Effect of Position in the Aircraft and Total Flight Time on Level of Back Pain in the Naval Helicopter Sea Combat Community

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Introduction

Back pain in helicopter aviation has been a reported issue for over 50 years, especially amongst helicopter pilots (Gaydos, 2012). In military helicopter aviation back pain is a multinational problem regardless of platform type. Multiple studies show the prevalence ranging from 50-92% (Gaydos, 2012). Civilian helicopter aviation is also not immune to back pain as Cunningham, Docherty, and Tyler (2010) reported a comparable prevalence among military and civilian helicopter pilots at 83% and 81%, respectively (as cited in Gaydos, 2012). Although the prevalence of low back pain in the general population is estimated at 70-90% (Gaydos, 2012), Aufret and Villeford (1982) determined that back pain is twice as frequent in helicopter pilots than the general population (as cited in Vallejo et al., 1999). The problem is so ubiquitous that most pilots and aircrew accept it as a standard occupational hazard.

The predominance of studies into helicopter back pain have focused on pilots, while largely ignoring the enlisted aircrew population. Limited studies exist focusing on enlisted aircrew back pain, specifically. In a recent extensive literature review by Gaydos (2012) on low back pain in rotary-wing aircrew, only three studies specifically addressed enlisted aircrew back pain. Delahaye (1982) cautioned, “The plight of pilots should not allow that of other members of the crew to be forgotten.” In one study on back pain in MH-60S Helicopter Pilots, Phillips (2011) stated, “A study designed specifically for their [enlisted aircrew] needs should be done. The author received several requests to do a similar study for the aircrew.”

Interest in this topic arose during my current assignment as the Aeromedical Safety Officer for the Helicopter Sea Combat Wing Pacific. I would consistently hear aircrew, especially experienced aircrew, complain about chronic back pain. Having to personally fly in the back of the MH-60S as part of my job, I can empathize with the uncomfortable and downright painful design of the troop seats. As someone that suffers from chronic back pain due to years of flying and sitting for long periods of time in a poor posture and no lumbar support, I felt it was important to address the plight of aircrew back pain. One case-control study of 5095 U.S. Navy pilots and aircrew showed aircrew, not pilots, to have higher risk of diagnosed back problem by physical exam for both helicopters and fixed-wing aircraft (Gaydos, 2012). A survey for helicopter seating systems in the DoD, reported a higher percentage of Naval aircrew experiencing pain or discomfort while flying with discomfort occurring greater than once per week compared to Naval pilots (Ex3, 2011). One of the main interests for this study was to determine if enlisted aircrew experienced more back pain than pilots and if that was dependent on total flight hours.

Gaydos (2012) noted several studies associating higher total flight time with increased back pain, while other studies showed no significant difference with higher total flight time. All of the noted studies focused solely at pilot back pain, but one could infer that since aircrew sit in poorly designed seats, contributing to poor posture, and experience the same vibrations as the pilot they too would have increased back pain with greater flight hours.

The 7 steps of hypothesis testing were utilized to conduct this study. The research question addressed was, what is the effect of position in the aircraft and total flight hours on level of back pain in the Helicopter Sea Combat (HSC) community? The primary hypothesis is enlisted aircrew will have higher levels of back pain than pilots. A secondary hypothesis is pilots and aircrew with greater number of total flight hours will have higher levels of back pain. The statistical hypotheses are stated as the Null (H_0) and Alternative (H_1). The null hypothesis for IV1 is H_0: $\mu_{pilots} = \mu_{aircrew}$. The alternative hypothesis for IV1 is H_1: $\mu_{pilots} \neq \mu_{aircrew}$. The null hypothesis for IV2 is H_0: $\mu_{0\text{-}1000hours} = \mu_{>1000hours}$. The alternative hypothesis for IV2 is H_1: $\mu_{0\text{-}1000hours} \neq \mu_{>1000hours}$. A random sample was drawn from pilots and enlisted aircrew in the HSC community. Observational data was collected via an on-line survey. Further information on sampling and collection techniques is discussed in the methods section. A two-way ANOVA was conducted with follow-up one-way ANOVAs. The F-statistics and p-values for each ANOVA were calculated with all relevant information reported in the results section. Decisions based on the resultant p-values are discussed in the results and discussion sections.

