USAARL Report No. 2013-20

Spinal Pain and Occupational Disability: A Cohort Study of British Apache AH Mk 1 Pilots

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September 2013

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Human subjects participated in this study after giving free and informed voluntary consent. The study protocol was approved by the Research Ethics Committees of USAARL and the United Kingdom MoD.

REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)*: 30-09-2013

2. REPORT TYPE: Final

3. DATES COVERED *(From - To)*:

4. TITLE AND SUBTITLE

Spinal Pain and Occupational Disability: A Cohort Study of British Apache AH Mk1 Pilots

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

6. AUTHOR(S)

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Army Aeromedical Research Laboratory
P.O. Box 620577
Fort Rucker, AL 36362

8. PERFORMING ORGANIZATION REPORT NUMBER

USAARL 2013-20

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Medical Research and Material Command
504 Scott Street
Fort Detrick, MD 21702

10. SPONSOR/MONITOR'S ACRONYM(S)

USAMRMC

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release, distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Spinal pain (principally cervical and lumbar) has been identified for many years as an exceedingly pervasive problem among the rotary-wing community. A ten-year collaborative longitudinal occupational health survey was undertaken to study British Army helicopter pilots. This coincided with the newly-released to service U.K. Apache Mk 1 attack helicopter. Two cohorts, Apache pilots (AP, n=63) and non-Apache pilots (NAP, n=135), were followed longitudinally by interval questionnaires regarding spinal pain characteristics and associated occupational disability. Despite a newer generation aircraft and lighter helmet for the Apache, there were no appreciable differences of notable consequence identified between the two cohorts. The study was subject to a number of limitations, most notably poor response numbers in later iterations of follow-up. Nonetheless, the data illustrate that neck and back pain remain prominent maladies among these cohorts with notable percentages of both groups reporting flight-related pain and associated disability and flying restriction.

15. SUBJECT TERMS

Apache, helicopter, rotary wing, back pain, neck pain longitudinal study

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON / 19b. TELEPHONE NUMBER *(Include area code)*
UNCLAS	UNCLAS	UNCLAS	SAR	111	Loraine St. Onge, PhD / 334-255-6906

Reset

Acknowledgements

This work is supported by the United States Army Aeromedical Research Laboratory (USAARL), Fort Rucker, Alabama; the Ministry of Defence, British Army Air Corps, United Kingdom; and the Drummond Trust Foundation.

The extended timeframe of study has necessitated a large effort by a great number of individuals. The role and contributions of major individuals are as follows (in alphabetical order) reflecting the title(s) and assignments as contributors to the study:

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PFC Alyssa J. Hathaway, Melinda Vasbinder, and Jill Parker, Research Technicians, USAARL; performed extensive data entry and de-identification and management of subject data (2009-2013).

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Introduction

Approximately 10 years ago, a collaborative longitudinal occupational health study was undertaken by the Headquarters, Army Air Corps (AAC), United Kingdom, and the U.S. Army Aeromedical Research Laboratory (USAARL) to study British Apache helicopter pilots (Hiatt et al., 2002). This research was conducted under the auspices of The Technical Cooperation Program (TTCP), Subgroup U, Technical Panel 7 (Human Factors in the Aviation Environment) (TTCP, 2011; Rash et al., 2009) with support from the Drummond Trust Foundation. This research endeavour provided a unique opportunity to study a cohort of Apache rotary wing (RW) pilots *ab initio*, as the Apache Mk 1 (figure 1) (Defence Image Database) was newly released into service with the AAC. The British Mk 1 Apache (formerly identified as WAH-64) is produced by Westland Helicopters Ltd. under license from Boeing and is very similar to the U.S. Army AH-64D Apache (Agusta Westland, 2011). The principal differences for the Mk 1 include the use of the Rolls Royce RTM 322 engine and the Helicopter Integrated Defensive Aid Suite protection system (MoD Factsheet, 2012).

Figure 1. AH Mk 1 helicopter.

The AH Mk 1 Apache is a twin-engine, four-bladed, multi-role attack helicopter. The weapons suite includes 30 mm automatic cannon, 70 mm aerial rockets, and the Hellfire Modular Missile System (MoD Factsheet, 2012). It is crewed by two tandem-seated pilots including a rear seat pilot and a front seat co-pilot/gunner. The helicopter may be flown from either crew station although the co-pilot/gunner usually operates the weapons systems (figures 2 and 3) (Defence Image Database).

Figure 2. AH Mk 1 co-pilot/gunner.

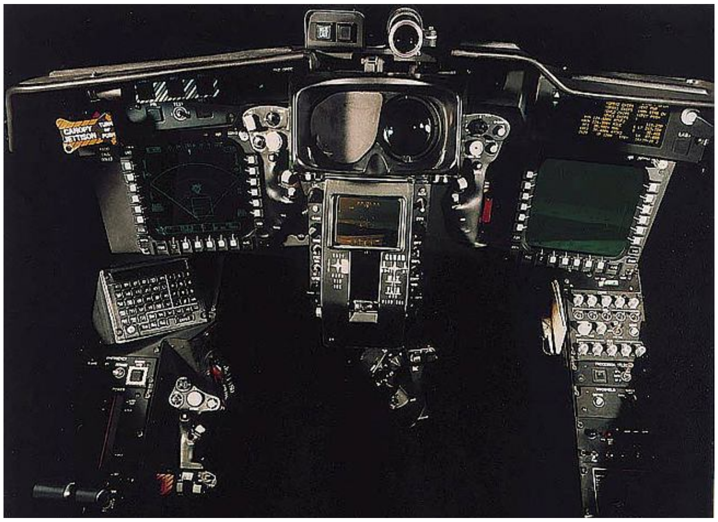


Figure 3. AH Mk 1 cockpit.

The purpose of the study was principally to research potential long-term ocular effects of the Integrated Helmet and Display Sighting System (IHADSS) helmet-mounted display (HMD) on visual performance. There have been interim reviews published regarding this endeavor (Rash et al., 2009; Rash et al., 2004; Hiatt et al., 2002), and final analysis is still underway at the time of this writing. In addition to this focus however, the opportunity was engaged to collect longitudinal survey data on aircrew health including neck pain and low back pain among pilots.

Spinal pain, principally cervical and lumbar, has been identified for many years as an exceedingly pervasive problem among helicopter pilots. Characteristics, prevalence, contributing and confounding factors, as well as the associated untoward effects on aircrew have varied in the literature among populations and airframes under study. The relatively newer generation seat, cockpit design, and lighter helmet of the Apache were anticipated to provide improved comfort over previous legacy generation aircraft (Hiatt et al., 2002).

Background

Rotary-wing low back pain

Episodes of low back pain are exceptionally common among the general adult population consistently ranking very high (if not first) as a reason to seek medical care, inability to work, and a major factor in poor quality of life (Hoaglund, 2007; Speed, 2004; Ehrlich, 2003). By one report, more than one-third (37 percent) of low back pain is attributed to occupational exposures with 818,000 disability-adjusted life years lost per annum (Punnett et al., 2005). Pope, Wilder, and Magnusson (1999) deemed the problem the “albatross of industry and the nemesis of medicine.” A large number of occupations have been associated with a high prevalence of low back pain, including helicopter aircrew. In fact, Lis, Black, Korn, and Nordin (2007) noted that among all occupations under review in 25 studies, the strongest association with back pain was found among helicopter pilots (odds ratio [OR]=9.0).

Low back pain among helicopter aircrew has been described in the scientific literature for more than 50 years (Bowden, 1987). It is common and multi-national with prevalence ranging from 50 to 92 percent (Pelham, White, Holt, and Lee, 2005; Hansen and Wagstaff, 2001; Thomae, Porteous, Brock, Allen, and Heller, 1998). There has been considerable literature published on the topic, but two factors have emerged prominently among etiologic factors: maladaptive piloting posture and whole body vibration (WBV). A number of authors have described the pathophysical seated posture common to helicopter pilots: kyphotic flexion of thoracic and lumbar spine segments, restricted pelvic rotation, extension of cervical spine, and forward-shifted center of mass (CM) (Gaydos, 2012; Salmon, Harrison, and Neary, 2011; Pelham et al., 2005). Discounting effects of autopilots and related flight control systems, RW pilots must simultaneously engage three separate aerodynamic controls: cyclic, collective, and anti-torque pedals. Pilots often adopt a posture whereby the right forearm is stabilized on the right thigh for cyclic control, while the left shoulder and forearm remain isometrically flexed for collective control. This is accompanied by a slight leftward rotation (right shoulder forward), left lateral bend, and unsupported sitting (loss of "feet flat on the floor" support in order to control pedals). This sustained, pathophysical position has been implicated as a major etiology in RW back pain. Multiple mechanisms have been postulated including muscular fatigue (both stabilizers and prime movers), chronic loading, compromised architecture (including intervertebral disk, ligaments, and vertebral structures), and others.

With regard to occupational exposure to WBV, back pain is reported to be the most common health issue (Kasin, Mansfield, and Wagstaff, 2011; Smith, Goodman, and Grosveld, 2008). This association with back pain and lumbar spine disorders has been recognized for more than 50 years (Hill, Desmoulin, and Hunter, 2009; De Oliveira, Simpson, and Nadal, 2001), and numerous at-risk occupations have been identified. Postulated mechanisms may include muscular fatigue, tissue micro-trauma, metabolic compromise and microvascular damage, pain neuropeptide alteration, chronic degenerative changes, and others. In general, critical review of epidemiologic studies implicating WBV and occupational back pain demonstrate a positive association, but a clear dose-response relationship is weak (Lings and Leboeuf-Yde, 2000; Bovenzi and Hulshof, 1999; International Standard Organisation, 1997). In helicopters, both mechanical and aerodynamic factors contribute to vibration, and levels may vary by aircraft and mode of flight (Kasin et al., 2011; Bongers, Hulshof, Dukstra, and Boshuizen, 1990; Delahaye, Auffret, Metges, Poirier, and Vettes, 1982). Vibration is transmitted (and may be amplified) to aircrew via contact with the seat, floor, and controls (Kasin et al., 2011; Vallejo et al., 1999). Recently, Kasin et al. (2011) provided a risk assessment measuring WBV for a number of civilian and military helicopters in different modes of flight noting that the A(8) calculated daily exposures to range from 0.32 to 0.51 m/s^2. The authors note that based on these findings, the risk to pilots should be low. However, there exists no imprimatur among the scientific community for a lower threshold at which WBV is considered to be without risk, and most argue to reduce levels to the lowest extent possible.

It is probable that one cannot consider posture and WBV as two distinct entities when assessing etiologic contributions to back pain. Seated principal resonance frequencies and associated shear deformations change with posture (Kitazaki and Giffin, 1998), and the two may be highly inter-related. Furthermore, there are a great number of other physical and psychosocial factors identified that may be plausibly associated with back pain including age, family history,

history of previous back injury, smoking, physical fitness, obesity, anxiety and depression, stress, workload, work dissatisfaction, compensation systems, and many non-occupational activities (Pope et al., 2002; Dempsey, Burdolf, and Webster, 1997; National Institute for Occupational Safety and Health [NIOSH], 1997). All combined, this makes a clear causative relationship very difficult to establish. Yet, despite the etiologic complexity, the deleterious effects of back pain on flying are clear: reduced operational effectiveness and lost duty time, occupational attrition, curtailed or cancelled missions, and performance deficits during flight. A thorough treatment of this subject is beyond the scope of this background; Gaydos (2012) provides a review of the topic including prevalence, mechanisms, potential contributing factors, and countermeasures.

Rotary-wing neck pain

Neck pain remains a significant malady in the general population (Grooten et al., 2004; Croft et al., 2001; Leclerc et al., 1999). Research implicates a multifactorial etiology in many cases including individual biologic mechanisms and external factors such as injury, loading, repetitive motions, psychosocial factors, and many others. Pathology may include muscular fatigue/strain, degenerative changes in muscles, vertebrae or disks, nerve impingement, ligamentous injury, and others (Salmon et al., 2011). Like back pain, RW flight has also been associated with cervical spine pain with varying degrees of personal suffering, untoward effects on flight performance and operational readiness, and disability. However, when compared to that of low back pain, the evidence supporting association between cervical spine pain and RW flight is relatively more exiguous (Harrison, Neary, Albert, and Croll, 2011; Hermes, Webb, and Wells, 2010; Ang and Harms-Ringdahl, 2006; Ang, Linder, and Harms-Ringdahl, 2005). In fact, only relatively recently has the issue of cervical pain been raised as a major aeromedical problem in the helicopter community (Salmon, et al., 2011; Harrison et al., 2007a; Ang and Harms-Ringdahl, 2006). Salmon et al. (2011) comment that “Only recently has the issue of neck pain in helicopter aircrew become an aeromedical concern with the potential for major health implications.” There is more scientific literature regarding cervical pain among the fast-jet community, particularly with high G loads in aerial combat maneuvers (cf. Ang et al., 2005; Hamalainen, 1993; Hamalainen, Vanharanta, and Bloigu, 1993). Laboratory, simulator, and in-flight studies have included such metrics as survey-based methodology, database mining (flight waivers, incident clinical encounters, etc.), radiographic (and other) medical imaging (Aydog et al., 2004), biomechanical modeling, electromyography, near-infrared spectroscopy (NIRS), isometric force capacity, and others (cf. Harrison et al., 2011; Hermes et al., 2010; Harrison et al., 2007; Ang and Harms-Ringdahl 2006; Ang et al., 2005; Aydog et al., 2004; Thuresson, Ang, Linder, and Harms-Ringdahl, 2003).

Recent reports cite prevalence of neck pain among the RW community to range from 48 to 57 percent (Ang et al., 2006; Wickes and Greeves, 2005; Bridger, Groom, Jones, Pethybridge, and Pullinger, 2002), though differences in methods, cohorts under study, airframes, missions/roles, and other factors make direct comparisons difficult. Experimental studies have demonstrated neuromuscular impairment in RW aircrew with neck pain (Ang et al., 2005), and RW pilots have been shown to have a higher prevalence of cervical spine changes by radiographs (especially osteoarthritis) compared to other pilot communities (Aydog et al., 2004). Like that of back pain, neck pain has also been associated with significant disability. For example, Ang et al. (2006)

noted that more than half of their RW cohort under study reported that their pain interfered with flying and non-flying activities, (58 and 55 percent, respectively).

In addition to contributing factors of RW posture, cockpit ergonomics, and WBV (discussed previously), cervical pain has also been associated with the issue of head-supported mass (HSM). Helmet weight alone has been shown to have a large effect on muscular workload (Sovelius, Oksa, Rintala, Huhtala, and Siitonen, 2008). The pilot helmet fielded with the Apache helicopter (for all nations) is the IHADSS (figure 4) (Rash, et al., 2003) weighing approximately 1700 g (not including the unilateral HMD. As a comparison, the standard RW helmet for the United Kingdom, the Mk 4B4L, is heavier weighing approximately 2000 g. A Mk 4B4L helmet with standard Nite-Op night vision goggles (NVGs) weighs more than 2700 g, and this does not include the helmet-mounted rear counterweight (ranging from 300 to 600 g depending on pilot preference) (personal communication, Royal Air Force Survival Equipment Section, Army Aviation Centre Middle Wallop, 2012).

Figure 4. AH IHADSS helmet with HMD over right eye.

Further to the weight of the helmet, any helmet-borne equipment askew from the CM of the head will cause additional stress and increased workload on supporting musculoskeletal structures (Sovelius et al., 2008; Phillips and Petrofsky, 1983). For example, forward-mounted NVGs increase the mechanical load on the neck and alter the CM upward and forward in relation to the axes of motion for the cervical spine (Salmon et al., 2011; Thuresson et al., 2003). Furthermore, due to the limited field of view provided by NVGs (40 degrees circular depending on specific type), aviators must increase head movement (multi-axis) for their visual scan patterns as compensation. Forde et al. (2011), for example, demonstrated that pilots spend significantly more time in high-risk cervical postures (notably flexion and axial rotation) during NVG flights. In fact, Thuresson et al. (2003) found that cervical position itself may be more of a factor on increased muscular activity about the cervical spine than the load of the helmet and helmet-borne equipment. HSM, shifted CM, and enhanced head movements all increase workload and potentially contribute to pain, fatigue, and musculoskeletal compromise (cf. Salmon et al., 2011; Sovelius et al., 2008; Thuresson et al., 2003; Ashrafiuon, Alem, and McEntire, 1997).

Pain, degenerative changes, and other cervical spine syndromes can be attributed to occupational exposure, but also to natural processes and many other non-occupational activities and risk factors. With respect to the RW community, one study (Ang and Harms-Ringdahl, 2006) implicated a previous history of neck pain [Relative Risk (RR) =1.8] and recent shoulder pain (RR=1.6) to be significant risk factors (use of NVGs showed non-significant but considerable trend). Other studies have implicated total flight hours, posture, and total number of NVG hours (Wickes and Greeves, 2005), as well as height and longest single NVG flight (Harrison, Neary, Albert, and Croll 2012; Harrison, 2009). However, a recent multivariate analysis of a large cross-sectional study among military pilots (Hermes et al., 2010) demonstrated age, not aircraft type or flight hours, to have a statistically significant association (OR=2.96 for RW). Clearly, the issue is complex with multiple contributing factors and potential confounders. However, it is with relative ease that one can appreciate that neck pain and cervical spine syndromes among RW aircrew may adversely affect flight performance and contribute to reduced operational capability and disability. A thorough treatment of this subject is beyond the scope of this background. For more comprehensive review of the subject, Salmon et al. (2011) provide an excellent review of the topic including prevalence, mechanisms, potential contributing factors, and countermeasures.

Methods

From January 2000 to December 2010, a longitudinal cohort of British RW pilots was prospectively followed with interval reporting. Lifetime and point prevalence data were collected via aviator self-report survey questionnaires. Data included pain characteristics, as well as aggravating and alleviating factors, and interventions or medical grounding. The spinal pain portion of the survey consisted of neck pain (defined as "above the shoulder blades") and back pain (defined as "below the shoulder blades") questions. The specific survey format and questions can be found in the appendices of USAARL Report No. 2002-04 (Hiatt et al., 2002). The study protocol was approved by the Research Ethics Committees of USAARL and Ministry of Defence (MoD).

Two cohorts of RW pilots were studied: a cohort of Apache pilots (AP; exposed) and a cohort of non-Apache pilots (NAP; controls). AP and NAP were recruited on an open basis from the Army Aviation Centre at Middle Wallop, Hampshire, United Kingdom. AP were largely recruited from initial airframe conversion training classes for the AH Mk 1, while NAP were recruited from various other airframes of the Army Air Corps. Subjects were then followed longitudinally throughout their service in the Army Air Corps with the intention of completing questionnaires annually (or near as possible, as posting at other locations and deployments precluded annual returns in many cases). As the purpose of the study was to investigate potential long-term ocular effects of the AH IHADSS/HMD on visual performance, power calculation was based on paired t-test for visual refractive error between right/left eyes (power 0.8; minimum detectable change 0.5 diopter; expected standard deviation diopter change 1.5 dioptres) (Hiatt et al., 2002). Self-report subjective spinal pain questionnaire data was considered supernumerary. More information and specific questionnaire format can be found in the USAARL Report No. 2002-04, the initial study report.

Participant enrollment was conducted on a rolling basis throughout the study period. Analysis was performed by initial and follow-up sessions to assess longitudinal changes, with session 1 corresponding to initial entry into study (which could be any calendar year), session 2 represented the time of completion of the second questionnaire and then subsequently by third, fourth, etc., sessions at longitudinal follow-ups. Hard-copy questionnaires were divested of identifiable subject information and entered into a separately maintained study database. Statistical analysis was performed using SPSS® (ver 15.0) and Microsoft Excel® (ver 2007).

Quality control and statistical analysis plan

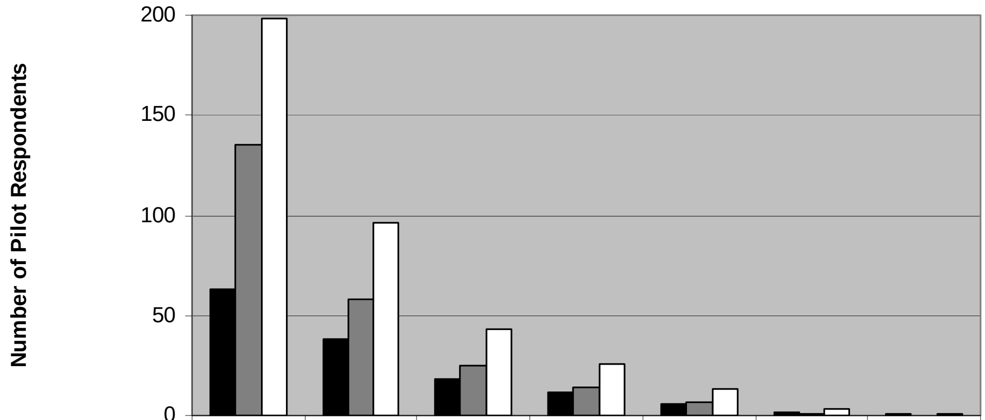
Data were recorded using paper and pencil surveys. Responses were then entered into a database using Microsoft Excel® 2007. Accuracy of data entry was checked using a 10 percent sample. Traditional hypothesis testing and inferential statistics were not appropriate for use with this dataset due to nominal and ordinal data for a majority of the survey questions. Also, the unequal sample sizes between Apache and non-Apache groups (e.g., at session 1, there are more than twice as many non-Apache pilots as Apache pilots) and poor retention of respondents over time promoted the use of non-parametrics. Given that no provisions were made to determine whether the attrition rate was due to chance or followed a systematic pattern, attrition bias also posed a challenge to the internal validity of the data and suggested the use of non-parametrics. Thus, descriptives (mean, median, and standard deviation [SD] where appropriate) were calculated and Mann Whitney-U tests were conducted to investigate differences between groups.

