, and 7 named the survival vest.

DISCUSSION

Back pain is an exceptionally common medical problem and remains a significant aeromedical issue. Because of this challenge to both maintenance of flight status and the longevity of an aviator's career, back pain in the aviation community may be underreported or unreported, making it difficult for clinical researchers to quantify.[11,16] The whole of the problem is multifactorial and exceedingly complex—not limited to occupational exposure. Age, smoking, physical fitness, obesity, anxiety and depression, family history, previous injury, stress and workload, work satisfaction and compensation systems, as well as other factors may be at play.[7,18,23] This level of complexity and number of confounders among such a common condition across the general adult population makes the issue an exceptionally difficult area of study. Furthermore, beyond the subject of aircrew health, back pain also remains a potentially significant operational readiness issue with respect to performance and safety, including occupational attrition, curtailed or cancelled missions, distraction, degraded performance during critical phases of flight, impaired emergency egress, or compromised survival and evasion. Isolation and quantification of these important issues were beyond the scope of the study, but remain important topics of further consideration, especially as pain and its effect on operationally relevant tasks is highly subjective and would likely reflect large intersubject variability.

Table IV. Descriptive Statistics for Before- and After-Flight Pain Ratings by Aircraft Platform.

	N	MEAN	SD	MEDIAN
Before-flight pain ratings				
AH-64 cockpit hours	69	2.03	1.33	2.00
UH-60 cockpit hours	191	2.23	1.87	2.00
CH-47 cockpit hours	36	1.78	1.29	2.00
OH-58 cockpit hours	72	1.65	1.54	2.00
AH-64 combat+	52	2.13	1.40	2.00
UH-60 combat	165	2.30	1.97	2.00
CH-47 combat	35	1.83	1.27	2.00
OH-58 combat	56	1.61	1.56	1.50
After-flight pain ratings				
AH-64 cockpit hours	70	5.24	1.85	5.00
UH-60 cockpit hours	192	5.28	2.10	5.00
CH-47 cockpit hours	36	5.33	2.04	5.00
OH-58 cockpit hours	72	4.90	1.92	6.00*
AH-64 combat	53	5.43	1.92	6.00*
UH-60 combat	165	5.29	2.19	5.00
CH-47 combat	35	5.37	1.99	6.00*
OH-58 combat	56	4.86	1.87	5.00
Time into flight pain begins (minutes)				
AH-64 cockpit hours	70	73.49	55.42	60.00
UH-60 cockpit hours	184	70.67	58.69	60.00
CH-47 cockpit hours	36	57.50	46.50	45.00
OH-58 cockpit hours	66	65.24	52.73	60.00
AH-64 combat	53	76.60	57.78	60.00
UH-60 combat	157	64.93	48.75	60.00
CH-47 combat	35	54.43	46.27	45.00
OH-58 combat	51	71.71	54.26	60.00

* Significant at $P < 0.05$; +combat hours is a subset of cockpit hours.

This study was conducted to assist with accounting for back pain issues in general and back issues related to specific aircraft flight duty among U.S. Army crewmembers. Statistically significant, platform-specific findings with relation to back pain severity were limited to the UH-60 A/L, AH-64, and OH-58D aircrafts. The UH-60 A/L flight hours were directly related to back pain severity before flight such that as hours increased so did pain severity. This is also reflected in the open-ended responses, where the UH-60 A/L received more complaints than any other platform: a total of 42 negative responses were almost exclusively attributed to seating in UH-60 A/L models, with six positive responses to the newer generation UH-60 M seating. This is an interesting corollary to a previous study in the literature, which suggests that utility helicopter pilots report more back pain prevalence and severity.[13] However, the higher amount of responses for this platform may be a product of the fact that reported UH-60 flight hours were more than double any other platform's average flight hours per respondent. When back pain ratings were compared between aircraft groups using cockpit hours, a significant difference was seen such that pain was worse for those in the AH-64 and CH-47 than in the other groups. However, when the groups were categorized using combat hours and pain ratings were compared, the OH-58D group had higher pain ratings than the other groups. This discrepancy is supported by the open-ended responses detailing complaints regarding combat gear and equipment as well as differences in mission duration between environments. Also, pilots of attack platforms (OH-58D and AH-64) may be spending more time in the aircraft per mission given that they often do "hot rearm/refuels" and return to flight without emerging from the cockpit.

In this study, age had statistically significant, but weak, correlations with back pain severity, onset during flight, and grounding. These relationships suggest that pain severity and the likelihood of having been grounded increase with age, whereas onset of pain in flight decreases with age. This may represent older aircrew who endure the pain as a fait accompli occupational nuisance. Age may likely also be a factor in the length of grounding given potential for more significant etiologic pathology and commensurate longer recovery times. Total flight hours was not significantly related to any measures of back pain. It may be that age is a better surrogate marker of the back pain descriptors used in this study than flight hours. This is plausible considering the multifactorial pathophysiological etiology of back pain as advancing age captures the cumulative stress on the back from all sources (in addition to age-related physiological and degenerative changes), not just time in flight.