Methods

An anonymous 17 question online survey was distributed to operational squadrons in the HSCWINGPAC, HSCWINGLANT, HSMWINGPAC, and HSMWINGLANT wings. Distribution of the survey to all the H-60 wings ensured as close to a random sample as possible. An online link via Google Doc Forms was given to each wing's Safety Officer and then emailed to all pilots and aircrew in the operational squadrons. Data was collected over a 3-month period from January to March 2014. See Appendix A for the survey.

511 pilots and aircrew responded to the survey. Of those 249 were from the HSC community. 6 responses were removed due to lack of answering the following question,

“On a scale of 1 to 10, how bad is your current back pain (1 being no pain and 10 being debilitating pain)?” This question is the measure used for the statistical analysis. The final sample size was N=243.

The first independent variable of position in the aircraft was split into two groups, pilot and aircrew. The second independent variable of total flight time was split into two groups, 0-1000 hours and more than 1000 hours. See Table 1 for sample size of each group.

Table 1. Group sample sizes

		n
Pilot	0-1000	89
	more than 1000	45
	Total	134
Aircrew	0-1000	47
	more than 1000	62
	Total	109
Total	0-1000	136
	more than 1000	107
	Total	243

Demographic data was collected to include total flight time, aircraft model, position in aircraft, age, height, weight, and gender. Individual age was not collected therefore mean age and SD could not be calculated. Ages ranged from 20-50 years old. See Figure 1 for age group percentage breakdown. 243 total pilots and aircrew participated with 217 males (89.3%) and 26 females (10.6%). Among the 134 pilots, 112 were male (83.6%) and 22 were females (16.4%). Among the 109 aircrew, 105 were male (96.3%) and 4 were females (3.7%). The raw data was initially filtered to only include the 3 types of aircraft flown in the HSC community, MH-60S, HH-60H, and SH-60F. Data was then filtered by position and flight time into the four groups listed above.

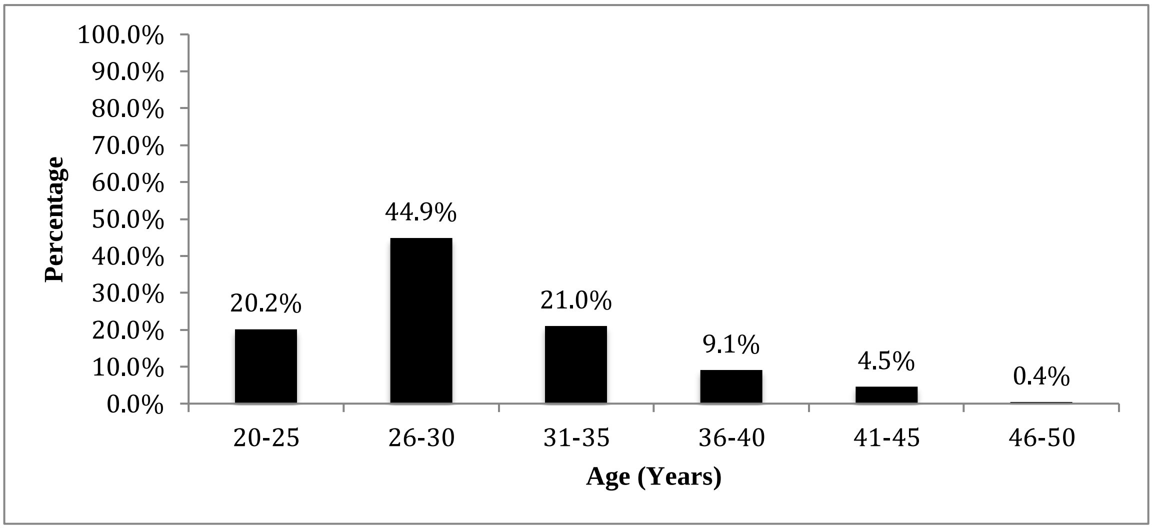

Figure 1. Age group percentage breakdown for both pilots and aircrew (N = 243)