Results

Pilot respondents and demographics

For the spinal pain portion of the questionnaire, a total of 198 subjects were enrolled (192 male, 6 female; 63 AP [exposed] and 135 NAP [unexposed]). The first subject was enrolled in November 2000 and the last in July 2006. A total of 380 questionnaires were returned for the study period (140 AP, 240 NAP).

Number of responses and mean number of months enrolled at each follow-up session for AP and NAP are depicted in figures 5 and 6.



	1	2	3	4	5	6	7
Apache	63	38	18	12	6	2	1
Non-Apache	135	58	25	14	7	1	
Total	198	96	43	26	13	3	1

Session No.

Figure 5. Number of pilot respondents by follow-up session.

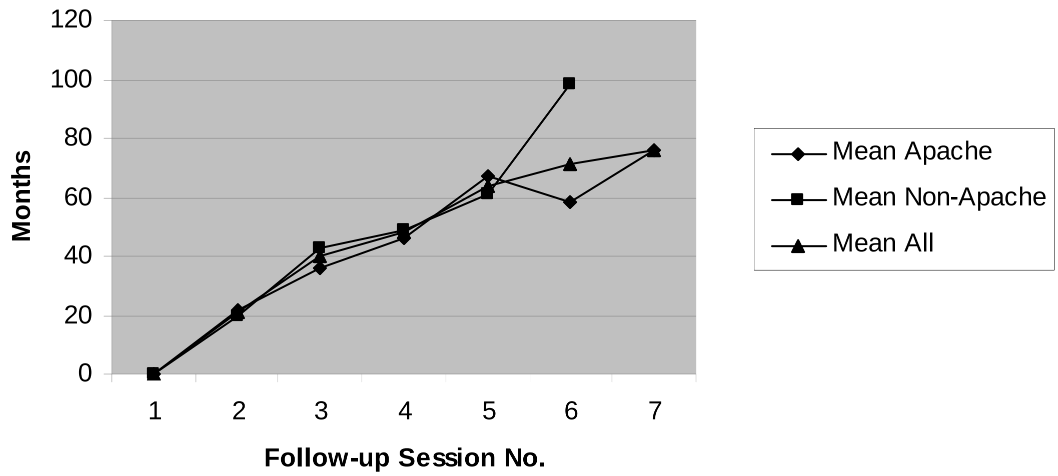
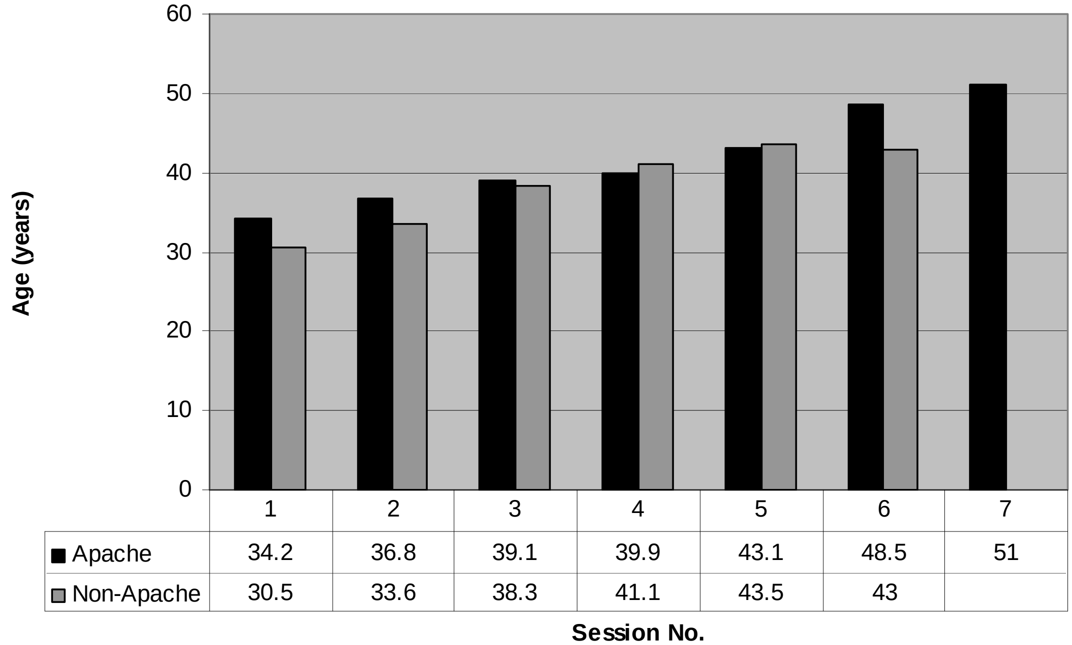


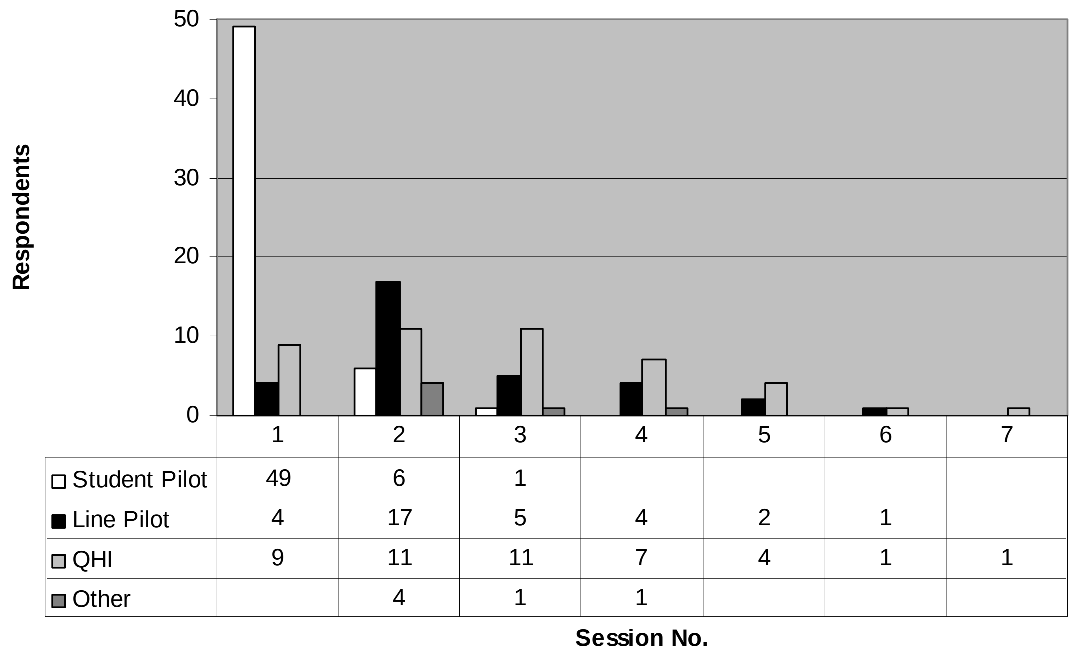
Figure 6. Mean number of months subjects enrolled at follow-up sessions.

Further tabulated data including mean, median, SD, and number of responses per follow-up session are depicted in appendix A. Pilot age and duty description of pilot respondents per session are represented in figures 7-9. Note: Qualified Helicopter Instructor Pilot (QHI).



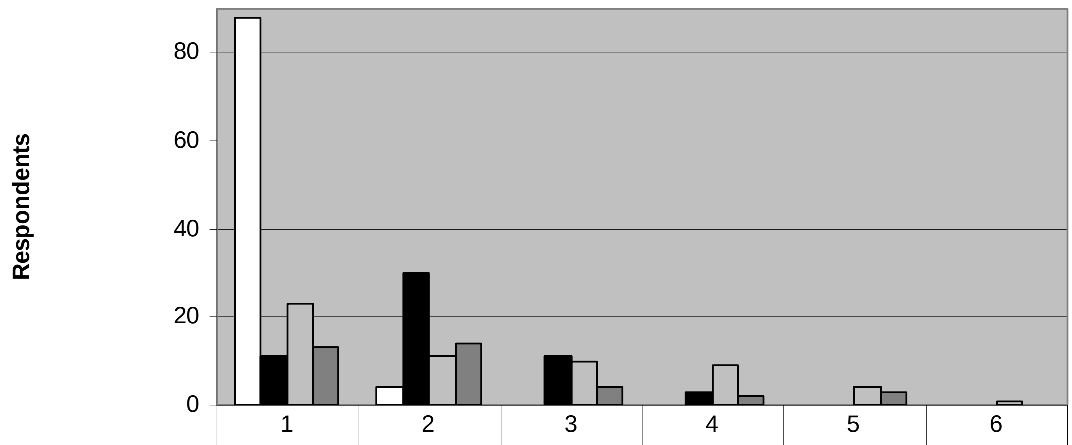
	1	2	3	4	5	6	7
Apache	34.2	36.8	39.1	39.9	43.1	48.5	51
Non-Apache	30.5	33.6	38.3	41.1	43.5	43	

Figure 7. Mean age of pilot respondents at follow-up sessions.



	1	2	3	4	5	6	7
Student Pilot	49	6	1				
Line Pilot	4	17	5	4	2	1	
QHI	9	11	11	7	4	1	1
Other		4	1	1			

Figure 8. AP duty description by session.



Session No.	1	2	3	4	5	6
Student Pilot	88	4				
Line Pilot	11	30	11	3		
QHI	23	11	10	9	4	1
Other	13	14	4	2	3	

Figure 9. NAP duty description by session.

A number of AP reported flying other aircraft at the time of intake (session 1) (some respondents listed more than one aircraft type) and the breakdown was as follows: Squirrel (10), Gazelle (30), Lynx (26), and others (including fixed-wing aircraft, 5). NAP flew a number of differing airframes throughout the study as reflected in table 1.

Table 1.
NAP aircraft flown.

Session	1	2	3	4	5	6
Squirrel	102	8	4	4	0	0
Gazelle	25	18	13	7	6	0
Lynx	22	36	14	7	3	1
Bell 212	3	3	1	1	0	0
Other	8	1	2	1	0	0
Not currently flying[1]	3	3	0	1	0	0

Some respondents reported flying more than one aircraft, while some had null response.
[1]Includes staff officers.

Pilots reported years of cumulative aviation service and flying hours at each session. Years of aviation service, total flying hours, hours within the previous year, and hours within the previous 8 weeks are presented in figures 10-13.

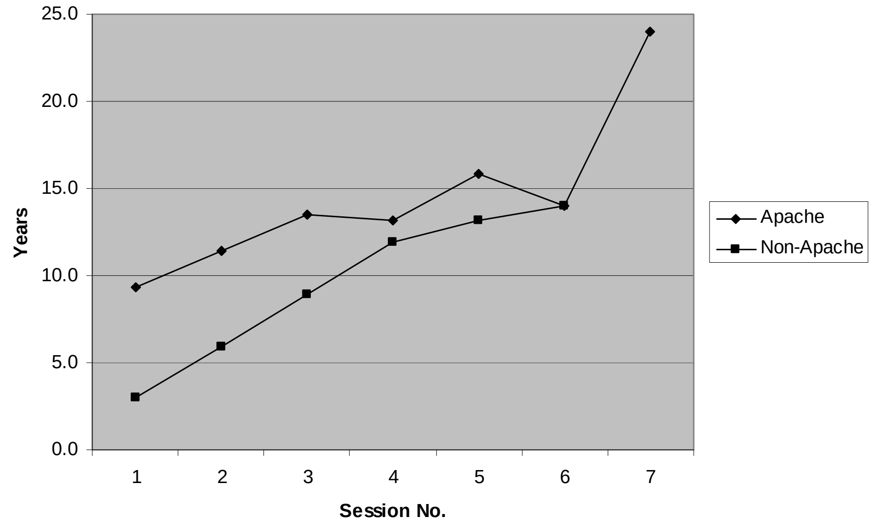


Figure 10. Mean years of cumulative aviation service reported per session.

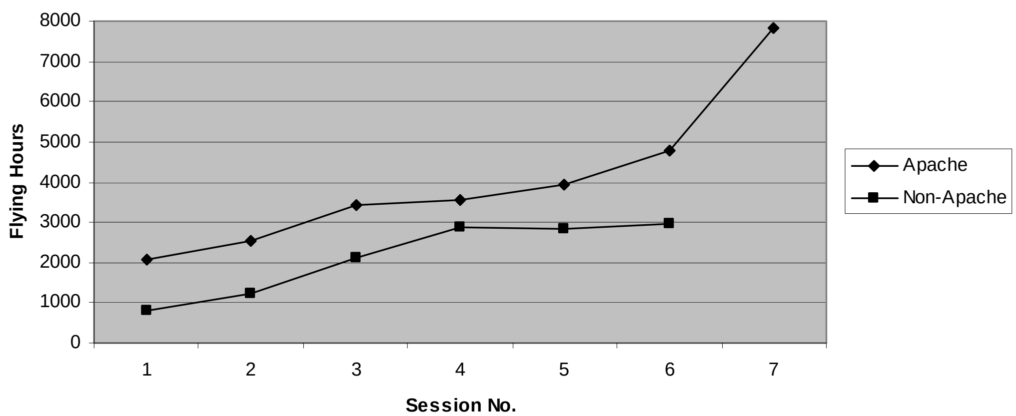


Figure 11. Mean total flying hours reported per session.

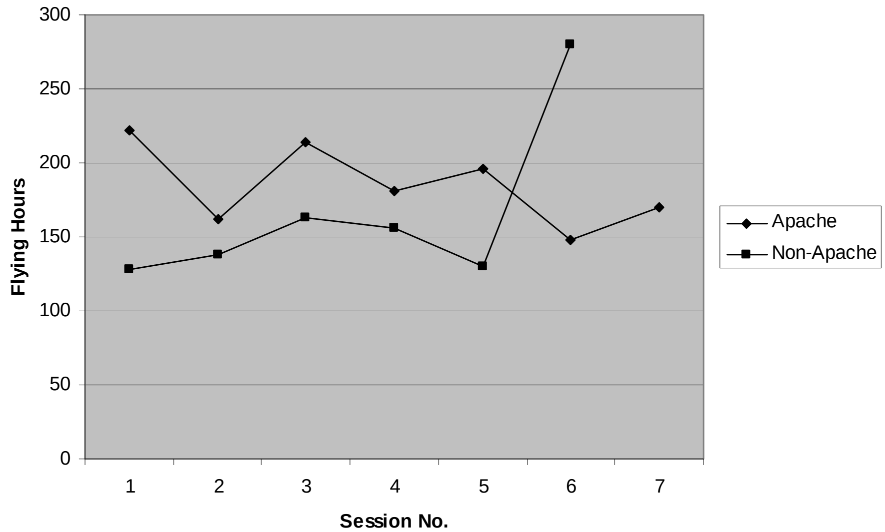


Figure 12. Mean flying hours in previous year reported per session.

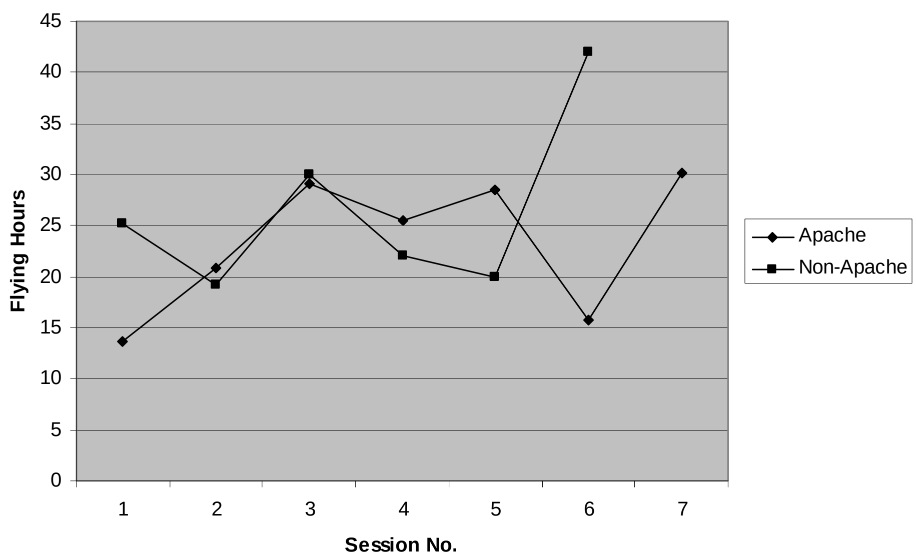


Figure 13. Mean flying hours in previous 8 weeks reported per session.

Further tabulated data for pilot age, duty description, and flight hours of respondents including mean, median, SD, and number of responses per follow-up session are depicted in appendix B.

Neck pain

Specific survey format and questions for neck pain (defined as "above the shoulder blades") can be found in the appendices of USAARL Report No. 2002-04 (Hiatt et al., 2002). Full tabulated data of questionnaire responses per session and subject comments are depicted in appendices C (AP) and D (NAP). Comparison of AP and NAP cohorts for neck pain and associated characteristics at time of intake (session 1) yielded a significant difference only for episodes of neck pain within the previous year (table 2).

Table 2.
Summary of Mann-Whitney U test results for AP and NAP cohorts at study intake.

Question	AP mean rank	NAP mean rank	*Z*	*p*
If you experienced neck pain during flight, how long into the flight were you before the pain began?	26.75	23.75	-0.661	0.508
How many episodes of neck pain during flight have you had in the last year?	31.14	23.91	-1.516	0.129
If you have experienced neck pain after flight, how long into the flight were you before the pain began?	33.87	26.57	-1.586	0.113
How many episodes of neck pain after flight have you had in the last year?	47.97	33.58	-2.784	0.005*
Indicate the severity of neck pain, for the worst episode of pain experience *during flight*	72.17	65.92	-0.901	0.368
Indicate the severity of neck pain, for the worst episode of pain experience *after flight*	63.46	62.74	-0.108	0.914
If you commonly experience neck pain, please indicate an average severity of pain experienced *during flight*	39.91	42.37	0.460	0.646
If you commonly experience neck pain, please indicate an average severity of pain experienced *after flight*	37.12	35.36	-0.356	0.722

*$p < 0.05$

Graphical representation of selected questionnaire responses for both AP and NAP are presented in figures 14-20.

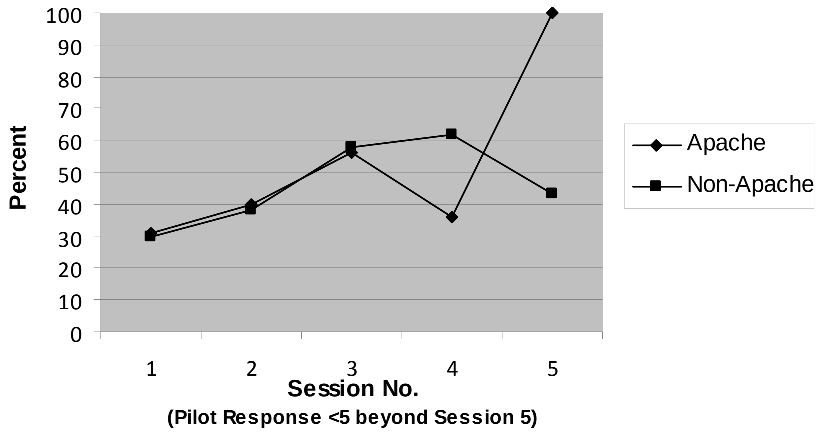


Figure 14. Percent of pilots reporting neck pain during flight.

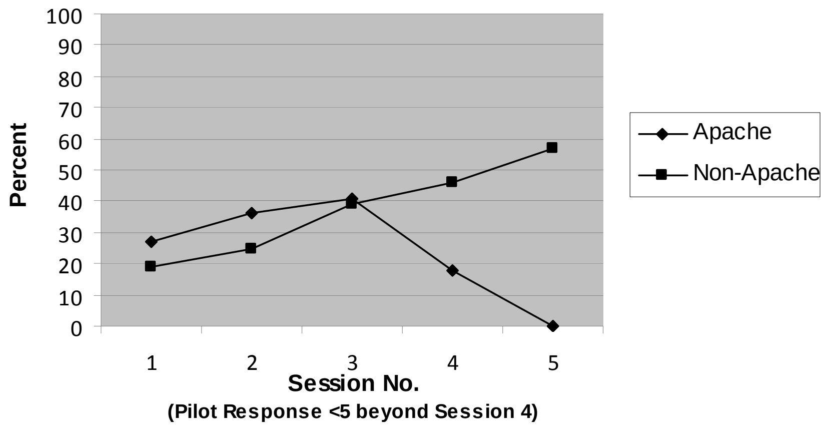


Figure 15. Percent of pilots reporting neck pain after flight.