Unfortunately, the small sample size of women relative to that of men in this study makes it difficult to draw any conclusions or interpretations based on gender differences. The sample proportion of women is reflective of the proportion of women in the total Army aviation population (personal communication, Deputy Director Army Aeromedical Activity, 2016). As such, data are presented for men and women where appropriate. It remains possible that there are gender-related constituents integral to low-back pain that are worthy of consideration among this population at risk given findings from a study of an occupationally related surrogate population.[17] While this study did not yield significant gender differences, this remains an area worthy of further investigation in light of potential mitigating strategies with respect to anthropometrics, ergonomics, and other factors.

The results of this survey with respect to the pervasiveness and significance of the problem mirror previous studies on the extent, effects, and factors of back pain within this community.[3,4,26] In our study, 395 (84.6%) subjects responded that they have had back pain while on flight status (not necessarily in flight), with 361 (77.3%) having had back pain in the year previous to participating in the survey. While in flight, the reported median time until back pain developed was 60 min, well before the time that the majority of flight missions would be completed. The literature has indicated body armor plus full combat load and a hostile environment are risk factors for low-back pain.[16,24] In this community, survival equipment may exacerbate poor posture and spinal loads in seats that may have never been originally designed to accommodate a seated pilot in such a configuration. In our study, 314 respondents (67.2%) chose "amount of combat gear including body armor" as having caused or contributed to their back pain. This was the response most often chosen, closely followed by "quality of lumbar support" [selected 301 times (64.4%)]. Lumbar support concerns are in keeping with reports of back pain issues surrounding inadequate seating and unhealthy postures.[12,21,25] The fact that the top factors cited by the study population included aviation life support equipment design/integration and lumber support is of significance as these are two relatively inexpensive and permissibly correctable elements within the current state of resource and fiscal constraint.

Other interesting points from this study derive from the open-ended questions, as well. Approximately 20% of respondents attributed exercising, especially weight lifting, as worsening or contributing to their back pain. This appears to be an interesting corollary with the 302 respondents (64.6% of the total group) who chose "stretching and exercise" as a method employed to reduce pain. Given the variability in specificity of physical activities, exercise regimens, and "back health programs," it is inappropriate to draw firm conclusions regarding this point. Open-ended questions did not provide that level of granularity. This most likely indicates that not all exercise routines have a positive effect on aviator back health.

The findings of this study are limited for a number of reasons, some of which are inherent to the methodology employed. In particular, self-report surveys are prone to bias, including recall, survival, and social desirability. In addition, some survey questions were not structured in such a way that back pain could be quantified. In other words, it is not possible to tell the severity of back pain specific to aircraft given the structure of the instrument. All respondents in this survey indicated experience in multiple aircraft platforms, posing a significant challenge to isolating relationships with specific aircraft. This is common given that Army flight school uses various training helicopters before the student transitions to his or her duty aircraft and experienced aviators transition back to training helicopters as they become instructors. In addition, various aircraft are phased out to be replaced by significantly newer models (i.e., UH-60 A/L to M) or completely new platforms (i.e., the UH-1 and the OH-58 are no longer part of the active-duty Army inventory, while the UH-72 was added to the inventory approximately 9 yr ago).

An additional limitation of the methodology employed is the sampling method. While a very large sample was obtained for this survey, it is a convenience sample, thus limiting in the generalizability of the results. In future efforts, 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.

Finally, recommendations for future studies include questions that determine when back pain first appeared in a respondent's career and how often the back pain occurs, questions that provide a more detailed definition of pain (e.g., localized, radiating), questions that identify body positions most likely to elicit or exacerbate pain, and questions to evaluate past medical, occupational, and recreational history more thoroughly. Attempts to create more homogenous groups of aviators among the different platforms would also be highly desirable. One way this grouping could be achieved is to restrict respondents to less than 10% of their flight hours in aircraft outside of their one, and only one, primary flight platform.

The results of this study suggest that back pain is weakly related to total flight hours in specific aircraft, including the UH-60 A/L, AH-64, and OH-58D. These relationships suggest increasing pain severity with increasing time in a UH-60 A/L. Also, age had a weak, negative correlation with time of pain onset and weak, positive correlations with pain intensity, duration, and grounding for and seeking treatment for back pain. Sitting and standing were the most frequently chosen activities made more difficult by the respondents' back pain and "stretching and exercise" was chosen most often as a preventive strategy prior to flying. Lastly, the concerns expressed by respondents related to wearing of body armor in the cockpit, lumbar support, and adjustability of seats should direct particular attention to studies that assess the potential benefit of various preventative strategies of ergonomic seat design.

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