The two independent variables (position in aircraft and total flight time) and dependent variable (level of back pain on a scale of 1 to 10) were analyzed in SPSS with a two-way ANOVA. An alpha level of .05 was selected. Even though the study is exploratory, which is one reason to increase the alpha level, I wanted to keep the alpha level at .05 due to the larger sample size and to reduce the risk of a type I error.

Follow up one-way ANOVAs were conducted to address the research question, does the effect of total flight time depend on position in the aircraft and does the effect of position in the aircraft depend on total flight time? The file was split by both IVs to answer both the primary and secondary hypothesis. No post-hoc tests were conducted since only 2 groups were compared. The 2 one-way ANOVAs were selected as follow up tests due to the interaction between position in the aircraft and total flight time.

The assumptions of random sample and independence were addressed during the study design. Although a true random sample is very difficult to obtain, this study comes close to a random sample since the survey was distributed to most of the pilots and aircrew in the population of interest. Independence can also be assumed since each person contributed only one score. The assumptions of homogeneity of variance and normality will be addressed in the results.

Results

A 2 (position in aircraft) x 2 (total flight time) two-way ANOVA examined differences of position in the aircraft and total flight time on back pain in the H-60 aircraft. Data were normally distributed except for the Pilots with 0-1000 hour group, which showed slight skewness (standardized skewness = 3.35). Calculations for a possible outliers in this group (values = 7, 8) were conducted and it was determined the values were not outliers ($3.3 \times 1.702 = 5.62$, $3.11 + 5.62 = 8.73$). Since the violation of normality for skewness was not severe and no outliers were found, no adjustments to the data were made. See Table 2 for standardized skewness and kurtosis and Figures 3 through 6 for histogram plots. The assumption of homogeneity of variance was met ($F(3,239) = 2.17$, $p = .092$). Results revealed a significant interaction ($F(1,239) = 11.73$, $p < .002$, $\eta^2 = .05$), as well as a significant main effect for position ($F(1,239) = 14.29$, $p < .001$, $\eta^2 = .06$), and a significant main effect for flight time ($F(1,239) = 11.02$, $p < .002$, $\eta^2 = .04$). Review of the profile plot in Figure 2 shows the interaction overriding the main effects. The plot shows no difference in back pain for pilots or aircrew with 1000 hours or less, but a significant difference between pilots and aircrew with more than 1000 hours. The plot indicates the effect of total flight hours is dependent on position in the aircraft.

Table 2. Standardized Skewness and Kurtosis for pilots and aircrew based on total flight time in hours.

	Pilots		Aircrew	
	0-1000 hrs	> 1000 hrs	0-1000 hrs	> 1000 hrs
Skewness	.854	-.065	.509	.206
Std error of Skewness	.255	.354	.347	.304
Standardized Skewness	**3.35**	**-.18**	**1.47**	**.68**
Kurtosis	.396	-1.003	-.196	-.676
Std error of Kurtosis	.506	.695	.681	.599
Standardized Kurtosis	**.78**	**-1.44**	**-1.73**	**-1.13**