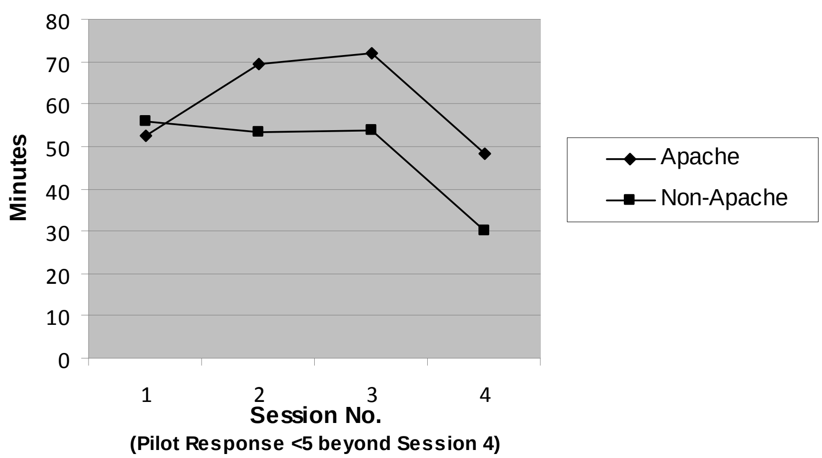


Figure 16. Mean time to onset of neck pain during flight.

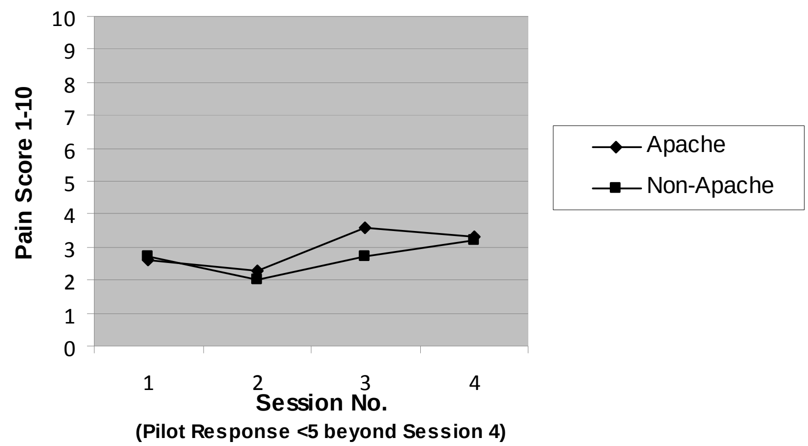


Figure 17. Mean severity of neck pain during flight.

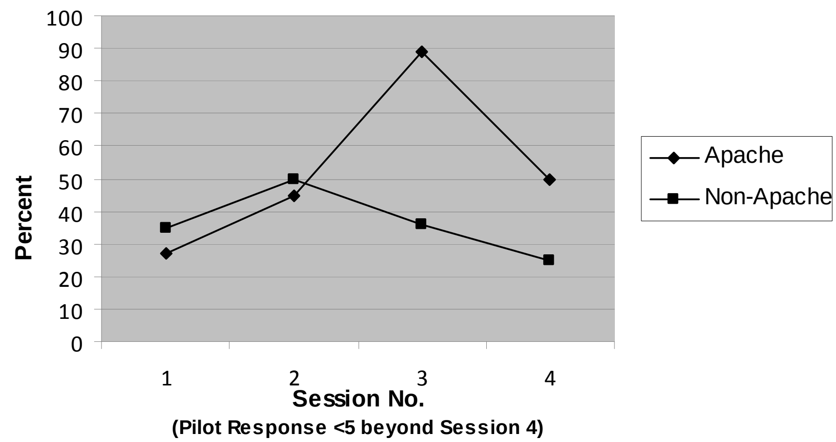


Figure 18. Percent of pilots that took action to minimize/avoid flight-related neck pain.

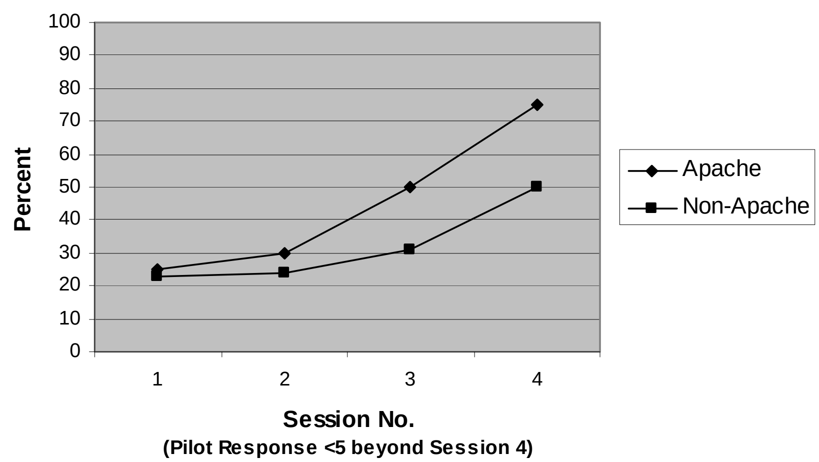


Figure 19. Percent of pilots that sought treatment for flight-related neck pain.

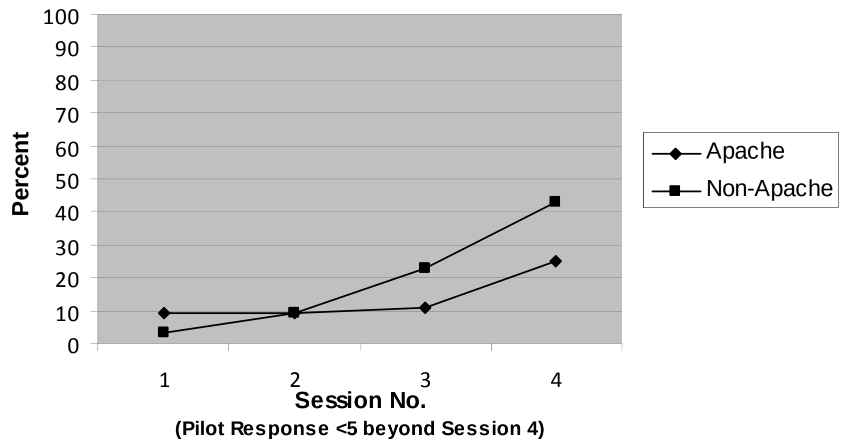


Figure 20. Percent of pilots grounded for flight-related neck pain.

Rates of pilot self-reported neck pain during flight were assessed per 5000 hours total flight time (TFT), per 500 hours flight time (FT) within the previous 12 months, per 25 hours within the previous 8 weeks, and per 5 years of total aviation service (figures 21-24). Summary results are listed in table 3.

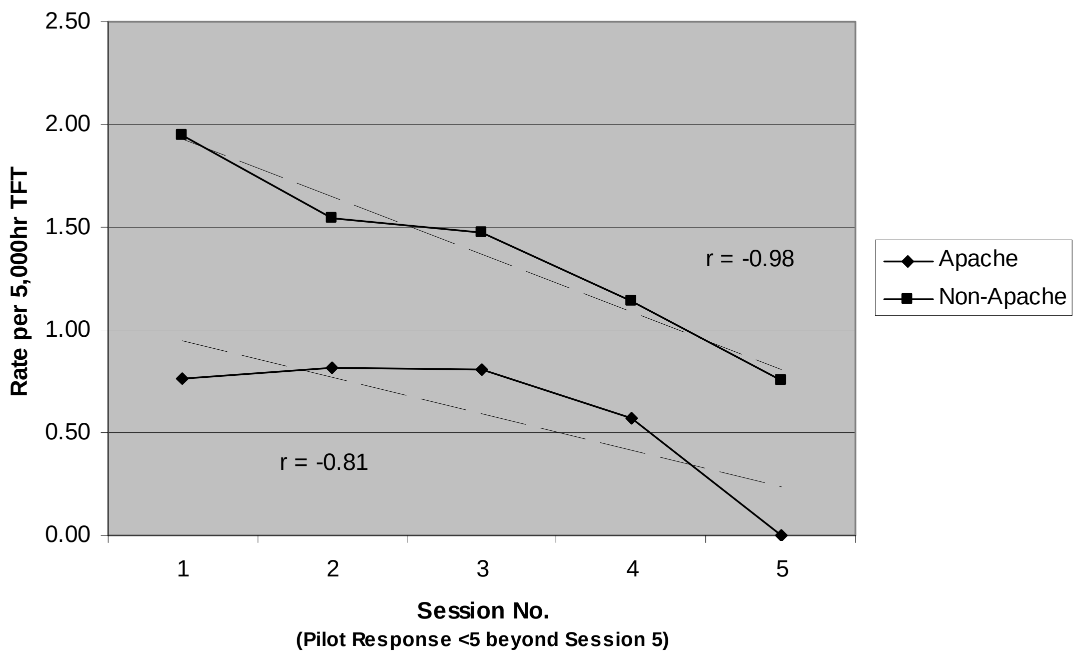


Figure 21. Rate of self-reported neck pain during flight per 5000 hours TFT.

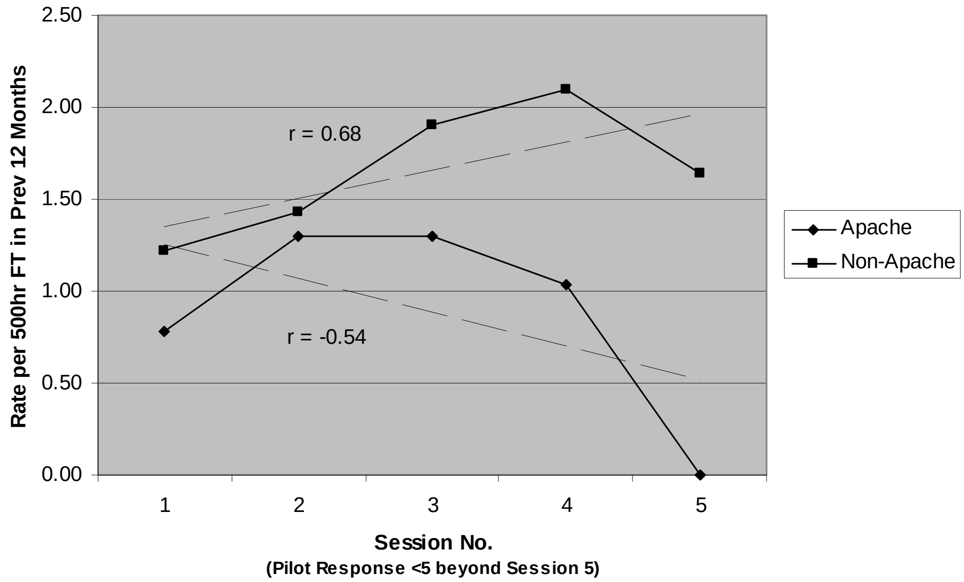


Figure 22. Rate of self-reported neck pain during flight per 500 hours FT in previous 12 months.

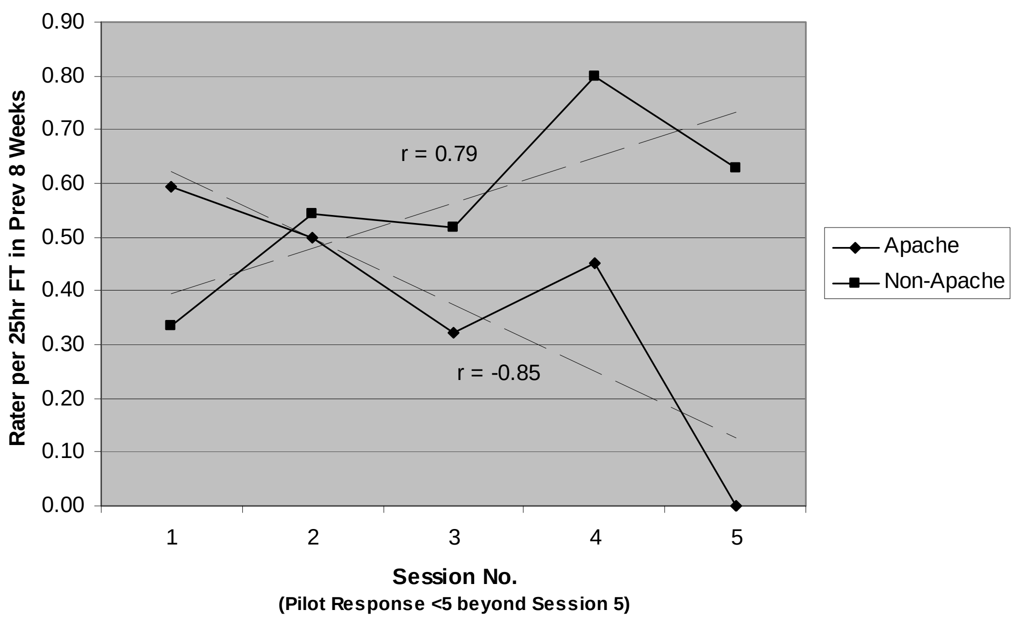


Figure 23. Rate of self-reported neck pain during flight per 25 hours FT in previous 8 weeks.

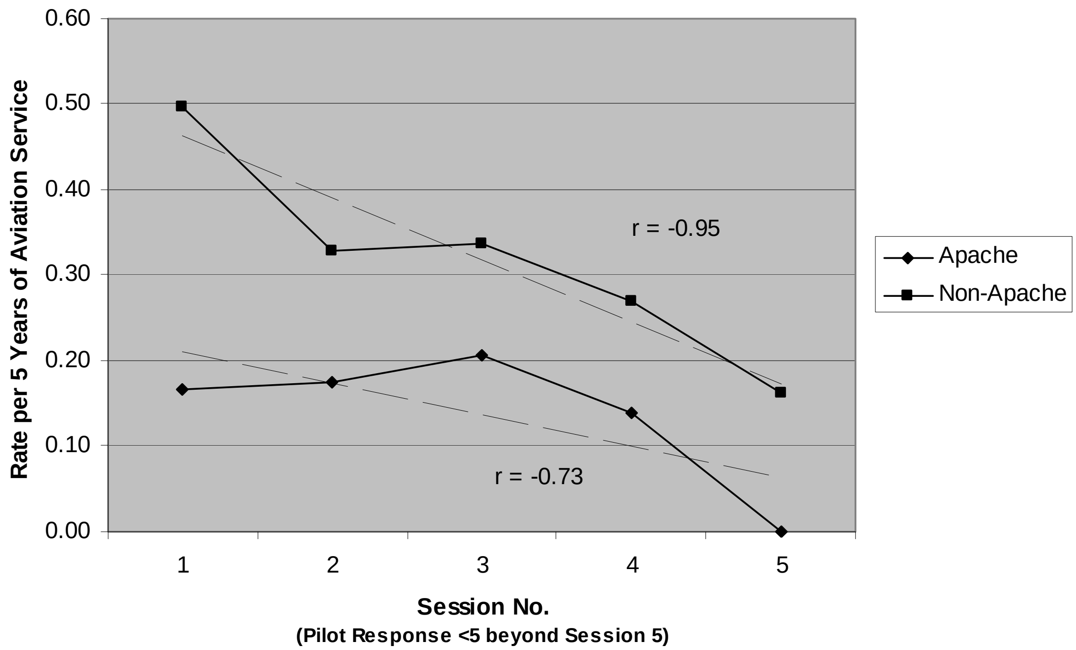


Figure 24. Rate of self-reported neck pain during flight per 5 years of aviation service.

Table 3.
Summary of correlation coefficient test results for rates of neck pain.

Rate	Aircraft	R^2	r	p
per 5000hr total flight time	AP	0.659	-0.81	0.097
	NAP	0.965	-0.98	0.003*
per 500hr flight time within previous 12 months	AP	0.289	-0.54	0.348
	NAP	0.462	0.68	0.207
per 25hr flight time within previous 8 weeks	AP	0.719	-0.85	0.068
	NAP	0.624	0.79	0.112
per 5yr total aviation service	AP	0.534	-0.73	0.161
	NAP	0.896	-0.95	0.013*

*$p < 0.05$

Back pain

Specific survey format and questions for back pain (defined as "below the shoulder blades") can be found in the appendices of USAARL Report No. 2002-04 (Hiatt et al, 2002). Full tabulated data of questionnaire responses per session and subject comments are depicted in appendices C (AP) and D (NAP). Comparison of AP and NAP cohorts for back pain and associated characteristics at time of intake (session 1) yielded a significant difference for *longer time until pain develops* (for those with pain) and *seat comfort* (table 4).

Table 4.
Summary of Mann-Whitney U test results for AP and NAP cohorts at study intake.

Question	AP mean rank	NAP mean rank	*Z*	*p*
If you have experienced back pain during flight how long into the flight were you before the pain began?	54.67	42.35	-1.970	0.049*
How many episodes of back pain during flight have you had in the last year?	39.45	39.52	0.012	0.991
How many episodes of back pain after flight have you had in the last year?	17.88	23.12	1.314	0.189
Indicate severity of back pain for the worst episode of pain experience *during flight*	51.48	54.09	0.377	0.706
Indicate severity of back pain for the worst episode of pain experience *after flight*	49.59	41.28	-1.387	0.165
If you commonly experience back pain, please indicate an average severity of pain experienced *during flight*	30.22	27.09	-0.680	0.497
If you commonly experience back pain, please indicate an average severity of pain experienced *after flight*	30.58	29.01	-0.333	0.739
How would you rate the overall comfort of the seat on a scale of 1 (extremely uncomfortable) to 9 (extremely comfortable)	52.36	74.26	2.339	0.019*

*p < 0.05

Graphical representation of selected questionnaire responses for both AP and NAP are presented in figures 25-31.

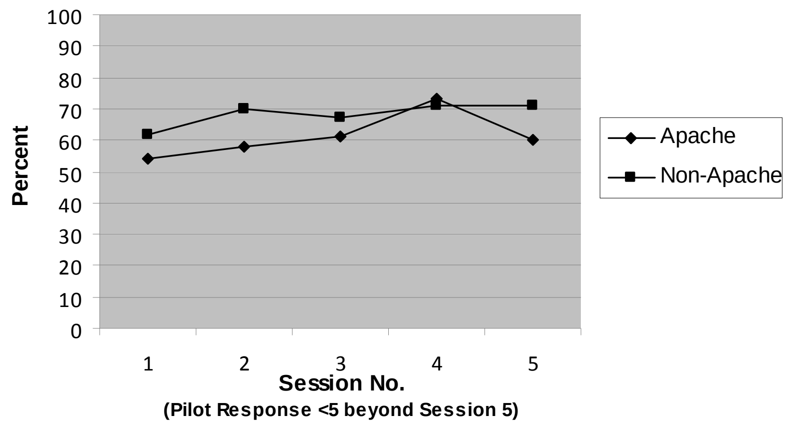


Figure 25. Percent of pilots reporting back pain during flight.

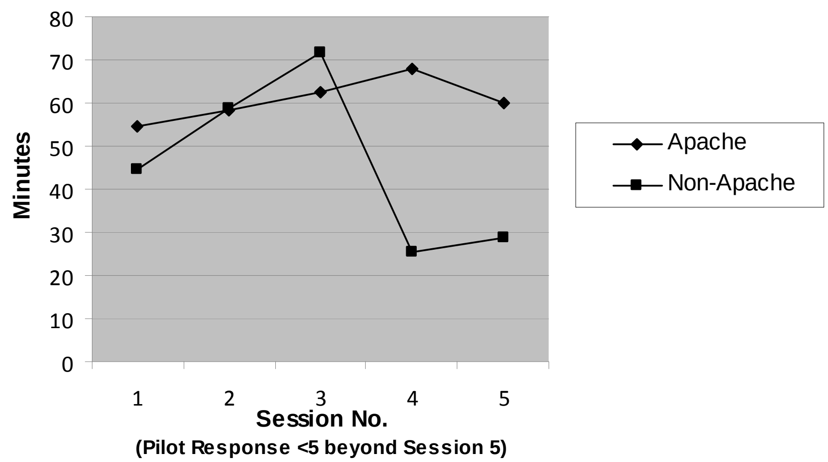


Figure 26. Mean time to onset of back pain during flight.

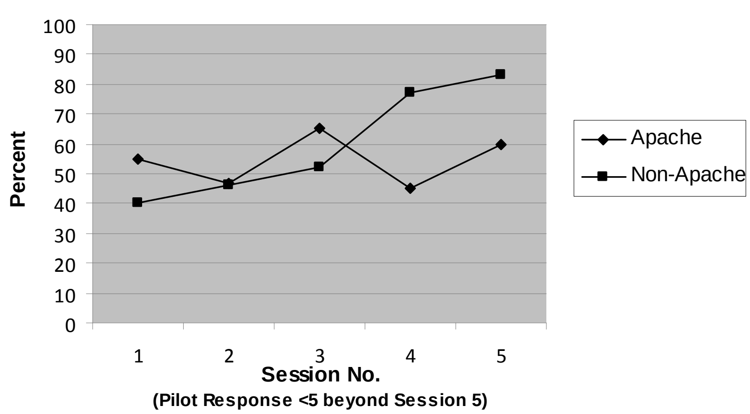


Figure 27. Percent of pilots reporting back pain after flight.