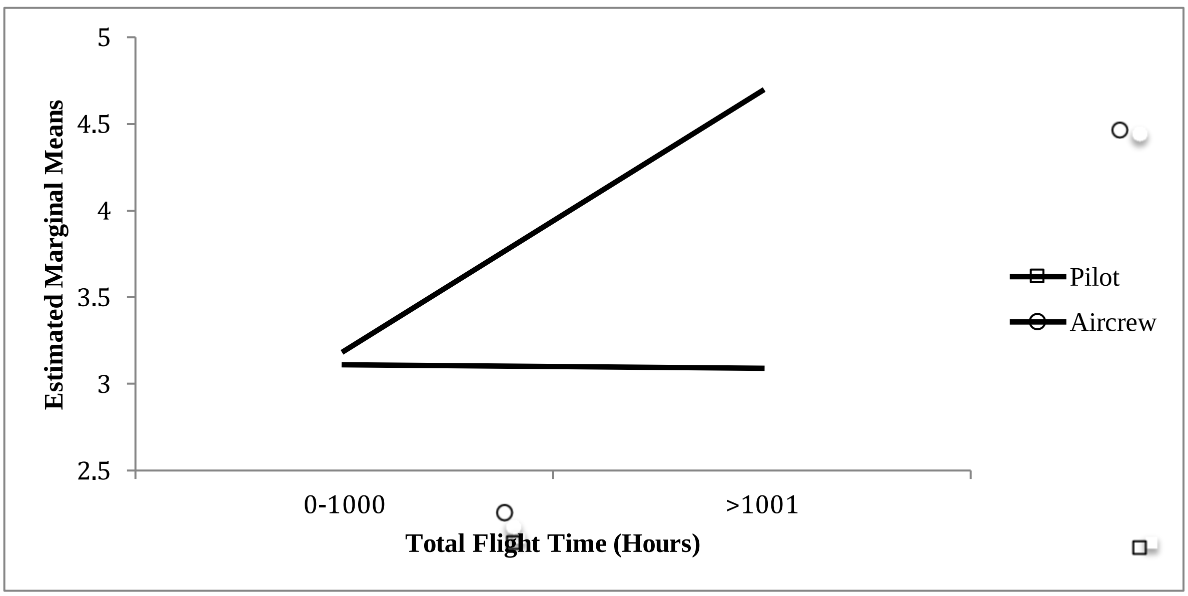

Figure 2. Profile plot showing the effect of total flight time on pilot and aircrew back pain levels self-reported on a 1 to 10 scale.

Follow up one-way ANOVAs examined differences in position in the aircraft on total flight time, separately. Alpha level was adjusted using the Bonferroni correction (.05/2 = .025) to protect against an inflated Type I error rate. The assumption of homogeneity of variance was met for both the 0-1000 hours ($F(1, 134) = .54$, $p = .47$) and more than 1000 hours ($F(1, 105) = 5.12$, $p = .03$) using the corrected alpha level. Results indicated a significant difference in position with more than 1000 hours ($F(1,105) = 22.68$, $p < .001$, $\eta^2 = .18$, CI_{diff} .94 to 2.27). Aircrew with more than 1000 total flight hours had significantly higher levels of back pain compared to pilots. No significant differences for 0-1000 hours was found ($F(1,134) = .07$, $p > .78$, $\eta^2 = .001$, CI_{diff} -.50 to .66). Means and standard deviations are found in Table 3.

To address the secondary hypothesis 2 additional follow up one-way ANOVAs examined the total flight time hour differences in pilots and aircrew, separately. The assumption of homogeneity of variance was met for both pilots ($F(1, 132) = .65$, $p = .42$) and aircrew ($F(1, 107) = 4.59$, $p = .03$) using the corrected alpha level. Results indicated a significant difference in flight hours for aircrew ($F(1,107) = 19.89$, $p < .001$, $\eta^2 = .16$, CI_{diff} .83 to 2.17). Aircrew with more than 1000 hours had significantly higher levels of back pain than aircrew with 1000 hours or less. No significant difference was found for pilots ($F(1,132) = .01$, $p > .93$, $\eta^2 = .00$, CI_{diff} -.61 to .56).