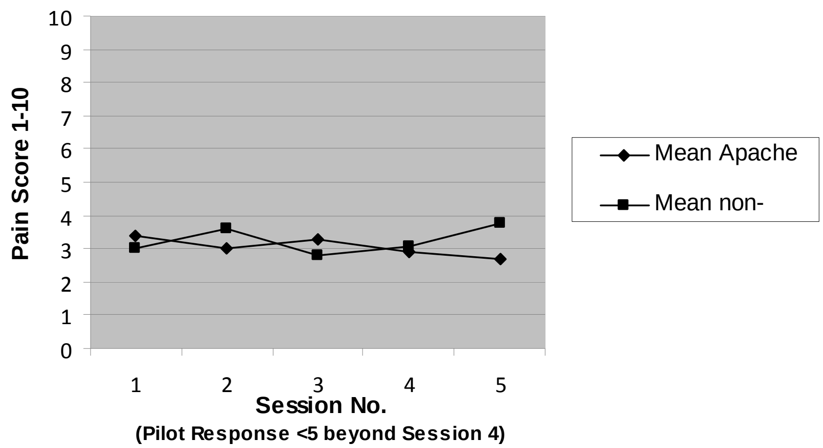


Figure 28. Mean severity of back pain during flight.

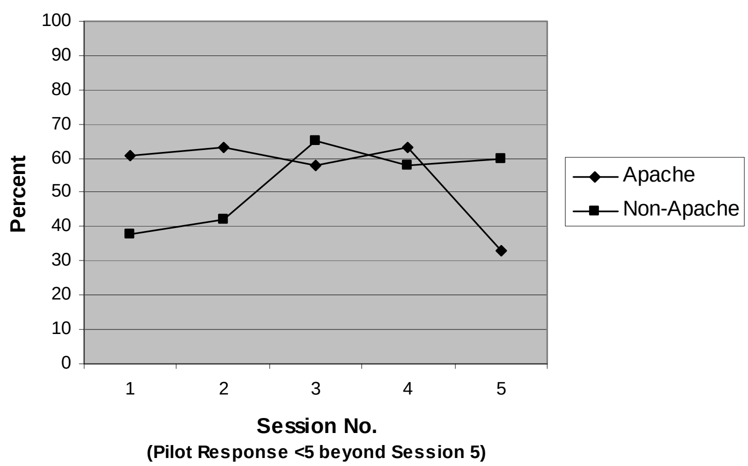


Figure 29. Percent of pilots that sought treatment for flight-related back pain.

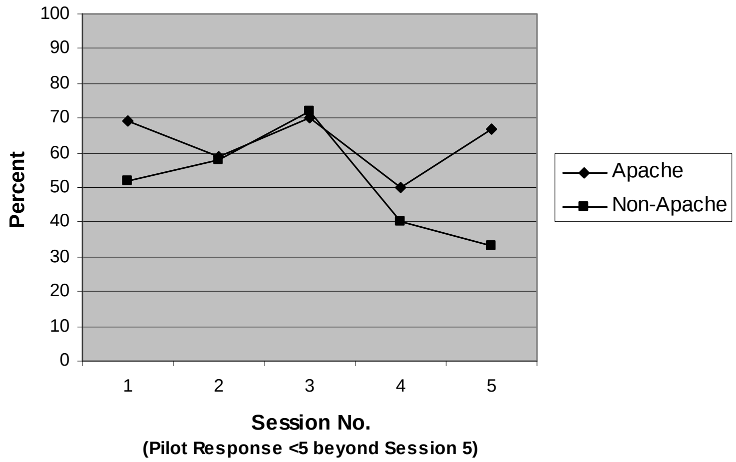


Figure 30. Percent of pilots that that took action to minimize/avoid flight-related back pain.

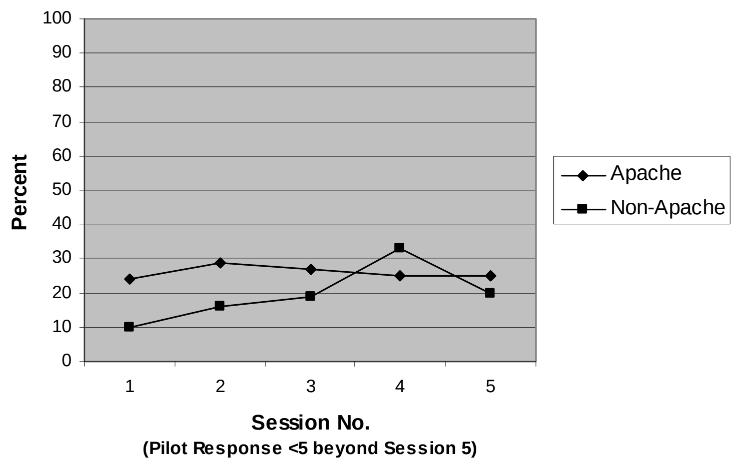


Figure 31. Percent of pilots grounded for flight-related back pain.

Rates of pilot self-reported back pain during flight were assessed per 5000 hours TFT, per 500 hours FT within the previous twelve months, per 25 hours within the previous 8 weeks, and per 5 years of total aviation service (figures 32-35). Summary results are listed in table 5.

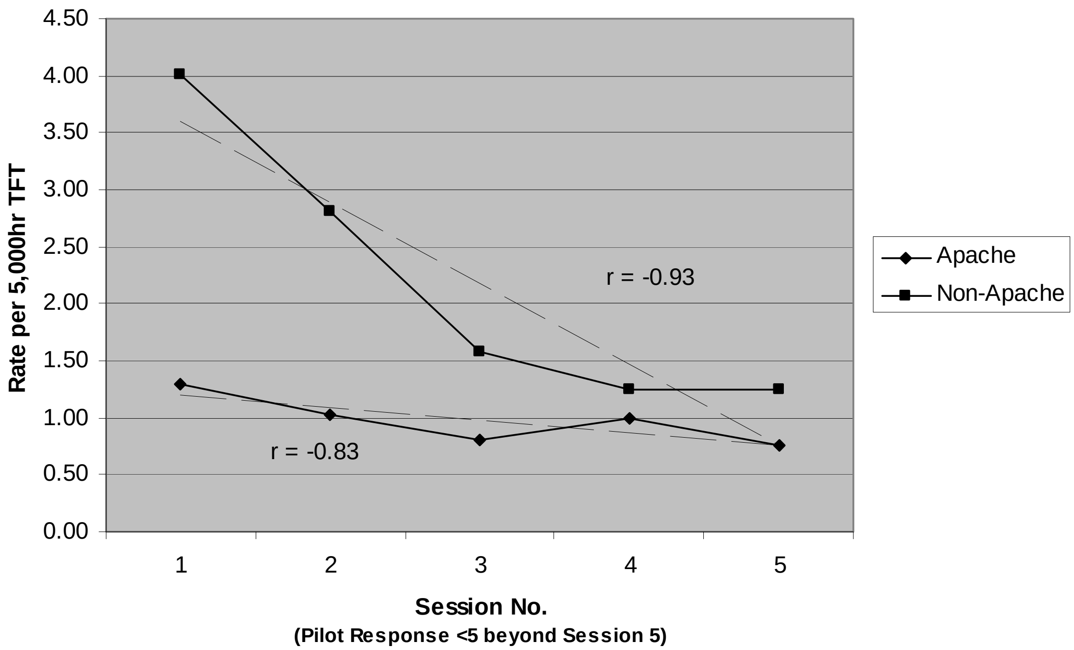


Figure 32. Rate of self-reported back pain during flight per 5000 hours TFT.

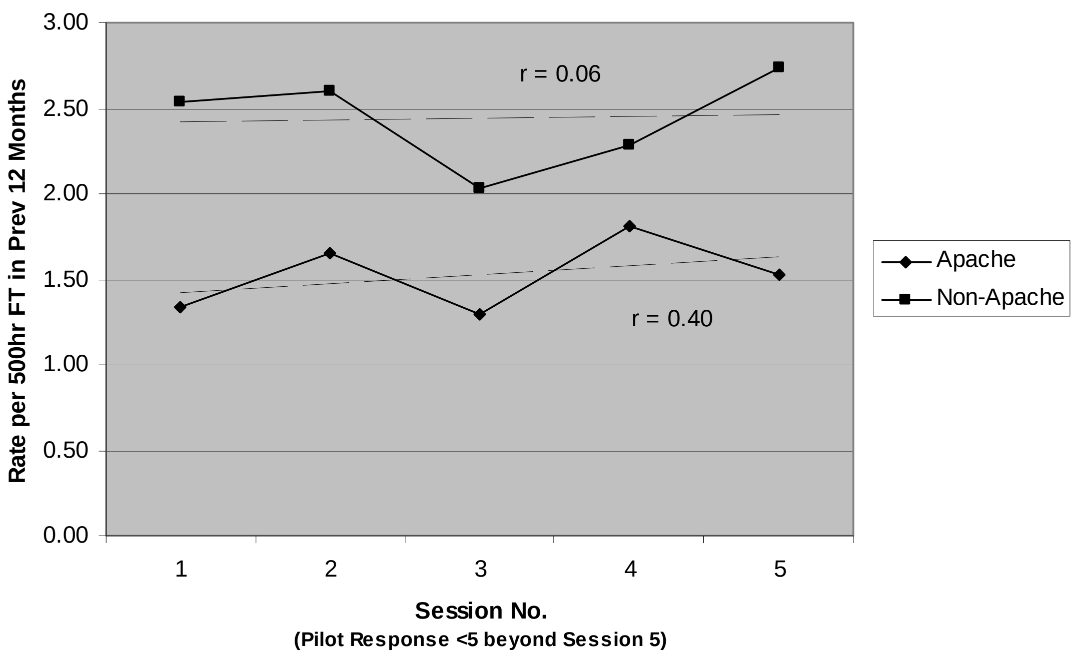


Figure 33. Rate of self-reported back pain during flight per 500 hours FT in previous 12 months.

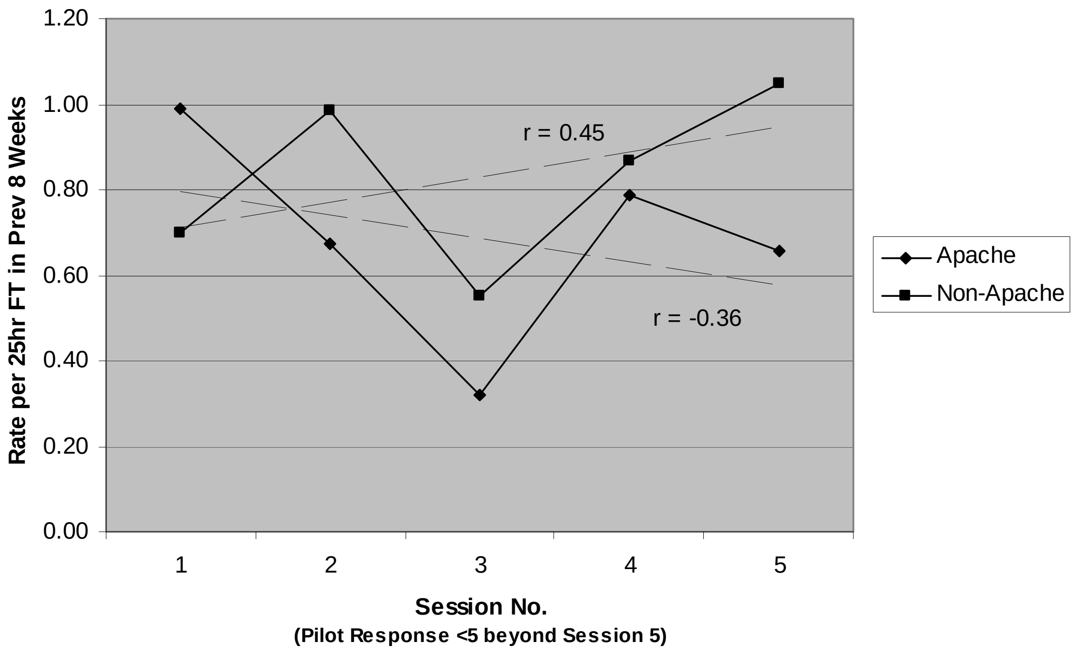


Figure 34. Rate of self-reported back pain during flight per 25 hours FT in previous 8 weeks.

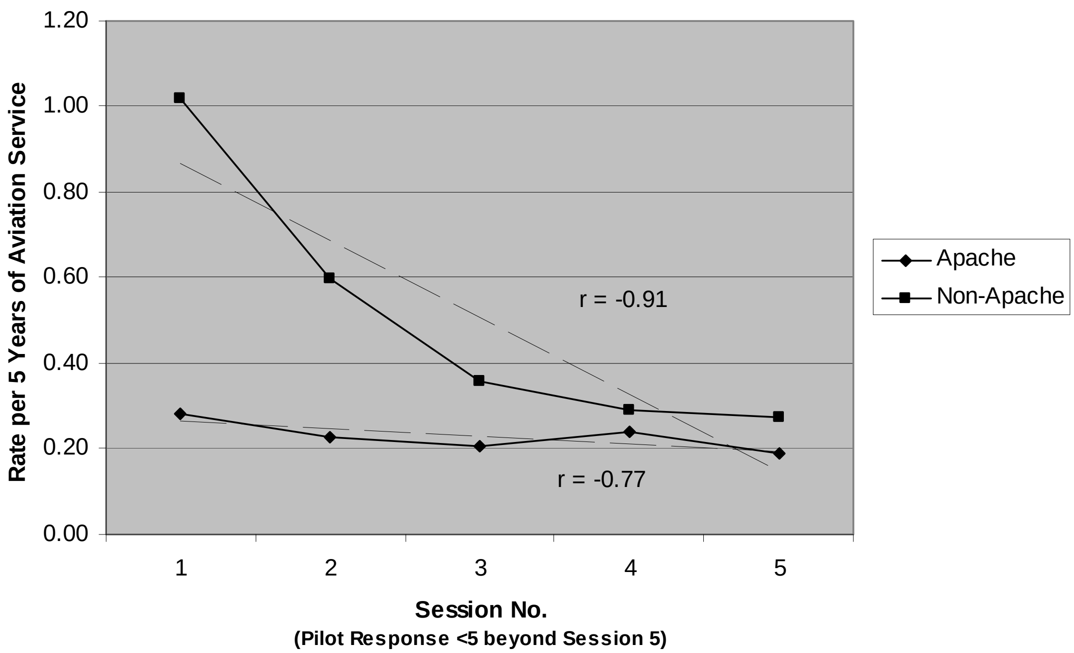


Figure 35. Rate of self-reported back pain during flight per 5 years of aviation service.

Table 5.
Summary of correlation coefficient test results for rates of back pain.

Rate	Aircraft	R^2	r	p
per 5,000hr total flight time	AP	0.686	-0.83	0.082
	NAP	0.857	-0.93	0.022*
per 500hr flight time within previous 12 months	AP	0.163	0.40	0.505
	NAP	0.004	0.06	0.924
per 25hr flight time within previous 8 weeks	AP	0.127	-0.36	0.552
	NAP	0.205	0.45	0.447
per 5yr total aviation service	AP	0.589	-0.77	0.128
	NAP	0.823	-0.91	0.032*

*$p < 0.05$

Discussion

This study followed Apache and non-Apache pilots for up to 10 years. During this time many of the subjects experienced both back and neck pain and prevalence rates were similar to those in the current literature. The study had particular value in the subjective comments elicited from the participants. Unsurprisingly, NVGs were oft-quoted as the main factor in development of neck pain and also persistence of neck pain after flight. This pattern extended to the use of helmet display unit in the Apache. Back pain was also a pervasive problem. Length of flight was the most frequently quoted factor in the development of back pain, and lack of lumbar support was a common complaint among the AP respondents. NAP respondents cited both length of flight and unsatisfactory seating position as factors in the development of back pain, often clarified as posture-related. Grounding is the ultimate measure of lost duty time and as many as one in four AP had been grounded for up to 2 weeks at some point in their career. Fewer NAP reported grounding due to back pain with rates ranging from one in ten at entry into the study to one in three by session 4.

Respondents and demographics

Mean number of months enrolled per session (figure 6) remained relatively consistent for the two cohorts, yet there was variation among individuals with a SD ranging from 14 to 21 months (up to session 5). Mean age (figure 7), years of cumulative aviation service (figure 10), and TFT (figure 11) increased through time predictably with AP having more years in service and more TFT consistently. This is understandable given the initial need to train QHIs and convert experienced pilots to the Apache during the early training phases. A large proportion of Apache subjects had prior experience before beginning training on the airframe. There was thus a subset of *ab initio* AP that had already served previous flying tours in other aircraft prior to conversion to the Apache. FT within the previous year (figure 12) and within the previous 8 weeks (figure 13) demonstrated anticipated variability over time with individuals changing duty assignments and temporal differences in operational tempo. Such variability emphasizes the importance of assessing rates (see below under neck and back pain sections, respectively). Comparison of the two cohorts at the time of enrollment demonstrated relative parity for both neck pain (table 2) and back pain (table 4) with respect to the questionnaire.

Neck pain

Prevalence of RW-associated neck pain in the literature ranges from approximately 50 to 60 percent. At the time of intake (session 1), equal percentages (30 percent) of AP and NAP reported experiencing neck pain in flight (figure 14). This rose to more than half (56 percent AP, 58 percent NAP) reporting in-flight pain by session 3 (mean 40 months of follow-up) suggesting a temporal contributory component. Interestingly, the mean time to onset of pain remained consistent over time for NAP (mean 53 to 56 minutes), while this time increased to a mean peak of 72 minutes for AP (figure 16). We have no explanation for these findings. Mean time to onset of pain decreased for both cohorts beyond session 3, which may illustrate limitations of bias, discussed later. Average severity of pain remained relative consistent and comparable between the two cohorts (mean 2.5-3.6 for AP and 2.0-3.2 for NAP, respectively [table C16 and D16]). This is consistent with a mean neck pain score of 4 (also on a scale 1-10) reported by Ang and Harms-Ringdahl (2006). Pain location was overwhelming located centerline for both cohorts (table C6 and D6). This centerline location may interest those who postulate that a side-by-side cockpit design (vice tandem cockpit of the Apache) could favor a predilection for unilateral pain, especially if a pilot should favor one seat position (e.g., a right-seated pilot who frequently is forced to look left and down at the center console containing radios, navigation equipment, and other switches). Harrison et al. (2007a) studied this using NIRS to assess metabolic stress in the trapezius muscle for pilots flying with NVGs finding no significant difference in variables between right- and left-seat pilots. These were simulated flights of approximately 90 minutes, however, and not reflective of possible long-term sequelae of consistently flying in a particular seat over a long time period. Nonetheless, unilateral pain was not prominently reported among either cohort. Predominant seat-side was not recorded as part of the questionnaire for NAP, however, this remains to be determined.

The percent of pilots that sought treatment for flight-related neck pain (figure 19), as well as pilots grounded for such pain (figure 20), is noteworthy and rose appreciably over time. This speaks to not only the untoward personal suffering associated with the condition, but also the larger issues of flight performance, operational readiness and safety. The limitations of bias (discussed in detail below) cannot be discounted. Another possibility is that aircrew may become more comfortable reporting medical issues at later stages in their career. The detrimental consequences of neck pain among the RW community have been reported previously (Grossman, Nakdimon, Chapnik, and Levy, 2012; Harrison et al., 2012; Salmon et al., 2011; Ang and Harms-Ringdahl, 2006; others). In 2005, Wickes and Greeves reported that flight-related neck pain among Royal Air Force RW pilots resulted in an occupational prevalence of 53.3 percent and was responsible for grounding 6.5 percent of aircrew. Similarly, Ang and Harms-Ringdahl (2006) reported a three-month prevalence of neck pain among Swedish RW pilots to be

57 percent (a third reporting frequent pain) whereby more than half reported that pain interfered with flying and leisure (58 and 55 percent, respectively).

Interestingly, a recent study from the Israeli Air Force Aeromedical Center (Grossman et al., 2012) reported that, among more than 500 pilots, cervical pain was most prevalent among utility helicopter pilots (47.3 percent), on par with fighter pilots (47.2 percent) and higher than attack helicopter pilots and transport pilots (36.4 and 22.3 percent, respectively). Furthermore, pain of moderate-severe degree was more prevalent among utility helicopter pilots than the other pilot groups. The authors cite vibratory forces, use of NVGs, and posture as potentially causative.