Table 3. Means and standard deviation of back pain for pilots and aircrew

	0-1000 hours	More than 1000 hours	Total
Pilot	3.11 ± 1.70	3.09 ± 1.43	3.10 ± 1.61
Aircrew	3.19 ± 1.50	4.69 ± 1.90	4.05 ± 1.89
Total	3.14 ± 1.63	4.02 ± 1.89	3.53 ± 1.80

Note: Back pain measured on a 1 to 10 scale

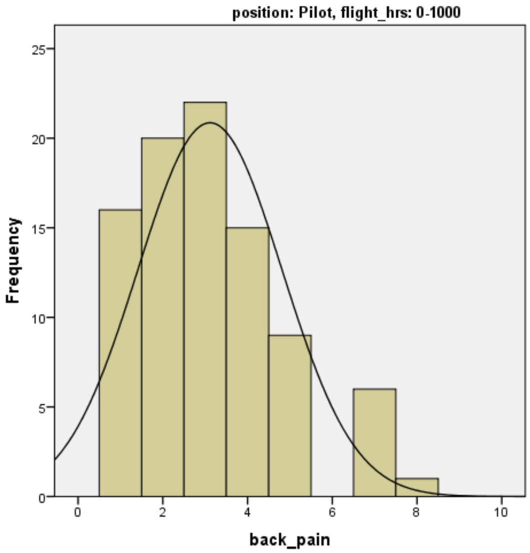

Figure 3. Frequency distribution of Pilot back pain with 0-1000 hours of flight time.

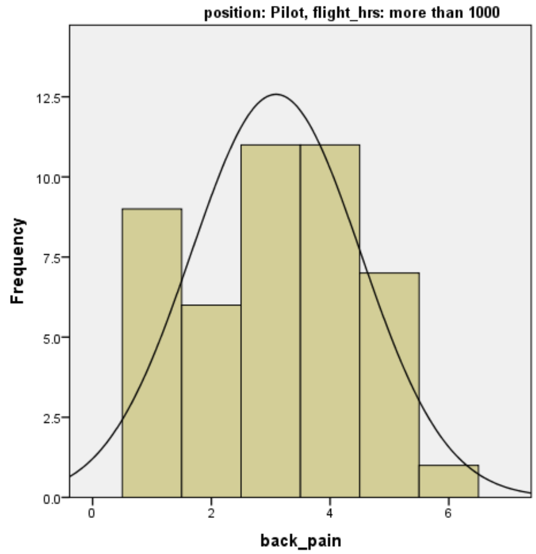

Figure 4. Frequency distribution of Pilot back pain with > 1000 hours of flight time.

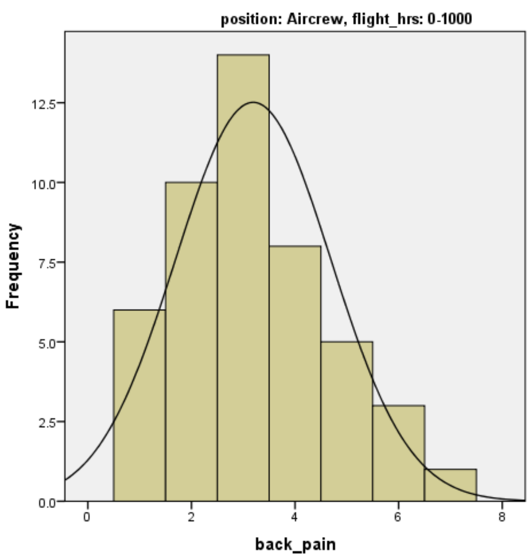

Figure 5. Frequency distribution of Aircrew back pain with 0-1000 hours of flight time.

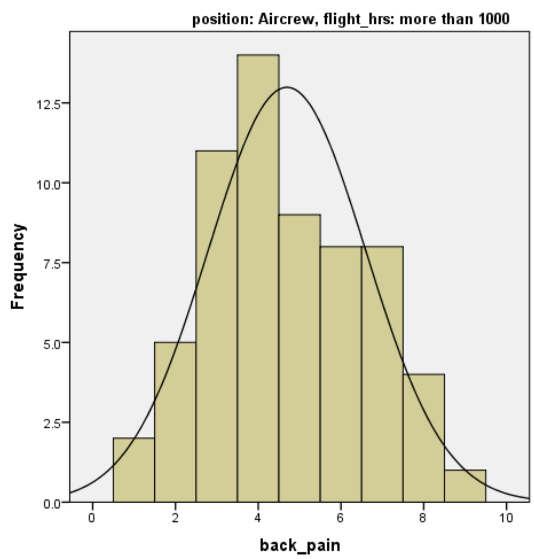

Figure 6. Frequency distribution of Aircrew back pain with > 1000 hours of flight time.