Naturally, in this study of AP and NAP cohorts, of prime interest regarding cervical pain differences was the possibility that the lighter-weight Apache IHADSS helmet and use of the HMD (vice NVGs) might manifest as less pain or disability among the AP cohort. The standard NAP Mk 4B4L helmet weighs approximately 300 g more than the IHADSS, and standard NVGs (Nite-Op) add another 700 g (rear-mounted NVG counterweights add an additional 300 to 600 g depending on pilot preference). Certainly, increased helmet weight, as well as use of NVGs has been shown to increase workload and result in more cervical pain among RW aircrew (Harrison et al., 2012; Salmon et al., 2011; Sovelius et al., 2008; Ang and Harms-Ringdahl, 2006; Wickes and Greeves, 2005). Cumulative cervical kinetic loading and differences in posture (namely cervical flexion) are higher with NVGs than during day flights (Forde et al., 2011). It is therefore interesting an overall remarkable difference among the two cohorts was not demonstrated. Because numbers of respondents changed through time, and individuals flew with differing frequency over time (e.g., different assignments, changing operational tempo, deployments), rate calculations were performed per session: a) per 5000 hours TFT, b) per 500 hours FT within the previous year, c) per 25 hours FT within the previous eight weeks, and d) per 5 years aviation service (figures 21-24). Contrary to expectations, these rates actually decreased over time (with some non-significant exceptions). One might anticipate that more exposure (FT, whether total or recently, and years of aviation service) would result in more reported pain. Again, this may be secondary to study limitations of non-representativeness in small numbers of follow-up and various possibilities of bias, discussed later. However, it is worth mentioning that a relationship between flight time exposure and more reported pain and/or disability has been inconsistent in the literature. Hermes et al. (2010) reported age, not flight hours/aircraft type, to be the principal factor in spinal disorders in stratified multivariate analysis. However, outcomes of this study included intervertebral disc bulge, disk herniation/protrusion, disk degeneration, and/or spondylosis by medical record (aeromedical waiver tracking system). It is important to note that is very different from self-reported pain by questionnaire, and that reported pain (of any location) does not necessarily correlate with radiologic findings (cf. Savage, Whitehouse, and Roberts, 1997). Considering a host of potential flight history, physical fitness, and physiologic variables, Harrison et al. (2012) developed a predictive logistic regression equation that implicated only height of the aircrew member and longest NVG flight (though flight experience and NVG experience did yield statistically significant associations with neck pain). Among 127 Swedish RW pilots (Ang and Harms-Ringdahl, 2006), history of previous neck pain and recent shoulder pain were demonstrated to be significant risk factors, excluding type of aircraft, use of NVGs, TFT, FT within previous year, FT within the previous month, and various anthropometric and fitness variables. The specific mission and type of flying may prove to be important, as well; it may be that flight time reported in general may not yield sufficient granularity (such specifics were not assessed in this questionnaire). Interestingly, Thuresson et al. (2003) reported that increased load caused by differing head positions had a greater impact on cervical muscle activity (upper/lower dorsal neck muscles and trapezius) than the HSM. Consider the pilot performing largely intelligence, surveillance, reconnaissance missions; he/she may spend a significant portion of time with head/eyes-forward viewing and operating video (vice the high-risk cervical positions associated with NVG flying). Although beyond the scope of this questionnaire, it remains an intriguing area of consideration.

Back pain

It is noteworthy that such a large proportion of pilots (54 percent AP; 62 percent NAP) reported back pain during flight at the time of intake. Prevalence in the RW community ranges from 50 to 92 percent according to the literature. Yet, even if not unexpected, this is significant given the associated untoward effects. Pain is a distraction at best, but can have serious consequences with respect to performance, readiness, and safety with occupational attrition, lost duty time, abbreviated or cancelled missions, compromised emergency egress, or performance deficits in flight. These data of 198, session 1 respondents reinforce this concept that back pain is a pervasive problem within the military RW community. This is not unlike other military RW populations (Gaydos, 2012). The percent of those reporting back pain in flight (figure 25) remained relatively consistent time for both cohorts and was not dissimilar from study intake reporting, ranging from 54 to 73 percent for AP and 62 to 71 percent for NAP. Interestingly, the percentage of pilots reporting back pain after flight was not substantially lower than that of in-flight pain (45 to 65 percent AP; 40 to 83 percent NAP; figure 27). The archetypal back pain that has been described in the literature is highly correlated with flight, and typically resolves post-flight or within hours after flight (though this time is variously described in the literature). It is likely that those reporting pain after flight were describing pain within the window shortly after flight rather than atypical chronic or persistent pain. This is evidenced in that the majority reported pain during flight within 2 hours post-flight for both cohorts (tables E18 and F18). There was, indeed, a smaller subset reporting pain within the 2 to 11 hours post-flight (and in some cases beyond; session 3 for AP and sessions 4 and 5 for NAP) compatible with literature describing a much smaller cohort of the RW back pain population that suffer from chronic, persistent pain. Mean time to onset of pain remained relatively consistent for AP (approximately 1 hour), but varied with NAP, possibly reflecting the varied airframes (and pursuant missions and common flight profiles) represented by the cohort (table 1). NAP responses regarding experiences with frequent back pain in Squirrel, Gazelle, and Lynx aircraft (table F8) varied over time.

Mean pain severity (figure 28) demonstrated relative consistency through time among both AP and NAP, ranging (scale 1-10) from 2.7 to 3.4 and 3.0 to 3.8 for AP and NAP, respectively. While this may seem relatively mild, worst pain episodes (tables E15, F15) did reach a maximum of nine for some respondents for both cohorts. Other studies have reported significant effects of such flight-related back pain. For example, in one study of more than 800 Army aviators (Shanahan, 1984), more than a quarter of respondents (28.4 percent) admitted to rushing missions and some (7.5 percent) had refused missions secondary to pain. In another study (Hansen and Wagstaff, 2001), almost half of Norwegian pilots with back pain admitted to adverse effects on performance, while Australian respondents (Thomae et al., 1998) also conceded to hurrying a mission or refusing to fly. Bridger et al. (2002) likewise reported significant pain-related deficits to aircrew: interference with flying (66 percent), sleep (51 percent), and duties outside the aircraft (32 percent of those rating pain higher). The main location of the back pain (tables E9, F9) was consistently in the lower back/lumbar region which is congruous with the literature (Gaydos, 2012; Delahaye et al., 1982). Also consistent with the literature, the majority of both cohorts cited unsatisfactory seating as a major factor influencing pain, both in-flight pain (tables E10, F10) and pain following flight (tables E14, F14). The majority of open-ended comments were also directed at poor posture and seat/cockpit design alluding to the oft-described ergonomic shortcomings of the pathophysical posture frequently adopted by RW pilots. Length of flight also represented a significant proportion of responses, which may also intimate the effects of posture and WBV. Both are known to be potential etiologic players (Gaydos, 2012; Bowden, 1987), and the two are likely interrelated. In fact, many pilots reported them concomitantly. Of course, the colloquial 'helo hunch,' as it is known within the RW community, is familiar to aircrew, and one cannot discount the possibility that pilots listed this as a primary etiology based upon their *a priori* knowledge of the phenomenon. Pilots that sought treatment for flight-related back pain, took action to minimize/avoid pain, and were grounded from pain (figures 29-31, and tables E19-E23 and F19-F23) are important in the illustration of the operational 'cost' of the malady. This reinforces the degree of impact not only on the individual pilot, but also readiness and the operational burden.

What is perhaps most surprising about the results are the rate calculations. Given the exponential decline in respondents over time and the fact that denominator data may change appreciably from one session to another, rate calculations for self-reported back pain were calculated per session: 1) per 5000 hours TFT, 2) per 500 hours FT within the previous year, 3) per 25 hours FT within the previous 8 weeks, and 4) per 5 years aviation service (figures 32-35). One would expect these to increase through time (i.e., more exposure). Shanahan (1984) demonstrated a logarithmic growth between the percentage of pilots reporting back pain symptoms and TFT, and Delahaye, et al. (1982) also noted higher incidence among aircrew with more flight hours. Bongers, et al. (1990) demonstrated an association between both flight hours per day and TFT with increased pain (transient and chronic, respectively). It was therefore unexpected to see a downward trend in self-report of back pain in flight for TFT and years of aviation service. While this possibly relates to study limitations, bias, and lack of representativeness of the respondents among later sessions, such a lack of association of pain with flight hours has been reported previously. Hansen and Wagstaff (2001) reported no significant difference in TFT between aircrew with and without pain (though more flight time was associated with more sick leave and treatment). Likewise, both Bridger et al. (2002), and Thomae et al. (1998) reported a very high prevalence of back pain within their RW populations under study, but failed to associate this with flight hours. Rates did increase (non-significantly) for pain per 500 hours FT within the previous year, possibly indicating that more recent flight exposure is more important than lifetime flight exposure over years of occupation service. It is worth mentioning that rate calculations were based on self-reported flight hours and years of aviation service, not objective verification by logbook or flight records.

Limitations

This study had many limitations and it is necessary to interpret the results within the context of these limitations. Figure 5 (number of respondents by follow-up session) is particularly germane: it depicts an exponential decline in follow-up over time with a mere 7 percent of all subjects (10 percent Apache, 5 percent Non-Apache) providing follow-up data by session 5 (mean 64 months enrollment). In fact, with 380 total returned questionnaires for the entire study period among 198 subjects, each subject only contributed, on average, less than two questionnaires (1.9 per individual). There are a number of both known and plausible explanations for this. Firstly, the overall size of the British AAC from which to recruit subjects is small, especially when compared to that of the U.S. Army Aviation forces. Secondly, on completion of flying training, British Army pilots complete a flying tour of duty usually 4 years in duration, after which junior officers may proceed to a second flying tour, non AAC officers who do not transfer to the AAC return to their original non-flying role, and young AAC Captains may go on to non-flying staff roles, placing them in the exclusion criteria (not having flown for a year or more) for further participation in the study. Thirdly, these data were supernumerary to the principal research question(s) pertaining to the long-term ocular effects of the Apache IHADSS system on visual performance. Intake and follow-up sessions necessitated a subject's physical presence for data collection on a number of visual metrics. These were performed at limited locations (whilst AAC pilots were serving duty at a number of distant geographic locations from Belize to Brunei). It was essential to separate the data collection from routine medical care and thus the majority of observations were carried out by one individual in a specific research role, with a limited travel budget. In many longitudinal surveys, questionnaires can be distributed via post or email, but in this case, the requirement that the respondent be physically present for data collection for the visual test metrics precluded this possibility in many instances. Finally, following a population of military pilots through time can be exceedingly problematic. In addition to frequent moves and relocations, exercises, and more pressing 'real-world' duty requirements, two major wartime operations were ongoing during this window of data collection: Operation Telic (Iraq) and Operation Herrick (Afghanistan) with many pilots serving multiple tours. Consequentially, questions regarding the 'representativeness' of such small sample sizes in later stages of follow-up are indeed valid — not only representativeness of cohorts under study, but also representativeness of the larger Apache and non-Apache RW communities in general. This severely limits inferential and predictive validity of results and largely restricts reporting to descriptive statistics.

Pursuant to this issue of poor longitudinal follow-up is the consideration of bias. One should appreciate that longitudinal survey data in general are subject to many types of bias including (but not limited to) selection bias, information (including recall and reporting) bias, and survivor response bias (Gordis, 2004). With respect to reporting bias, for example, aviators are often reluctant to voluntarily participate in research (even if anonymously) or accurately self-report for fear of flying restriction or potential effects on duty status. This has been described previously (Thomae et al., 1998; Simon-Arndt, Yuan, and Hourani, 1997; Froom et al., 1986). Also worth particular mention is the healthy worker effect whereby subjects discharged from the military or flying status due to spinal (or other) pathology or occupational disability are no longer available to provide data. Such survivor bias has been rightly noted in other survey-based studies of RW spinal pain (Gaydos, 2012).

The majority of AP were recruited to the study with few, if any, Apache flying hours which should have resulted in comparative groups. However, the non-Apache control group was not well matched. Personnel initially accepted to the Apache training program were medically screened and excluded if they had any long-term medical conditions that could limit the long-term duration of their flying career. No flying waivers were allowed during the initial introduction of the Apache. Non-Apache personnel could, however, fly with a waiver for pre-existing conditions, and these personnel were not excluded from participation in the study. However, some of the Apache pilots were older, with more years cumulative aviation service, and more total flying hours. The longitudinal effects are thus measured from different starting points of age, experience and pain level.

Considering both neck and back pain, there are a significant number of confounders that must be appreciated. Although occupation and exposure (e.g., years of aviation service, flight time) are apposite, a number of other physical and psychosocial factors may be important as well. With back pain, for example, age, family history, smoking, physical fitness, body mass index/obesity, history of previous injury, anxiety and depression, stress, workload, work dissatisfaction, non-occupational activities, and others may all be cogent considerations (Pope, Goh, and Magnusson, 2002; Dempsey et al., 1997; NIOSH, 1997). Similarly, age, gender, history of previous injury, poor general health, poor psychological status, and previous history of low back pain have been identified as risk or predictive factors for neck pain (Croft et al., 2001; Leclerc et al., 1999). These were not assessed or controlled in this study. In fact, a recent review of the literature for RW low back pain (Gaydos, 2012) noted that well-designed longitudinal studies with relevant exposure data and control for such confounders are required, specifically to identify factors of causation and direct interventions. It is worth mentioning, however, that the relative contribution and/or degree of confounding for such factors are a matter of some debate. For example, a recent publication outlining a predictive logistic regression equation for neck pain in RW aircrew in Canadian Forces (Harrison et al., 2012) identified only the longest single NVG mission and height of the aircrew to be included. Another recent study (Hermes et al., 2010) that reviewed almost 20,000 aircrew flight records with multivariate analyses demonstrated significant association between age and spinal disorder diagnosis for all pilots (OR=2.96 for lumbar disorders in RW pilots) discounting many other variables thought to be important. Despite the uncertainty of relevance and importance, it should be recognized that such variables were not assessed by the questionnaire and multivariate analysis is not reflected in these results.

Conclusions

Spinal pain and resultant occupational disability remain enduring problems for RW aircrew across the spectrum of nations and airframes. This was demonstrated among cohorts of British Apache and non-Apache pilots in this study as well, with notable percentages of both reporting flight-related pain, requirement for clinical intervention and the necessity for flying restriction and grounding.

The etiologic factors of pathophysical RW piloting posture, as well as cumulative exposure to WBV have emerged prominently in the scientific literature. Despite being a newer generation aircraft, the Apache is not insulated from these constituents, and therefore it is not wholly surprising that there was not an appreciable difference between the cohorts with respect to low back pain. In fact, almost 20 years ago, many of the ergonomic deficiencies (common to the overwhelming majority of RW aircraft) of the Apache were identified (Greth, 1994) including shortcomings of the seat design, cockpit geometry, and seat cushion. Regarding neck pain, there is ample evidence identifying HSM as a major antecedent factor. However, despite the lighter IHADSS helmet and use of the HMD (vice NVGs), the Apache cohort did not report fewer neck pain episodes or lower severity and associated disability. The reason is likely multifactorial. Both neck pain and back pain among RW populations remain a complex problem with a multitude of potential contributing agents and confounding variables. Reviews of the topic have rightly noted this, and advocated that clarity must be established for clear etiologic causality (vice simple association), especially when advocating for costly interventions or modifications. Furthermore, such improvements, when implemented, must be executed within the milieu of safety (crash-worthiness, fire retardance, emergency egress, and related factors), aircrew acceptance, and of course, fiscal permissiveness. Nonetheless, the detriments to aircrew health, operational performance and readiness, and disability and attrition are clear and deserving of abatement and remedy.

This study is subject to many limitations, most notably poor longitudinal follow-up and potential for many types of bias. The study does illustrate many of the complex difficulties associated with the conduct of longitudinal studies (particularly within military populations), as well as control for confounding variables. Nonetheless, the results clearly demonstrate that spinal pain and disability remain a persistent, pervasive issue within the British RW community.

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Appendix A.

Months enrolled per follow-up session.

Table A1.
AP months of enrollment.

Session	2	3	4	5	6	7
Number of responses	38	18	12	6	2	1
Mean	22	36	46	67	58	76
Median	21	33	48	72	58	76
Standard deviation	12.0	10.7	8.5	15.2		

Table A2.
NAP months of enrollment.

Session	2	3	4	5	6	7
Number of responses	59	25	14	7	1	
Mean	20	43	49	61	98	
Median	15	31	39	58	98	
Standard deviation	17.2	26.6	27.5	13.9		

Table A3.
All pilots months of enrollment.

Session	2	3	4	5	6	7
Number of responses	97	43	26	13	3	1
Mean	21	40	48	64	71	76
Median	17	32	41	70	61	76
Standard deviation	15.2	21.5	20.7	14.3	23.2	

Appendix B.

Pilot age, duty description, and number of flying hours per session.

Table B1.
AP responses and age by session.

Session	1[1]	2	3	4	5	6	7
Number of responses	63	38	18	12	6	2	1
Mean Age	34.2	36.8	39.1	39.9	43.1	48.5	51.0
Standard deviation	5.2	4.5	4.2	4.6	3.5		
Range	24-49	27-46	29-47	31-48	40-49	47-50	51
Median	34.5	37	39	39	41.5		

[1]One null age response for session 1.

Table B2.
NAP responses and age by session.

Session	1[1]	2	3	4	5	6
Number of responses	135	58	25	14	7	1
Mean Age	30.5	33.6	38.3	41.1	43.5	43.0
Standard deviation	6.0	6.0	6.9	7.7	5.6	
Range	24-49	26-50	27-53	31-54	35-52	
Median	29	32	39	40.5	42	

[1]Four null age responses for session 1.

Table B3.
AP duty description by session.

Session	1	2	3	4	5	6	7
Student Pilot	49	6	1				
Line Pilot	4	17	5	4	2	1	
QHI[1]	9	11	11	7	4	1	1
Other	0	4	1	1			
No answer	1						

[1]QHI: Qualified Instructor Pilot.

Table B4.
NAP duty description by session.

Session	1	2	3	4	5	6
Student Pilot	88	4				
Line Pilot	11	30	11	3		
QHI	23	11	10	9	4	1
Medical	10	5	3	1	2	
Other	3	9	1	1	1	

Table B5.
AP total flying hours by session.

Session	1	2	3	4	5	6	7
Mean	2065.7	2554.0	3427.4	3547.1	3944.0	4800.0	7820.0
Range	2-5200	600-6720	1000-7000	1390-7250	2460-4300	2600-7000	
Median	1890	2295	3500	3580	4200		
Standard deviation	1248.0	1361.6	1460.2	1643.5	1194.0		
Number of responses	61	38	18	12	5	2	1
No answer	2	0	0	0	1	0	0

Table B6.
NAP total flying hours by session.

Session	1	2	3	4	5	6
Mean	815.9	1228.9	2108.1	2897.6	2854.3	2960.0
Range	30-7400	20-7800	149-8400	300-8450	490-6430	
Median	180	605	1350	2150	2460	
Standard deviation	1356.8	1537.5	2082.7	4024.4	2443.7	
Number of responses	126	58	25	14	7	1
No answer	9	1	0	0	0	0

Table B7.
AP total flying hours in last year by session.

Session	1	2	3	4	5	6	7
Mean	222.5	161.8	214.0	181.5	196.0	148.0	170.0
Range	0-2220.0	0-290.0	150-309.2	70-300.0	150-240.0	126-170.0	N/A
Median	160	160	200	175	200	N/A	N/A
Standard deviation	319.3	68.7	61.1	61.4	33.6	N/A	N/A
Number of responses	60	37	18	12	5	2	1
No answer	3	1	0	0	1	0	0

Table B8.
NAP total flying hours in last year by session.

Session	1	2	3	4	5	6
Mean	128.5	137.7	163.4	156.1	130.4	280.0
Range	0-400	0-1277	0-350	0-300	10-250	
Median	110	105	200	165	160	
Standard deviation	80.0	180.8	93.0	91.1	107.6	
Number of responses	128	56	25	14	7	1
No answer	7	3	0	0	0	

Table B9.
AP total flying hours in preceding 8 weeks by session.

Session	1	2	3	4	5	6	7
Mean	13.7	20.8	29.1	25.5	28.5	15.7	30.1
Range	0-102.4	0-53.5	0-67.0	0-67.0	15-60.0	10.3-21.0	N/A
Median	5.0	21.1	23.0	23.2	19.5	N/A	N/A
Standard deviation	19.8	16.9	20.7	17.5	21.1	N/A	N/A
Number of responses	57	35	17	10	4	2	1
No answer	6	3	1	2	2	0	0

Table B10.
NAP total flying hours in preceding 8 weeks by session.

Session	1	2	3	4	5	6
Mean	25.2	19.2	30.0	22.1	19.9	42.0
Range	0-94.5	0-64.4	0-119.2	0-63.0	0-27.6	
Median	20.0	17.0	24.1	14.8	25.6	
Standard deviation	21.9	18.2	26.1	21.4	16.2	
Number of responses	118	53	25	13	6	
No answer	17	6	0	1	1	1

Appendix C.

AP: Tabulated data for neck pain questionnaire responses per session.

Table C1.
Proportion of AP that experienced neck pain during flight.

Session	1	2	3	4	5	6	7
Pain	15 (31%)	14 (40%)	10 (56%)	4 (36%)			
No pain	33 (69%)	21 (60%)	8 (44%)	7 (64%)	5 (100%)	1 (100%)	1 (100%)
Number of responses	48	35	18	11	5	1	
No answer	15	3		1	1	1	

Table C2.
Time (minutes) to onset of neck pain during flight in AP.

Session	1	2	3	4	5[1]	6[1]	7[1]
0-30	3 (21%)	3 (25%)	3 (33%)	2 (50%)			
31-60	8 (57%)	4 (33%)	2 (22%)				
61-90	2 (14%)	2 (17%)	1 (11%)				
91-120	1 (7%)	1 (8%)	1 (11%)	1 (25%)			
121-150		0					
151-180		1 (8%)					
180+			1 (11%)				
Other		1 (8%)	1 (11%)	1 (25%)			
Number of responses	14	12	9	4			
No answer	49	26	9	8	6	2	1

[1]There were no responses to this question in sessions 5-7.

Table C3.
Total number of episodes of neck pain in AP during flight.

Session	1	2	3	4	5	6	7
1-3	5 (33%)	4 (33%)	3 (33%)				
4-10	5 (33%)	3 (25%)	1 (11%)	2 (50%)			
10+	5 (33%)	5 (42%)	5 (56%)	2 (50%)			
Number of responses	15	12	9	4	0	0	0
No answer	48	26	9	8	6	2	1

Table C4.
Episodes of neck pain experienced by AP during flight in the last year.

Session	1	2	3	4	5	6	7
0	4	3	1				
1-3	3	2	1	1			
4-10	5	5	5	3			
11-20	1	1					
21-30		2	1				
31 +	1		1				
No answer	49	25	9	8	6	2	1

Table C5.
Aircraft in which AP experienced the most episodes of neck pain.

Session	1[1]	2	3[2]	4	5	6	7
Apache	5 (33%)	10 (67%)	5 (50%)	3 (75%)			
Gazelle	6 (40%)	2 (13%)	5 (50%)				
Lynx	4 (27%)	3 (20%)	3 (30%)	1 (25%)			
Squirrel	2 (13%)						
Number of responses	15	15	10	4	1		
No answer	48	23	8	8	6	2	1

[1] Two reported most pain in Lynx and Gazelle.
[2] One individual reported most neck pain in Apache and Lynx, one in Apache, Gazelle and simulator and one in Lynx and Gazelle.

Table C6.
Location of neck pain in AP.

Session	1	2	3	4	5	6	7
Left	5 (33%)	2 (13%)	2 (20%)	1 (25%)			
Right	3 (20%)	6 (38%)	1 (10%)				
Center	7 (47%)	9 (56%)	8 (80%)	3 (75%)	1 (100%)		
Number of responses	15	16	10	4	1		
No answer	48	22	8	8	5	2	1

[1]In sessions 2 and 3, one person answered both left and right.

Table C7.
Factors resulting in neck pain during flight in AP.

Session	1[1]	2[2]	3[3]	4[4]	5	6	7
Without NVG			1 (10%)	2 (50%)			
With NVG	8 (53%)	8 (50%)	5 (50%)	4 (100%)	1 (100%)		
IHADSS helmet without HDU			1 (10%)	1 (25%)			
IHADSS helmet with HDU	4 (27%)	10 (63%)	7 (70%)	3 (75%)			
Other	4 (27%)	1 (7%)	1 (10%)				
Number of responses	15	16	10	4	1	0	0
No answer	48	22	8	8	5	2	1

[1] One dual answer- with NVG and IHADSS with HDU.
[2] One dual answer, one triple answer, one quadruple answer (all except other).
[3] Two dual answers – with NVG, with HDU, one quadruple answer (all except other)
[4] One dual answer, one triple answer, one quadruple answer

The aircrew made the following comments:
IHADSS helmet with HDU-suspect as a result of neck muscle wastage after NVG.
Other: posture leaning forward for extended duration
Poor fitting helmet
Instrument flying only
Spending 4 hours and sat in the aircraft
No specific links between episodes.
With NVGs fitted to an IHADSS helmet

Table C8.
Factors that may have influenced neck pain during flight in AP.

Session	1	2[1]	3	4	5	6	7
Student pilot	2 (22%)	1 (17%)					
QHI	2 (22%)	2 (33%)	2 (33%)				
Infrequent flying duties		1 (17%)	2 (33%)	1 (25%)	1 (100%)		
Recent illness/ injury	1 (11%)	1 (17%)					
Mission type	4 (44%)	6 (67%)	2 (33%)	2 (50%)			
Other				1 (25%)			
Number of responses	9	9	6	4	1	0	0
No answer	54	28	12	8	5	2	1

[1] 1 person gave 3 responses (being a student, being a QHI, mission type)

The aircrew qualified their responses with the following comments:
Recent illness/ injury – I have a recurring shoulder injury which causes the neck pain
Mission type   long sorties
Operational sortie with HDU and NVG fitted to helmet
NVG system and balance weights
Looking down all the time at unnatural angle
NVG injury manifested after NVG stopped
NVS flight where constant head movement is required
Long duration night and NVG
Prolonged flying on ops
Position of MPDs
Long operational mission with IHADSS and NVS
Long periods of time with NVG fitted
Long ones
Other   General seated position

Table C9.
Proportion of AP that experienced neck pain after flight.

Session	1	2	3	4	5	6	7
Pain	13 (27%)	13 (36%)	7 (41%)	2 (18%)			
No pain	35 (73%)	23 (64%)	10 (59%)	9 (82%)	5 (100%)	1 (100%)	1 (100%)
No answer	15	2	1	1	1	1	

Table C10.
Time (minutes) to onset of pain in AP that experienced neck pain after flight.

Session	1	2	3	4	5	6	7
0-30	2 (29%)	7 (58%)	3 (50%)	1 (50%)			
31-60	1 (14%)	2 (17%)	2 (33%)				
61-90	1 (14%)	1 (8%)					
91-120							
121-150	1 (14%)						
151-180							
180+	1 (14%)	1 (8%)					
Other	1 (14%)	1 (8%)	1 (17%)	1(50%)			
Number of responses	7	12	6	2			
No answer	56	26	12	10	6	2	1

Table C11.
Total number of neck pain episodes after flight in AP.

Session	1	2	3	4	5	6	7
1-3	4 (31%)	3 (23%)	1 (14%)				
4-10	5 (38%)	3 (23%)	2 (29%)	1 (50%)			
10+	4 (31%)	7 (54%)	4 (57%)	1 (50%)			
Number of responses	13	13	7	2			
No answer	50	25	11	10	6	2	1

Table C12.
Number of episodes of neck pain after flight in the last year in AP.

Session	1	2	3	4	5	6	7
0	3	4	1				
1-3	5	2	2	1			
4-10	4	2	1	1			
11-20		3	1				
21-30			1				
31 +		1	1				
No answer	51	26	11	10	6	2	1

Table C13.
Factors resulting in neck pain after flight in AP.

Session	1[1]	2[2]	3[3]	4[4]	5	6	7
Without NVG	1 (8%)	1 (7%)	1 (20%)				
With NVG	7 (58%)	8 (57%)	1 (20%)	1 (50%)			
IHADSS helmet without HDU			1 (20%)				
IHADSS helmet with HDU	4 (33%)	9 (64%)	3 (60%)	2 (100%)			
Other	1 (8%)	2 (14%)					
Number of responses	12	14	5	2			
No answer	51	24	13	10	6	2	1

[1] 1 double answer
[2] 2 double answers, 2 triple answers
[3] 1 double answer
[4] 1 double answer

The aircrew qualified their answers with the following comments:
Other: using PNVS
IHADSS with HDU and NVG
Degenerative C spinal disc on recent MRI
Carrying webbing on exercise for 2 weeks

Table C14.
Factors influencing neck pain after flight in AP.

Session	1[1]	2[2]	3	4	5	6	7
Student pilot	2 (18%)	1 (14%)					
QHI	2 (18%)	2 (29%)	2 (100%)				
Infrequent flying duties	2 (18%)	2 (29%)					
Recent illness/ injury	1 (9%)						
Mission type	4 (36%)	3 (43%)		1 (50%)			
Other	1 (9%)			1 (50%)			
Number of responses	11	7	2	2			
No answer	52	30	16	10	6	2	1

[1]One QHI also answered mission type in session 1.
[2]One individual in session 2 responded student pilot, QHI and mission type long sorties.

The aircew qualified their answers with the following comments:
Misison type: Hard work
NVG and weights
Very long (8 hour) periods in the cockpit
Back to back sorties
NVS(NVG black) flights is no left eye eves
Night NVG long duration
Long sortie times > 2 hours
Other: Seated position, I tend to hunch after looking around
Neck pain occurs several hours after flying.

Table C15.
Severity of neck pain during worst episode of neck pain reported by AP.

a) During flight

Session	1	2	3	4	5	6	7
Mean	2.9	3.1	4.6	5.3	3.0		
Median	3	3	4	5	N/A		
Range	1-6	1-7	3-8	5-6	1-5		
Standard deviation	1.4	1.5	2.0	0.5	N/A		
Number of responses	19	17	3	4	1	0	0

b) After flight

Session	1	2	3	4	5	6	7
Mean	3.1	3.6	4.9	4.3	1.0		
Median	3.0	3.0	4.5	6.0	1.0		
Range	1-9	1-9	1-8	1-6	1		
Standard deviation	2.3	2.2	2.5	2.9	N/A		
Number of responses	21	17	8	3	2	0	0

Table C16.
Average severity of neck pain reported by AP.

a) During flight

Session	1	2	3	4	5	6	7
Mean	2.6	2.3	3.6	3.3	1.0		
Median	3	2	3	3	N/A		
Range	1-4	1-7	2-8	3-4	N/A		
Standard deviation	1.3	1.5	2.2	0.6	N/A		
Number of responses	9	13	7	3	1	0	0

b) After flight

Session	1	2	3	4	5	6	7
Mean	1.9	3.0	3.8	5.0	1.0		
Median	1.5	3	3	5	N/A		
Range	1-4	1-9	2-7	4-6	N/A		
Standard deviation	1.1	2.2	2.1	N/A	N/A		
Number of responses	8	13	6	2	1	0	0

Table C17.

Duration of symptoms for the worst episode of neck pain in AP.

Session	1	2	3	4	5	6	7
During flight	7 (29%)	5 (26%)	2 (22%)	2 (50%)			
<2 hrs after flight	4 (22%)	4 (21%)	1 (11%)		1 (100%)		
2-11 hrs after	1 (6%)	4 (21%)	1 (11%)				
12-24 hrs after	3 (17%)	2 (11%)	2 (22%)				
1-4 days after	2 (11%)	2 (11%)	2 (22%)	2 (50%)			
>4 days after	1 (6%)	2 (11%)	1 (11%)				
Number of responses	18	19	9	4	1		
No answer	45	19	9	8	5	2	1

Table C18.

Duration of symptoms for an average episode of neck pain in AP.

Session	1	2	3	4	5	6	7
During flight	8 (47%)	6 (33%)	2 (22%)	2 (50%)	1 (100%)		
<2 hrs after flight	4 (24%)	7 (39%)	2 (22%)				
2-11 hrs after	3 (18%)	4 (22%)	3 (33%)				
12-24 hrs after	2 (12%)	1 (6%)	2 (22%)	2 (50%)			
1-4 days after							
>4 days after							
Number of responses	17	18	9	4	1		
No answer	46	20	9	8	5	2	1

Table C19.

Proportion of AP that sought treatment for flight-related neck pain.

Session	1	2	3	4	5	6	7
Treatment	6 (25%)	7 (30%)	5 (50%)	3 (75%)			
No treatment	18 (75%)	16 (70%)	5 (50%)	1 (25%)	1 (100%)		
No answer	39	15	8	8	5	2	1

Table C20.
Clinician approached for treatment by AP.

Session	1	2[3]	3[4]	4[5]	5	6	7
Doctor (SAM)	5 (83%)[1]	6 (86%)	4 (80%)	2 (67%)			
Physiotherapist	4 (67%)[2]	2 (29%)	4 (80%)	1 (33%)			
Osteopath/Chiropractor	1 (17%)	4 (57%)	2 (40%)	3 (100%)			
Other	1 (17%)	1 (17%)	1 (20%)	1 (33%)			
Number of responses	6	7	5	3			
No answer	57	31	13	9	6	2	1

All but one individual that consulted a doctor, consulted their specialist in aviation medicine.

[1]One individual consulted the general practitioner.

[2]Three of the four personnel who attended the physiotherapist saw their doctor as well, one individual also consulted an osteopath and had acupuncture.

[3]All individuals who had rehabilitation therapy also saw the doctor. The two individuals who saw the physiotherapist also attended either the osteopath of chiropractor. One individual reported seeking treatment from their manager.

[4]There were five individuals that responded to the question. Of the four who consulted a doctor, one saw a physiotherapist and neurologist, one saw the physiotherapist and chiropractor, one saw the osteopath and chiropractor, and one saw the physiotherapist alone. One individual saw the physiotherapist without reporting seeing the doctor.

[5]There were only three responses. All saw either a chiropractor or osteopath. One individual also saw a sports therapist. One saw the doctor, physiotherapist, and chiropractor.

Table C21.
Proportion of AP that received treatment for neck pain.

Session	1	2	3	4	5	6	7
Treated	5 (71%)	6 (40%)	5 (71%)	2 (50%)			
Untreated	7 (29%)	9 (60%)	2 (29%)	2 (50%)	1 (100%)		
No answer	51	23	11	8	5	2	1

The comments made by AP detailing the treatment received are listed below:

Physio
Physio
Physio and chiropractic manipulation
Exercises traction
Heat traction physio manipulation
Massage and heat treatment also electric pulse treatment
Heat pads/ electric pulses
Period of physiotherapy including acupuncture (3 sessions total)
Remedial massage
Xray/ pain killers
Pain relief/anti inflammatory medication followed by pysio
pain killers
Sleeping pillow
Manipulation
Manipulation by chiro
Chiropractor realigned physio treated symptom and core strength / posture exercises
Prolonged over last 8 years

Table C22.

Proportion of AP that have taken action to minimize or avoid flight-related neck pain.

Session	1	2	3	4	5	6	7
Action taken	6 (27%)	9 (45%)	8 (89%)	2 (50%)			
No action taken	16 (73%)	11 (55%)	1 (11%)	2 (50%)	1 (100%)		
No answer	41	18	9	8	5	2	1

The comments made by AP describing the details of action taken to minimize neck pain are listed below:

I took up martial arts in order gain better flexibility since then the severity and frequency has reduced significantly

Flexibility training

Neck stretches

Stretching limited effect

Stretching exercises/ massage

Jump out the a/c for a quick stretch

Stretching exercises which bring slight relief

Exercises to strengthen neck muscles

Physical ex and stretching

Continued pt and stretching exercises

Use pt session included pumpkin bobs to stretch the neck. No effects noticed

Exercises given by physio in head, shoulder movement and posture

Exercise

Gentle neck exercises before flight this was advised by the SAM on an aircrew medical

Exercises

Neck strengthening improved posture

Posture and exercise

Posture and stretching post flight

Posture changes etc

Orthopedic pillow

Whilst using NVG using correct counter weight

Remove counter weight on helmet also exercise neck during and after flight

Minimize time with NVG on helmet

Taken NVGs off

I tied a bungie to my helmet and to the roof- it worked

Table C23.
Proportion of AP that have been grounded as a result of flight-related neck pain.

Session	1	2	3	4	5	6	7
Grounded	2 (9%)	2 (9%)	1 (11%)	1 (25%)			
Not grounded	20 (91%)	21 (91%)	8 (89%)	3 (75%)	1 (100%)		
No answer	41	15	9	8	5	2	1

Table C24.
Duration of grounding for neck pain in AP.

Session	1	2	3	4	5	6	7
< 1 week	2	2	1	1			
No answer	61	36	17	11	6	2	1

Appendix D.

NAP: Tabulated data for neck pain questionnaire responses per session.

Table D1.
Proportion of NAP that have experienced neck pain during flight.

Session	1	2	3	4	5	6
Pain	40 (30%)	22 (38%)	14 (58%)	8 (62%)	3 (43%)	
No pain	95 (70%)	36 (62%)	10 (42%)	5 (38%)	4 (57%)	1 (100%)
Number of responses	135	58	24	13	7	1
No answer	0	1	1	1	0	0

Table D2.
Time (minutes) to onset of neck pain during flight in NAP.

Session	1	2	3	4	5	6
0-30	10 (27%)	8 (38%)	5 (38%)	5 (63%)	1 (33%)	
31-60	17 (46%)	5 (24%)	5 (38%)	2 (25%)	1 (33%)	
61-90	5 (14%)	3 (14%)	1(8%)			
91-120	2 (5%)	3 (14%)	1 (8%)			
121-150						
151-180			1 (8%)			
180+	1 (3%)					
Other	2 (5%)	2 (10%)		1 (12%)	1 (33%)	
Number of responses	37	21	13	8	3	
No response	98	38	12	6	4	1

Table D3.
Total number of episodes of neck pain experienced by NAP during flight.

Session	1	2	3	4	5	6
1-3	13 (33%)	10 (48%)	3 (23%)	4 (50%)	1 (33%)	
4-10	12 (31%)	8 (38%)	6 (46%)	2 (25%)	2 (67%)	
10+	14 (36%)	3 (14%)	4 (31%)	2 (25%)		
Number of responses	39	21	13	8	3	
No answer	96	38	12	6	4	1

Table D4.
Episodes of neck pain experienced by NAP during flight in the last year.

Session	1[2]	2	3	4	5	6
Episodes[1]						
0	17	7	3	4	1	
1-3	14	10	8	1	1	
4-10	4	3	1	3		
11-20	2					
21-30						
31 +			1			
No answer	98	39	12	6	5	

[1]The worst case scenario was analyzed so if an individual gave a range, the upper value of that range was taken for number of episodes in the last year.
[2]The following statements could not be quantified in session 2 and were thus not included in the analysis: "all, most flights, every flight, unable to specify"

Table D5.
Aircraft in which most episodes of neck pain were experienced by NAP.

Session	1[1]	2[2]	3[3]	4[4]	5[5]	6
Gazelle	15(38%)	12 (57%)	6 (46%)	5 (63%)	2 (100%)	
Lynx	16 (41%)	8 (38%)	5 (38%)	4 (50%)		
Squirrel	11 (28%)	3 (14%)	1 (8%)			
Other	4 (10%)	2 (10%)	2 (15%)	1 (13%)		
Number of responses	39	21	13	8	2	
No answer	96	38	12	6	5	1

[1]Four pilots responded both Gazelle and Squirrel, three pilots responded both Lynx and Gazelle, one pilot responded squirrel and firefly. Other included Bell 212 (one pilot) firefly (two pilots) and one non-specified aircraft.
[2]One pilot reported most pain in both Squirrel and Gazelle, three in both Lynx and Gazelle. The two others were Puma and Wessex.
[3]One pilot reported most pain in both Lynx and Gazelle. The two other aircraft were August 109 and Wessex.
[4]Two pilots reported most pain in both Lynx and Gazelle. The other aircraft was a Wessex.
[5]One individual reported that their neck pain was not aircraft related.

Table D6.
Location of neck pain in NAP.

Session	1	2	3	4	5	6
Left	5 (13%)	5 (24%)	2 (15%)	1 (13%)	1 (33%)	
Right	3 (8%)	1 (5%)	1(8%)		1 (33%)	
Center	30 (79%)	15 (71%)	10 (77%)	7 (87%)	1 (33%)	
Number of responses	38	21	13	8	3	
No answer	97	38	12	6	4	1

Table D7.
Factors resulting in neck pain during flight in NAP.

Session	1[1]	2[2]	3[3]	4[4]	5[5]	6
Without NVG	8 (20%)	1 (5%)	2 (15%)	1 (13%)	1 (33%)	
With NVG	30 (75%)	17 (81%)	13 (100%)	7 (87%)	3 (100 %)	
Other	7 (18%)	4 (19%)		1 (13%)		
Number of responses	40	21	13	8	3	
No answer	95	38	12	6	4	1

[1]With NVGs – one comment stated incorrect weight fitted, new heavier weight fitted resulting in no neck pain. There were three individuals who reported pain both with and without NVGs, one reported with NVG and gazelle seat position, one reported both NVG and aerobatics affecting neck pain.
[2]With NVGs one individual reported one episode when counterweight was displaced by mic/tel lead. One person reported pain when flying with NVGs and when display flying.
[3]Two reported pain both with and without NVGs
[4]One individual reported pain both with and without NVG, one reported pain with NVG and also other
[5]One pilot reported pain both with and without NVG.

The aircrew provided the following comments regarding other causes of neck pain during flight:
Other: aerobatics
- no pain
- Gazelle seat position
- old injury
- instrument flying
- being student pilot
- stress
- extended time in cockpit
- display flying
- weight of helmet (more when haven’t flown for a while)
- contribution of heavy trial helmet/ NVG trial equipment.
- trial hand held thermal imager

Table D8.
Factors that may have influenced neck pain in NAP during flight.

Session	1[1]	2[2]	3[3]	4[4]	5	6
Student pilot	8 (30%)	4 (27%)	2 (29%)	1 (14%)	1 (50%)	
QHI	5 (19%)	3 (20%)	1 (14%)	3 (43%)		
Infrequent flying duties	2 (7%)	3 (20%)	1 (14%)	1 (14%)		
Recent illness/ injury	3 (11%)	1 (7%)			1 (50%)	
Mission type	10 (37%)	5 (33%)	5 (33%)	3 (43%)		
Other	3 (11%)			1 (14%)		
Number of responses	27	15	7	7	2	
No answer	108	44	18	7	5	1

[1]One pilot reported both infrequent flying duties and mission type, one pilot reported recent injury and mission type, one pilot reported recent illness and being a student, one reported infrequent flying duties and mission type.
[2]One student pilot also reported mission type, one student pilot reported infrequent flying duties.
[3]One student pilot also reported infrequent flying duties, one QHI also reported mission type, one pilot reported infrequent flying duties and mission type.
[4]Two individuals reported being a QHI and mission type as factors.

The aircrew provided the following comments clarifying the details of the factors influencing their pain:

Mission type: long periods on NVG trial flights
- a lot of flying day and night
- night low level operations NVG CAT 2 sorties
- prolonged NVS sorties in NI and France
- NVG
- stressful NVG sortie in mountainous terrain with no counterweight
- wearing NVG for long periods
- long periods on NVG
- long period with it on
- long periods on NVG
- NVGs
- high hover for long periods with NVG fitted while constantly looking up and down to use visual references in chin window and instruments and distance;
- solo pilot NI
- forced to look out side window in awkward position
- prolonged orbits looking in same direction
- long missions wearing helmet for extended period
- long duration sorties
- missions over 1 hour
- instrument flying
- low level missions
- multi aircraft operations in Northern Ireland
- left hand seat Gazelle cramped cockpit

Other: not known

part of learning how to use NVS
aerobatics and helmet weight with large forces
familiarization flights during the whole day.