Discussion

The results partially supported the primary hypothesis. The two-way ANOVA results indicated the effect of total flight time on level of back pain was dependent on the position in the aircraft. There was no significant difference between pilot and aircrew with 1000 hours or less, but aircrew had significantly higher back pain than pilots with more than 1000 hours. The results also only partially supported the secondary hypothesis that both pilot and aircrew will have greater levels of back pain with higher total flight hours. Pilots did not show a significant difference between 0-1000 hours and more than 1000 hours, but aircrew did show significant differences.

The results for the primary hypothesis provide a basis for further research into the prevalence of back pain in enlisted aircrew. Since this study did not utilize validated measures for surveying back pain, follow on research using validated measures would be beneficial. Further research also looking at objective measures of posture and whole body vibrations on back pain in aircrew is important to help determine a causative relationship for their increased back pain. The two main factors most commonly associated with back pain in helicopters are posture and exposure to vibrations (Vallejo et al., 1982). Although a causative relationship has not been proven, it has been suggested that transient back pain is associated with poor posture while chronic back pain is associated with repeated exposure to vibration (Gaydos, 2012). Current data is unclear as to the amount of influence helicopter vibrations have on back pain, but it is known that vibration can lead to microtrauma and damage to intervertebral disks on a molecular level (Sargent and Bachmann, 2010). Gaydos (2012) states that the review of literature favors a positive association between whole body vibration and back pain, but a clear causative and dos-response relationship is weak.

Current seat design for aircrew in the HSC community has not changed since the Vietnam War era. The troop and gunner seats are fabric wrapped over a metal tube frame with a 90° back rest angle, no recline, and no lumbar support. The design requires aircrew to consistently lean forward with no ability to lean back to relieve any back strain. Bridger et al. (2002) stated that a forward flexed trunk posture has been associated with back pain in industrial workers. The metal tubes create pressure points on the thighs, reducing circulation in the legs causing greater discomfort. Although aircrew have the ability to get up and move about the cabin, the ceiling height is so low as to not allow the aircrew to stand up straight. The aircrew are also required to perform loading of personnel and equipment, especially during search and rescue operations which can create greater strain on the back. All of these factors could explain the increased back pain for aircrew, especially those aircrew with greater total flight time.

Current research into the association of total flight time and back pain is unclear. Several studies referenced in Gaydos' (2012) literature review showed an association of increased total flight hours with increased back pain while others showed no significant difference in total flying time between pilots with and without back pain. The results of the secondary hypothesis are in line with current research.

Practically the results of the follow-up ANOVAs showed that 18% of the variability was due to difference in flight hours and 16% of the variability was due to the position in the aircraft. Although the eta-squared values are low and may not provide much practical significance, the results do warrant further investigation into aircrew back pain. The preliminary nature of the study also limits the practical significance of the results, but does help to elucidate the problem of aircrew back pain as equivalent or greater with pilot back pain.

Back pain in aviation is a complex issue especially in helicopter aviation. A multitude of factors contribute to back pain to include seat design, poor posture, vibration, previous back injury, and physical fitness to name a few. All of these make tackling the issue of back pain much more difficult and time consuming. Most of the research into back pain in the helicopter community has focused on the pilots, most likely due to the cost and time invested in training pilots, while aircrew have been suffering in silence for years. My hope with this preliminary study is to bring to light the issue of aircrew back pain as a significant problem that needs to be properly addressed through further research. Building a foundation of scientific data on the issue is the first step in ultimately solving the problem. Follow on studies looking at more objective measures can be used to decision makers in the Navy and DoD to provide funding to improved seats and extensive preventative back pain programs.

References

1. Auffret R, Viellefond H. (1982). Spinal Stresses in Flight. *Physiopathology and pathology of spinal injuries in aerospace medicine*, 2nd ed. AGARD-AG-250; 48-53.
2. Bridger RS, Groom MR, Jones RJ, Pethybridge RJ, Pullinger N. (2002). Task and postural factors are related to back pain in helicopter pilots. *Aviation, Space, and Environmental Medicine* 73:805-11.
3. Cunningham LK, Docherty S, Tyler AW. (2010). Prevalence of low back pain (LBP) in rotary wing aviation pilots. *Aviation, Space, and Environmental Medicine* 81:774-8.
4. Delahaye RP, Auffret R, Metges PJ, Poirier JL, Vettes B. (1982). Backache in helicopter pilots. *Physiopathology and pathology of spinal injuries in aerospace medicine*. Neuilly-sur-Seine, France: NATO Advisory Group for Aerospace Research and Development (AGARD); AGARD-AG-250.
5. Ex3. (2011). *Helicopter Seating System Preliminary Survey Results.*
6. Gaydos SJ. (2012). Low back pain: Considerations for rotary-wing aircrew. *Aviation, Space, and Environmental Medicine* 83:879-89.
7. Kadix Systems.(2010). *Business Case Analysis for the Improved Navy Helicopter Seat System.* Arlington, VA. PRN: N5523609RC01982. RN: N00244-09-T-0499.
8. Phillips AS. (2011). The scope of back pain in Navy helicopter pilots [thesis]. Monterey, CA: Naval Postgraduate School.
9. Sargent, P., & Bachmann, A. (2010). *Back Pain in the Naval Rotary Wing Community.* Retrieved 24 Nov 2014, from Naval Safety Center Aviation: http://safetycenter.navy.mil/.
10. Vallejo P, Lopez J, Rios-Tejada F, Azofra J, Del Valle J, Velasco C, Garcia-Mora L. (1999). Low back pain in helicopter pilots. *NATO Research and Technology Organization (RTO) Human Factors and Medicine Panel Symposium on "Current Aeromedical Issues in Rotary Wing Operations."* Neuilly-sur-Seine, France. NATO RTO; RTO Meeting Proceedings-19.

Appendix A. Survey

Edit this form

Back Pain Demographic Information

* Required

Total Flight Time in H-60s *

- less than 500
- 500-750
- 751-1000
- 1001-1500
- 1501-2000
- more than 2000

H-60 Model currently flying *

- MH-60S
- MH-60R
- SH-60B
- SH-60F
- H-60H
- Other: ______

Position in aircraft *

- Pilot
- Aircrew

Age *

- younger than 20
- 20-25
- 26-30
- 31-35
- 36-40
- 41-45

◯ 46-50
◯ 50-55
◯ older than 55

Height *

Weight *

Gender *

◯ Male
◯ Female

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Edit this form

Back Pain Demographic Information

* Required

Back Pain Survey

*Have you experienced back pain since you started flying/flying in the Seahawk? **

Please provide a detailed description of the physical location of the back pain, duration, and intensity.

On a scale of 1 to 10, how bad is your current back pain (1 being no pain and 10 being debilitating pain):

1 2 3 4 5 6 7 8 9 10

On a scale of 1 to 10, what is the level of back pain at it's worst (1 being no pain and 10 being debilitating pain):

1 2 3 4 5 6 7 8 9 10

How does back pain affect your work life? Personal life?

What is the current cause of your back pain, temporary or permanent? (Ex: Seat, aircraft vibrations, etc.)

What are some solutions to prevent pain? (Ex: new seats, back cushion, etc.)

Are you currently or have you ever been down due to back pain/injury from flying? Please provide approximate dates of downing period and type of injury (Ex: bulging disk, herniated disk, back strain etc.)

Are you currently being treated by your Healthcare provider *for back pain?*

Have you ever done Physical Therapy or Chiropractic care to relieve back pain? If so was it helpful?

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