Table D9.
Proportion of NAP experiencing neck pain after flight

Session	1	2	3	4	5	6
Pain	24 (19%)	14 (25%)	9 (39%)	6 (46%)	4 (57%)	
No pain	101 (81%)	42 (75%)	14 (61%)	7 (54%)	3 (43%)	1 (100%)
No answer	10	3	2	1		

Table D10.
Time (minutes) to onset of neck pain in NAP experiencing neck pain after flight

Session	1	2	3	4	5	6
0-30	7 (58%)	5 (50%)	1 (14%)	4 (80%)		
31-60	3 (25%)	4 (40%)	3 (43%)	1 (20%)	1 (100%)	
61-90		1 (10%)	2 (29%)			
91-120	1 (8%)		1 (14%)			
121-150						
151-180						
180+	1 (8%)					
Other						
Number of responses	12	10	7	5	1	
No answer	123	49	18	9	6	1

Table D11.
Total episodes of neck pain experienced after flight by NAP.

Session	1	2	3	4	5	6
1-3	8 (33%)	7 (54%)	5 (56%)	4 (67%)	1 (25%)	
4-10	10 (42%)	2 (15%)	3 (33%)	2 (33%)	2 (50%)	
10+	6 (25%)	4 (31%)	1 (11%)		1 (25%)	
Number of responses	24	13	9	6	4	0
No answer	111	46	16	8	3	1

Table D12.
Episodes of neck pain experienced by NAP after flight in the preceding year.

Session	1	2	3	4	5	6
0	8	1	3	2	1	
1-3	6	8	4	2	1	
4-10	4	1	1	1		
11-20						
21-30						
31 +		1	1			
No answer	117	48	16	9	5	1

Table D13.
Factors resulting in neck pain after flight in NAP.

Session	1[1]	2[2]	3[3]	4	5[4]	6
Without NVG	6 (25%)	2 (14%)	1 (11%)		1 (25%)	
With NVG	17 (71%)	10 (71%)	8 (89%)	6 (100%)	3 (75%)	
Other	4 (17%)	5 (36%)	1 (11%)		1 (25%)	
Number of responses	24	14	9	6	4	0
No answer	111	45	16	8	3	1

[1]Two reported pain both with and without NVG, one reported without NVG and other.
[2]One individual responded both with and without NVG, one gave a triple answer.
[3]One dual answer of with and without NVG.
[4]One pilot reported with and without NVG as well as an old injury. One pilot reported being a QHI/ mission type (long instructional sorties back to back).

The pilots qualified the factors with the following comments:
Other: injury
Recurring
getting used to helmet
periodically get a stiff neck I do not know the cause
long time in the cockpit
hand held thermal imager, pulled neck muscles
after not flying for a week or so then flying a couple of hours after NVG after a long flight 2-3 hours +.
Blue eagles display pilot.

Table D14.
Factors influencing neck pain after flight in NAP.

Session	1[1]	2[2]	3[3]	4[4]	5	6
Student pilot	4 (24%)	2 (25%)		1 (20%)		
QHI	2 (12%)		2 (40%)	3 (60%)		
Infrequent flying duties	2 (12%)	2 (25%)	1 (20%)	1 (20%)		
Recent illness/ injury	3 (18%)	1 (13%)				
Mission type	7 (41%)	5 (62%)	3 (60%)	1 (20%)		
Other	2 (12%)					
Number of responses	17	8	5	5		
No answer	118	51	20	9	7	1

[1]Three dual answers- student pilot and infrequent flying duties, student pilot and recent illness, recent injury and mission type.
[2]Two dual answers – being student pilot and mission type, infrequent flying duties and mission type.
[3]One dual answer of being a QHI and mission type.
[4]One dual answer or QHI and mission type.

The aircrew made the following comments regarding detail of the factors:
Mission type: NVG mission

- a lot of NVG flying in NI and in Gazelle in France
- low level Cat 2 NVG flight
- 5 hours on tasking on NVG in Bosnia
- prolonged NVG flying
- long periods on NVG
- 5 hour NVG mission in one night
- NVG mission
- Familiarisation flights
- familiarization flights for cadets
- extended period
- trial equipment flight
- instrument flying with lack of head movement for a prolonged period
- display flying.

Other: stressful NVG flight in mountains with no counterweight

Table D15.
Severity of neck pain for worst episode of neck pain in NAP.

a) During flight

Session	1	2	3	4	5	6
Mean	3.3	3.4	3.8	3.3	2.3	
Median	3.0	3.0	3.0	3.5	2.0	
Range	1-9	1-7	2-7	2-4	1-4	
Standard deviation	1.8	1.4	1.6	0.8	1.5	
Number of responses	46	20	9	6	3	0

b) After flight

Session	1	2	3	4	5	6
Mean	3.3	3.7	3.4	4.0	4.0	
Median	3.0	3.0	3.0	3.0	3.5	
Range	1-9	1-9	1-5	3-6	2-7	
Standard deviation	2.1	2.5	1.2	1.6	2.2	
Number of responses	35	19	10	6	4	0

Table D16.
Average severity of neck pain in NAP.

a) During flight

Session	1	2	3	4	5	6
Mean	2.7	2.0	2.7	3.2	1.5	
Median	3	2	3	3	1.5	
Range	1-6	1-3	1-4	2-4	1-2	
Standard deviation	1.5	0.7	1.0	0.8	N/A	
Number of responses	22	10	10	5	2	0

b) After flight

Session	1	2	3	4	5	6
Mean	2.6	3.1	2.3	3.3	3.0	
Median	2.0	3.0	1.5	4.5	3.0	
Range	1-8	1-9	1-5	1-6	N/A	
Standard deviation	2.0	2.6	1.6	2.5	N/A	
Number of responses	19	9	8	4	1	0

Table D17.
Duration of symptoms for the worst episode of neck pain in NAP.

Session	1	2	3	4	5	6
During flight	20 (47%)	9 (38%)	6 (40%)	2 (25%)	1 (20%)	
< 2 hrs after flight	12 (28%)	6 (25%)	2 (13%)	2 (25%)		
2-11 hrs after	4 (9%)	2 (8%)	3 (20%)		1 (20%)	
12-24 hrs after	1 (2%)	1 (4%)	2 (13%)	1 (13%)	1 (20%)	
1-4 days after	3 (7%)	4 (17%)	1 (4%)	2 (25%)	1 (20%)	
> 4 days after	3 (7%)	2 (8%)	1 (4%)	1 (13%)	1 (20%)	
Number of responses	43	24	15	8	5	
No answer	92	35	10	6	2	1

Table D18.
Duration of symptoms for an average episode of neck pain in NAP.

Session	1	2	3	4	5	6
During flight	20 (53%)	9 (39%)	7 (47%)	3 (38%)	1 (20%)	
< 2 hrs after flight	11 (29%)	7 (30%)	4 (27%)	1 (12%)	2 (40%)	
2-11 hrs after	3 (8%)	2 (9%)	2 (13%)	3 (38%)		
12-24 hrs after	1 (3%)	1 (4%)	2 (13%)	1 (12%)	1 (20%)	
1-4 days after	2 (5%)	4 (17%)			1 (20%)	
> 4 days after	1 (3%)					
Number of responses	38	23	15	8	5	
No answer	97	36	10	6	2	1

Table D19.
Proportion of NAP that have sought treatment for flight related neck pain.

Session	1	2	3	4	5	6
Treatment	12 (23%)	6 (24%)	4 (31%)	4 (50%)	3 (60%)	
No treatment	40 (77%)	19 (76%)	9 (69%)	4 (50%)	2 (40%)	
No answer	83	34	12	6	2	1

Table D20.
Clinician approached for treatment by NAP.

Session	1[1]	2[2]	3[3]	4[4]	5[5]	6
Doctor (SAM)	10 (83%)	6 (100%)	3 (75%)	3 (75%)	2 (67%)	
Physiotherapist	5 (42%)	3 (50%)	3 (75%)	1 (25%)	3 (100%)	
Osteopath/Chiropractor	6 (50%)	4 (67%)	2 (50%)		2 (67%)	
Other	2 (17%)			1 (25%)		
No. of responses	12	6	4	4	3	
No answer	123	53	21	10	4	1

[1]The majority saw a doctor for treatment and seven of the 10 attended the SAM. One attended an accupuncturist and one attended a consultant orthopaedic surgeon. All who attended the physiotherapist also attended a doctor. Two individuals saw the chiropractor without seeing the doctor.
[2]All respondents saw a doctor and five of the six saw the SAM. One saw both the physiotherapist and the osteopath, the remainder saw one or the other.
[3]One individual saw the chiropractor and the physiotherapist but not the doctor. The remaining three all saw a doctor.
[4]One person went for a massage to treat their symptoms.
[5]All respondents saw the physiotherapist, two also saw the doctor and chiropractor.

Table D21.
Proportion of NAP given treatment for neck pain.

Session	1	2	3	4	5	6
Treated	12 (43%)	6 (35%)	5 (42%)	5 (71%)	3 (75%)	
Untreated	16 (57%)	11 (65%)	7 (58%)	2 (29%)	1 (25%)	
No answer	107	42	13	7	3	1

If yes what treatment?

Massage and ointment
Massage
Massage (non-military)
Massage and exercises to help relieve neck pain
Massage and manipulation which treated the problem in three visits
Massage/ heat treatment
Chiropractor, due to posting regular chiropractor not used in the process of seeking new one
Chiropractor
Osteopath session put neck back in
Osteopath- still in treatment now at 6 month appt.
Since 1993 manipulation by osteopath on 4-6 month basis normally means is 204 vertebrae being put back in
Physio and chiropractor treatment two visits with footed the problem
Physio for approx 4 months advised to visit a chiropractor

Regularly physio sessions at Wattisham and re-referred to RAF Honnington for rehab
Physio
Physio
Phsyio for a number of weeks
Mobilization and stretching
Physio, pills
Algiban neck cream, physiotherapy
Headley court/hospitalised/ pink smarties
Back support from N. Luffenham
NSAIDs
Rest and pain killers
Rest
Accupuncture
Most pain starts after prolonged wearing of NVG whilst programming nav aids prior to t/o

Table D22.
Action taken by NAP to minimize or avoid flight-related neck pain.

Session	1	2	3	4	5	6
Action	19 (35%)	12 (50%)	5 (36%)	2 (25%)		
No action	36 (65%)	12 (50%)	9 (64%)	6 (75%)	4 (100%)	
No answer	80	35	11	6	3	1

Details of actions taken are as follows:
Physical exercise in the gym
Kept neck muscles strong and supple
Neck exercise
Neck exercised
Exercises no always
Exercise neck
Gymnasium, exercises to build up muscles and stretching
Exercise it
I regularly exercise my neck muscles and stretch
Gentle stretching exercises prior to flight
Exercise neck post flight
Gym
Exercise
Exercise neck/ fly more often
A simple warm up exercise prior to flying
Stretch neck muscles
Exercise, anti-inflammatory prior to NVG flying
Ground myself if bad

Private medicine- massage monthly since Jan 04 more effective than army system
Tried to alter position but it wasn't conducive to if flying
Constantly adjust seating position
Wearing back support
Use back rest to improve sitting posture maintain chin retraction during flight
Ensure correct fitting of NVG and counter balances/ weights to minimise effect
Varying position of counter balance weights and regular servicing of flying helmet
Fit correct balance weight when nite op!!
Pain occurs from forcing head/ eyes around to check for obstacles. Limited field of view on NVG twist body move
NVG counterweight
Use NVG counter-weight
Reduced frequency of NVG flying whilst under treatment
Better weight on helmet
Changed NVG counterbalance weight
Manipulation, sport to keep supple and careful movement
Chiropractor - neck exercises
Move neck and to crack loose neck
400 mg of Brufen
Flying more regularly

Table D23.
Proportion of NAP that have been grounded as a result of flight related neck pain.

Session	1	2	3	4	5	6
Grounded	2 (3%)	2 (9%)	3 (23%)	3 (43%)	2 (40%)	
Not grounded	56 (97%)	21 (91%)	10 (77%)	4 (57%)	3 (60%)	
No answer	77	36	12	7	2	1

Table D24.
Duration of grounding in NAP.

Session	1	2	3	4	5	6
< 1 week	1	3	2	2	2	
1-2 weeks	1		1	1		
No answer	133	56	22	11	5	1

Appendix E.

AP: Tabulated data for back pain questionnaire responses per session.

Table E1.
Primary reason for adjusting Apache seat.

Session	1	2	3	4	5	6	7
Optimum vision	1 (2%)	3 (8%)	2 (11%)	2 (18%)	1 (20%)		1 (100%)
Optimum control position	20(44%)	7 (19%)	2 (11%)		3 (60%)		
Compromise	22(49%)	24 (65%)	13 (72%)	8 (73%)	1(20%)	1 (100%)	
Other	2 (4%)	3 (8%)	1 (6%)	1 (9%)			
Number of responses	45	37	18	11	5	1	1
No answer	18	1			1	1	

Comments made by the aircrew to clarify their response are listed below:
Other:

- All of the above and comfort
- Leg room
- Combination of vision position and also crash attenuation (max seat height)
- bore sight height
- Compromise comfort/vision/control
- Maximum height as per release to service
- Maximum crash protection

Table E2.
Level of difficulty reaching and fully operating critical and emergency control switches with seat in normal position and normal flying posture with inertia reel locked in AP.

Session	1	2	3	4	5	6	7
Not problem	28 (72%)	30 (83%)	15 (83%)	9 (82%)	3 (60%)		1 (100%)
Slight difficulty	7 (18%)	6 (17%)	3 (17%)	2 (18%)	1 (20%)	1 (100%)	
Moderate difficulty	4 (10%)				1(20%)		
Cannot reach							
Number of responses	39	36	18	11	5	1	1
No answer	24	2		1	1	1	

Table E3.
Proportion of aircrew reporting previous back injury.

Session	1	2	3	4	5	6	7
Injury	19 (44%)	12 (33%)	6 (33%)	1(9%)	1(20%)		
No injury	24 (56%)	24 (67%)	12 (67%)	10 (91%)	4 (80%)	1 (100%)	1(100%)
No answer	20	2		1	1	1	

Descriptions of prior back injury given in Session 1:
General back problems since beginning flying
Mild back pain
1982? & 1991, lower back spasms resulting in incapacitation
Lower back locks up infrequently was more frequent when on Gazelle
Restricted movement of lower vertebrae
1994 damaged lower back during pt
During pilots course with incorrect position of Gazelle seat
Fracture (compression) to lower 4 vertebrae (as a result of helicopter crash)
Approx 1987 parachute compression injury
Early 01 torn ligament in right shoulder resulted in treatment by an osteopath
1990 low spine prolapsed disc
Narrowing of disk
June 02 sporting injury and (disc bulge)
Various times through career lower back. Trapped nerve
Whiplash symptoms but below the shoulder blades
Damage to back in RTA professional back support fitted when started flying Gazelle. All in med docs
Crashed Gazelle 15 Dec 02
Car crash April 2002
Schermans disease (growing pains)

Table E4.
Proportion of AP that have experienced back pain during a flight.

Session	1	2	3	4	5	6	7
Pain	25 (54%)	21 (58%)	11 (61%)	8 (73%)	3 (60%)		
No pain	21 (46%)	15 (42%)	7 (39%)	3 (27%)	2 (40%)	1 (100%)	1 (100%)
No answer	17	2		1	1	1	

Table E5.
Time to onset of back pain during flight in AP.

Session	1	2	3	4	5	6	7
Mean	54.6	58.4	62.7	67.9	60.0	N/A	N/A
Median	60	50	60	60	60	N/A	N/A
Range	<30-100	0-120	0-120	5-120	30-90	N/A	N/A
Standard deviation	24.3	41.6	36.9	45.3	30.0	N/A	N/A
Number of responses	24	18	11	7	3	N/A	N/A

In cases where a range of time was given the lowest number, or worst case scenario has been taken. When a pilot responded “various” that value has been excluded as it could not be quantified.

Table E6.
Total number of episodes of back pain reported during flight in AP.

Session	1	2	3	4	5	6	7
1-3	4 (17%)	3 (15%)	1(9%)	2 (25%)	1 (33%)		
4-10	7 (29%)	4 (20%)	6 (55%)	3(37.5%)			
10+	13 (54%)	13 (65%)	4 (36%)	3 (37.5%)	2 (67%)		
No answer	39	18	7	4	3	2	1

Table E7.
Number of episodes of back pain reported by AP in the last year.

Session	1	2	3	4	5	6	7
Mean	12.1	10.9	9.6	8.6	4.3	N/A	N/A
Median	1.0	5.0	8.0	4.5	2.0	N/A	N/A
Range	0-100	0-70	0-50	0-30	1-10	N/A	N/A
Standard deviation	23.8	17.5	14.0	11.0	4.9	N/A	N/A
Number of responses	21	19	11	8	3	N/A	N/A

Where answers were a single figure followed by a + sign the figure alone was used in calculations. Where a range was given, the upper number was used.

Table E8.
Aircraft in which most frequent back pain was experienced among AP.

Session	1[1]	2[2]	3[3]	4[4]	5[5]	6	7
Apache		11 (52%)	7 (64%)	5 (63%)	2 (67%)		
Gazelle	19 (76%)	8 (38%)	6 (55%)	5 (63%)	1 (33%)		
Lynx	10 (40%)	3 (14%)	1(9%)		1 (33%)		
Squirrel	2 (8%)	1 (5%)					
Other							
Number of responses	25	21	11	8	3		
No answer	38	17	7	4	3	2	1

[1]Two pilots reported both Lynx and Gazelle, two pilots reported Lynx gazelle and Squirrel
[2]Two pilots reported Gazelle and Apache
[3]Two pilots reported both Gazelle and Apache, one pilot reported Lynx and Apache
[4]Two pilots reported Gazelle and Apache
[5]One pilot reported both Lynx and Apache

Table E9.
Main site of back pain in AP.

Session	1[1]	2[2]	3	4[3]	5[4]	6	7
Lower back	20 (83%)	20 (95%)	9 (82%)	6 (75%)	3 (100%)		
Mid back	4 (17%)	1 (5%)					
Shoulders	3 (13%)	3 (14%)	2 (18%)	3 (38%)	1 (33%)		
Number of responses	24	21	11	8	3		
No answer	39	17	7	4	3	2	1

[1]Two pilots reported both lower and mid back, one reported lower back and shoulders
[2]Two reported pain in lower back and shoulders, one reported pain in lower and mid back
[3]One reported pain in lower back and shoulders
[4]One reported pain in lower back and shoulders

Table E10.

Factors influencing back pain during flight in AP.

Session	1[1]	2[2]	3[3]	4[4]	5[5]	6	7
Unsatisfactory seating position	16 (64%)	7 (35%)	6 (60%)	3 (38%)	1(33%)		
Length of flight	12 (48%)	11 (55%)	5 (50%)	4 (50%)	3 (100%)		
Infrequent flying duties	1 (4%)	1 (5%)		2 (25%)			
Recent illness/ injury	1 (4%)	2 (10%)	2 (20%)				
Mission type	3 (12%)	5 (25%)	3 (30%)	1 (13%)	1 (33%)		
Number of responses	25	20	10	8	3		
No answer	38	18	8	4	3	2	1

[1]Six pilots reported both seating position and length of flight, one reported seating position and recent illness of injury, one reported length of flight and mission type.
Length of flight 30 – 90 min

[2]Two pilots reported seat position and length of flight, four pilots reported both length of flight and mission type, one reported length of flight and infrequent flying
Length of flight 30 – 120 min

[3]One pilot reported unsatisfactory seating position, length of flight and recent illness or injury, one reported seating position, length of flight and mission type, one reported seating position and mission type, one pilot reported length of flight and mission type
Length of flight 60 – 120 min

[4]Two reported seating position and length of flight, one reported length of flight and infrequent flying duties, one reported length of flight and mission type.
Length of flight 20-120 min

[5]One reported seating position and length of flight, one reported length of flight and mission type.
Length of flight 60-90 min.

The aircrew qualified the factors influencing their pain with the following comments:
Unsatisfactory seating position: cockpit design

I get very little pain if I consciously maintain posture
Insufficient lumbar support
Poor seat posture with tendency to lean forward
Slouching in seat
Gazelle seat poor design
Gazelle seat design
Not enough lumbar support
Harness supports are low down your back
Poor lumbar support
Strap take off lower than shoulders forces clumping
Gazelle armoured seats (Northern Ireland)
If I forget to wear a back support it can ache slightly by the 2 hour point
Gazelle seat, enough said!
Insufficient lumbar support

Lynx and gazelle
Poor design
Need more lumbar support
Compromise between vision and controls
Leaning forwards into ort (front seat)
The seat slopes out at the bottom
Gazelle seat
Because seat cannot be adjusted fore and aft to obtain a comfortable flying position, upper body tends to be rotated anticlockwise thus straining when looking starboard
Gazelle seats
Poor front seat position
Can adjust seat height but not fore/aft leading to a slightly right shoulder forward position

Recent illness/ injury: I had a harsh crash in the sim at the start of my CSF, since then I have had pain.

Misison Type: Instrument flying
Goggles increase pain by 50%
During TLT NITEX long periods in cockpit, 4 hours or so, and challenging flying (i.e. tensed up)
Sometimes sat in hover in surveillance position for 5-7 hours
Wearing full immersion suit with dinghy pack with no seat cushion, you had a hard dinghy pack as a seat cushion and no lumbar support
Night longer than normal mission, increase in tension on tactical ex
Front seat (ort)
Flying 2 hours 20 minutes then staying in the cockpit, rearm, refuel and going again, 673 routinely stays in the cockpit for 5 hours at a time
Night low level increased intensity of back and shoulder pain

Table E11.
Proportion of AP that have experienced back pain after flight.

Session	1	2	3	4	5	6	7
Pain	24 (55%)	16 (47%)	11(65%)	5 (45%)	3 (60%)		
No pain	20 (45%)	18 (53%	6 (35%)	6 (55%)	2 (40%)	1(100%)	1(100%)
No answer	19	4	1	1	1	1	

Table E12.
Total number of episodes of back pain after flight reported by AP.

Session	1	2	3	4	5	6	7
1-3	5 (22%)	3 (19%)	1 (9%)	2 (40%)	1 (33%)		
4-10	4 (17%)	3 (19%)	5 (45%)				
10 +	14 (61%)	10 (62%)	5 (45%)	3 (60%)	2 (67%)		
Number of responses	23	16	11	5	3		
No answer	40	22	7	7	3	2	1

Table E13.
Number of episodes of back pain after flight in the last year among AP.

Session	1	2	3	4	5	6	7
Mean	5.2	7.4	8.2	18.3	5.5		
Median	0.5	3.0	7.5	16.5	5.5		
Range	0-30	0-40	0-30	0-40	1-10		
Standard Deviation	9.3	11.5	8.6	19.8	N/A		
Number of responses	14	13	10	4	2	0	0

Numbers reported as x + have been added as the value of x only, if a range was given the upper value of that range was used, responses of various or lots have been excluded from the calculation)

Table E14.
Factors that influenced back pain after flight in AP.

Session	1[1]	2[2]	3[3]	4[4]	5[5]	6	7
Unsatisfactory seating position	11 (58%)	6 (43%)	5 (50%)	1 (50%)	2 (100%)		
Length of flight	7 (37%)	8 (57%)	6 (60%)	2 (100%)	1 (50%)		
Infrequent flying duties	1 (5%)						
Recent illness/ injury	2 (11%)	2 (14%)	2 (20%)				
Mission type	2 (11%)	2 (14%)	1 (10%)				
Number of responses	19	14	10	2	2		
No answer	44	24	8	10	3	2	1

[1]Two pilots reported seat position and length of flight, one reported seat position and recent illness/ injury, one reported length of flight and mission type
Length of flight 30-60 min
[2]Two pilots reported seating position and length of flight, two responded length of flight and mission type
Length of flight 30-120 min
[3]Two reported seating position and length of flight, one reported seat position, length of flight and mission type.
Length of flight 120 min +
[4]One reported length of flight and unsatisfactory seating position
Length of flight 60-120 min
[5]One reported seating position and length of flight
Length of flight 60 min

The aircrew clarified the factors with the following comments:
Unsatisfactory seat position: Gazelle seat
Front seat on Apache when operating ORT and MPDS leaning forward and moving
Gazelle seat
Gazelle seat poor design
Only if I forget my back support at max of 2 hours (not always)
Climbing in and out of front seat casues problems
Lynx and Gazelle
Gazelle seat
Design
Need more lumbar support
Having stretched to reach the nav switches
Front seat ingress/egress
Front seat
Seat cushion moving in flight
Mission type: NVG increase pain
Long hours

Table E15.
Severity of worst back pain episode in AP.

a) During flight

Session	1	2	3	4	5	6	7
Mean	3.8	4.0	4.1	3.9	3.0		
Median	3.5	4.0	4.0	4.5	3.5		
Range	1-7	1-9	1-8	2-6	1-4		
Standard deviation	1.8	2.1	1.8	1.6	1.4		
Number of responses	26	22	12	8	4	0	0

b) After flight

Session	1	2	3	4	5	6	7
Mean	3.9	4.0	5.3	5.0	2.25		
Median	4	4	5	4.5	2		
Range	1-9	1-9	1-9	2-9	1-4		
Standard deviation	2.03	2.44	2.86	3.02	1.26		
Number of responses	25	21	12	8	4	0	0

Table E16.
Severity of average back pain episode in AP.

a) During flight

Session	1	2	3	4	5	6	7
Mean	3.4	3.0	3.3	2.9	2.7		
Median	3.0	3.0	2.0	2.0	3.0		
Range	1-6	1-5	1-7	2-5	1-4		
Standard deviation	1.2	1.4	2.1	1.2	1.5		
Number of responses	17	16	9	7	3	0	0

b) After flight

Session	1	2	3	4	5	6	7
Mean	3.4	3.0	3.5	3.0	2.8	1.0	
Median	3.0	2.5	3.0	3.0	2.5		
Range	1-7	1-7	1-7	2-4	1-5		
Standard deviation	1.8	2.0	2.2	1.0	1.7		
Number of responses	19	14	10	7	4	1	

Table E17.
Duration of symptoms for worst episode of back pain in AP.

Session	1	2	3	4	5	6	7
During flight	5 (16%)	6(27%)	1 (8%)	1 (12.5%)			
< 2 hours after flight	13 (41%)	2 (9%)	3 (25%)	3 (37.5%)	2 (67%)		
2-11 hours after	4 (13%)	5 (23%)	1 (8%)				
12-24 hours after	2 (6%)	4 (18%)	2 (17%)	1 (12.5%)			
1-4 days after	5 (16%)		2 (17%)	2 (25%)	1(33%)		
> 4 days after	3 (9%)	5 (23%)	3 (25%)	1 (12.5%)			
Number of responses	32	22	12	8	3		
No answer	31	16	6	4	3	2	1

Table E18.
Duration of symptoms for average episode of back pain in AP.

Session	1	2	3	4	5	6	7
During flight	7 (24%)	6 (29%)	2 (17%)	1 (12.5%)			
< 2 hours	13 (45%)	5 (24%)	3 (25%)	4 (50%)	3 (100%)		
2-11 hrs	3 (10%)	7 (33%)	3 (25%)	2 (25%)			
12-24 hrs	2 (7%)		1(8%)				
1-4 days	2 (7%)		1 (8%)				
> 4 days	2 (7%)	3 (14%)	2 (17%)	1 (12.5%)			
Number of responses	29	21	12	8	3		
No answer	34	17	6	4	3	2	1

Table E19.
Proportion of aircrew that have sought treatment for flight related back pain

Session	1	2	3	4	5	6	7
Treatment	20 (61%)	15 (63%)	7 (58%)	5 (63%)	2 (33%)		
No treatment	13 (39%)	9 (37%)	5 (42%)	3(37%)	1(67%)		
No answer	30	14	6	4	3	2	1

Table E20.
Clinician approached for treatment of back pain by AP.

Session	1[1]	2[2]	3[3]	4[4]	5	6
Doctor	17	9	6	4	2	
Physiotherapist	6	5	3			
Osteopath/Chiropractor	5	5	3	1		
Other	1	1				
Number of responses	17	11	6	1		
No answer	46	27	12	4	2	1

[1]One attended the military GP, the remainder saw the SAM. Three saw the doctor and a physiotherapist, one saw the doctor, a physiotherapist and an osteopath, one saw both SAM and military GP, chiropractor, osteopath and physiotherapist, one saw SAM physiotherapist chiropractor and acupuncturist.
Other: Acupuncturist
[2]One saw SAM and physiotherapist, one saw SAM and chiropractor, four saw SAM, physiotherapist, osteopath and/or chiropractor.
Other: Manager and Yoga
[3]One saw SAM and physiotherapist, one saw SAM and osteopath, one saw SAM, physiotherapist and osteopath or chiropractor.
[4]One saw SAM and other consultant, one saw SAM, physiotherapist and chiropractor.

Table E21.
Proportion of AP that received treatment for back pain.

Session	1	2	3	4	5	6	7
Treated	18 (78%)	10 (59%)	7 (88%)	4 (67%)	1 (25%)		
Untreated	5 (22%)	7 (41%)	1 (12%)	2 (33%)	3 (75%)		
No answer	40	21	10	6	2	2	1

Table E22.
Proportion of AP that have taken action to minimize flight-related back pain.

Session	1	2	3	4	5	6	7
Action taken	22 (69%)	13 (59%)	7 (70%)	4 (50%)	2(67%)		
No action	10 (31%)	9 (41%)	3 (30%)	4 (50%)	1 (33%)		
No answer	31	16	8	4	3	2	1

Table E23.
Proportion of AP that have been grounded as a result of flight-related back pain.

Session	1	2	3	4	5	6	7
Grounded	8 (24%)	7(29%)	3 (27%)	2 (25%)	1 (25%)		
Not grounded	26 (76%)	17 (71%)	8 (73%)	6 (75%)	3 (75%)		
No Answer	29	14	7	4	2	2	1

Table E24.
Duration of grounding for back pain in AP.

Session	1	2	3	4	5	6	7
< 1 week	3 (37.5%)	1 (17%)	1 (33%)	1 (50%)			
1-2 weeks	2 (25%)	2 (33%)		1 (50%)	1 (100%)		
3-4 weeks	1 (12.5%)	1 (17%)					
> 1 month	2 (25%)	2 (33%)	1 (33%)				
Currently grounded			1 (33%)				
No answer	55	32	15	10	5	2	1

Table E25.
Proportion of AP that agree that standard procedures for adjusting the seat allow them to achieve a good flying position.

Session	1	2	3	4	5	6	7
Agree	21(68%)	24 (96%)	9 (75%)	6 (86%)	4 (100%)		
Disagree	10 (32%)	1 (4%)	3 (25%)	1 (14%)			
No answer	32	13	6	5	2	2	1

Aircrew experiencing difficulties with seat adjustment provided the following suggestions to improve flying position:

I would like to be able to adjust the rake
Insufficient lumber support
Bad seat in lynx ok in AH-64
Not on the Gazelle I have not suffered back pain since flying Gazelle
The Lynx requires you to lean forward during normal flight- this posture has always made pain worse with goggles on due to the movement of the googles weight
The cyclic in the back is too low when the seat is fully up
Back pain is worse in the front
The Gazelle seat is designed so poorly it has to be seen to be believed
AH is pretty good but would prefer more lumbar support
No fore/ aft adjustment to seat
Squirrel has no seat adjustment

Gazelle seat cavity produces poor back position
Difficult to adjust for good boresight and optimum flying
Lap straps allow backside to slide forward
Use of back support in gazelle AH not yet known

Table E26.
Overall comfort rating for Apache seat.

Session	1	2	3	4	5	6	7
Mean	4.3	5.2	6.0	5.4	5.0		
Median	5.0	6.0	7.0	5.5	5.0		
Range	1-8	1-9	3-8	3-8	3-7		
Standard deviation	1.9	2.3	1.6	1.5	1.6		
Number of responses	23	22	11	8	4	2	1

1-9 (1= extremely uncomfortable, 5= adequate, 9=extremely comfortable)

The aircrew qualified the discomfort of the Apache seat with the following comments:

Lumbar support too small
No lumbar support
Lumbar support cushion moving
The back support cushions are now wearing out and may need to be regularly replaced
Need better cushions plus lumbar support
Lack of lumbar support strap take off too low
Lack of back support
Helicopters
Leaning forward
Right shoulder forward flying position
Posture relaxation unrestrained by lap belts
Poor sitting profile
Legroom in front seat right knee can rest on the lower edge of right mpd
On longer flights (2 hrs plus) painful backside (lack of padding on seat)
Sortie duration in cramped cockpit poor lumbar support
Time
Gazelle 3 lynx 5 / long flying hours
Inability to move for hours
Sore/ numb posterior during all flights in any aircraft where the duration exceeds 1.5-2 hours
Seat is hard after 2 hours in it
Seat/ harness design
Seat cushion could provide more comfort
Seat cushion extremely compressed and worn
Seat cushion unsuitable for weight and duration
Seat cushion is useless

Lack of adjustment fore/aft
Pre disposed condition
Climbing in and out of front of aircraft
Climbing in/out front seat. Length of flight/trial
Lynx armoured seat and poor cushions
My problems were primarily from poor seat in lynx , AH is much better
After a long flight the only pain I suffer is the need to stretch my back

Appendix F.

NAP: Tabulated data for back pain questionnaire responses per session.

Table F1.
Main reasons for adjusting seat in aircraft other than Apache.

Session	1	2	3	4	5	6
Optimum vision	1 (1%)	3 (5%)	2 (17%)	1(7%)		
Optimum control position	95 (73%)	27 (47%)	9 (38%)	5 (36%)	5 (71%)	
Compromise of both	27 (21%)	26 (45%)	11(46%)	8 (57%)	2 (29%)	1 (100%)
Other	8 (6%)	2 (3%)	2 (8%)			
Number of responses	131	58	24	14	7	1
No answer	6	1	1			

The aircrew made the following comments to clarify their responses:

Other: Because I can't fit otherwise
To prevent legs becoming tense
Comfort
Seat settings in all aircraft are insufficient for tall people
Comfort
Compromise between comfort and control
Optimum posture
Always fully rear for leg room
For back pain i.e. to stop it
Comfort
Get as low as possible
To minimize discomfort

Table F2.
Level of difficulty reaching and fully operating critical and emergency control switches with seat in normal position and normal flying posture with inertia reel locked in NAP.

Session	1	2	3	4	5	6
Not a problem	90 (68%)	39 (67%)	19 (79%)	9 (64%)	6 (86%)	1 (100%)
Slight difficulty	40 (30%)	18 (31%)	5 (21%)	5 (36%)	1 (14%)	
Moderate difficulty	2 (2%)	1 (2%)				
Cannot reach	1 (1%)					
Number of responses	133	58	24	14	7	1
No answer	2	1	1			

Table F3.
Proportion of NAP that experienced previous back pain.

Session	1	2	3	4	5	6
Previous pain	28 (26%)	22 (38%)	10 (42%)	8 (62%)	5(71%)	1(100%)
No pain	102 (95%)	36 (62%)	14 (58%)	5 (38%)	2 (29%)	
No answer	5	1	1	1		

The details of prior back conditions reported in session 1 are detailed below:

Oct 85- injured lower back during firemans carry run. July 98 injured lower back whilst lifting person on shoulders. Late 96 reinjured lower back after slipping whilst pushing aircraft into bay

Slipped / prolapsed disc due to weight lifting

March 1999 Sandhurst narrowed disc space between l4 & l5

Suspect slipped disc as a 16 yr old

Oct 95- fractured side process of t4

1984-85 operation to lower spine- fused s1-s5

Slipped disc in 1996

"prolapsed l3,l4,l5. 1995 Cyprus on exercise casevaced back to uk grounded for 3 months for physio"

Approx oct 1991 cracked disk in the lower back

Disc bulge l4/l5 nerve compression operation. Discetomy l4/l5 decompression

Trapped nerve lower back in 2000 however completely gone after treatment

4th verebrae mild spin bifida (or simlilar) identified @ 13 years old

Displaced sacro-illiac joint damaged disc

Broken ribs

Two episodes of back strain first age 17 playing rugby second age 30.

April/ may 2000 jarred lower back on a cross country run

Fall from a horse 1997

1992 injury to right shoulder whilst playing rugby

Rugby injury stems from linked movement of lower spine

Details in med docs sport injuries

Sore back resulting from a car crash

Rugby injury / car crash/ bike crash

Progressive 96-97 rowing lower back damage

1991 rock climbing vertical drop 2 metres jarred spine at small of back

97 sore back caused by sports hockey and rugby needed chiropractic attention

11/01/77- car bomb in NI

Fall on loaded bergan forced march in 1994. Recurred after car accident in 2000

On pilots course started during fixed wing

Table F4.

Proportion of NAP that have experienced back pain during flight.

Session	1	2	3	4	5	6
Pain	82 (62%)	40 (70%)	16 (67%)	10 (71%)	5 (71%)	1 (100%)
No pain	50 (38%)	17 (30%)	8 (33%)	4 (29%)	2 (29%)	
No answer	3	2	1			

Table F5.

Time to onset of back pain during flight in NAP.

Session	1	2	3	4	5	6
Mean	44.5	58.6	71.7	25.6	28.8	20.0
Median	30	55	60	27.5	20	N/A
Range	0-240	0-90	0-360	0-50	15-60	N/A
Standard deviation	41.7	41.3	95.0	19.0	21.0	N/A
Number of responses	66	32	12	8	4	1

Table F6.

Total number of episodes of back pain experienced by NAP during flight.

Session	1	2	3	4	5	6
1-3	22 (27%)	12 (31%)	2 (12%)	1(10%)	2 (40%)	
4-10	23 (28%)	7 (18%)	4 (25%)	3 (30%)		
10+	37 (45%)	20 (51%)	10 (63%)	6 (60%)	3 (60%)	1 (100%)
No answer	53	20	9	4	2	

Table F7.

Episodes of back pain experienced by NAP during flight in the preceding year.

Session	1	2	3	4	5	6
Mean	3.7	4.4	3.1	6.0	1.8	10.0
Median	2	2	1	2	1	N/A
Range	0-30	0-30	0-10	0-20	0-5	N/A
Standard deviation	5.3	7.7	3.9	7.3	2.4	N/A
Number of responses	57	29	13	7	4	1

Table F8.
Aircraft type in which most frequent back pain was experienced by NAP.

Session	1[1]	2[2]	3[3]	4[4]	5[5]	6
Gazelle	21 (26%)	20(50%)	6 (38%)	6 (60%)	4 (80%)	
Lynx	20 (25%)	18 (45%)	6 (38%)	3 (30%)	2 (40%)	1 (100%)
Squirrel	37 (46%)	6 15%)	3 (19%)	2 (20%)		
Other	7 (9%)	2 (5%)	1(6%)	1(10%)	1 (20%)	
Number of responses	80	40	16	10	5	1
No answer	55	19	9	4	2	

[1]Three Gazelle pilots also reported Squirrel, one reported both Lynx and Gazelle, one pilot reported both Lynx and Squirrel, one pilot reported Firefly and Squirrel.
Four reported pain in the Firefly, one in the Wessex and one in the Bell 212. A seventh person reported pain in all types flown.
[2]Three pilots reported pain in the Lynx and Gazelle, one in Lynx, Gazelle and Squirrel and one in Gazelle and Squirrel.
One pilot reported pain when flying the Puma and one when flying the Wessex.
[3]One pilot reported pain in the Wessex.
[4]One pilot reported pain in both Gazelle and Squirrel, one in both Lynx and gazelle and one pilot reported pain when flying the Wessex.
[5]One pilot reported pain in Lynx, Gazelle and Bell 212

Table F9.
Main site of back pain reported by NAP.

Session	1[1]	2[2]	3	4[3]	5[4]	6
Lower back	64 (79%)	32 (80%)	15 (94%)	9 (90%)	5 (100%)	1 (100%)
Mid back	14 (17%)	9 (23%)	1 (6%)	2 (20%)		
Shoulders	8 (10%)	4 (10%)				
Other	2 (2%)	1 (2%)				
Number of responses	81	40	16	10	5	1
No answer	54	19	9	4	2	

[1]Three pilots reported pain in both lower back and shoulders, two reported pain in lower back and buttocks, two reported pain in lower and mid back.
Other related to buttocks.
[2]One pilot reported pain in lower back and buttocks, one in lower and mid back and two in lower, mid back and shoulders
[3]One pilot reported pain in both lower and mid back

Table F10.
Factors influencing back pain during flight in NAP.

Session	1[1]	2[2]	3[3]	4[4]	5[5]	6
Unsatisfactory seating position	36 (48%)	19 (50%)	8 (53%)	7 (70%)	3 (60%)	
Length of flight	34 (45%)	24 (63%)	12 (80%)	2 (20%)	2 (40%)	
Infrequent flying duties	9 (12%)	4 (11%)				
Recent illness/injury	6 (8%)	4 (11%)	2 (13%)	4 (40%)	1 (20%)	1 (100%)
Mission type	8 (11%)	7 (18%)	2 (13%)	1(10%)		
Other	4 (5%)					
Number of responses	75	38	15	10	5	1
No answer	60	21	10	4	1	

[1]Seven pilots responded both unsatisfactory seating position and length of flight, one reported seating position and mission type, one reported seating position and infrequent flying duties, three reported length of flight and infrequent flying duties, four reported length of flight and infrequent flying duties, two reported length of flight and recent injury, two reported seating position, length of flight and mission type.
Length of flight ranged from 10 min – 180 min
[2]Three pilots reported seat and mission type to be factors, four reported seat and length of flight, one reported seat, length of flight and infrequent flying duties, one reported seat and infrequent flying duties, two reported length of flight and mission type, two reported length of flight and recent illness or injury, one reported recent illness and mission type, one reported length of flight, infrequent flying duties and mission type.
Length of flight varied from 25 min to 120 min.
[3]Three reported unsatisfactory seating position and length of flight, two reported seating, length of flight and mission type, two reported length of flight and recent illness or injury
Length of flight ranged from 40-90 min
[4]Two reported seating position and recent illness, one reported length of flight and recent illness, two reported seating position and length of flight.
Length of flight 30-45 min
[5]One pilot responded both seating position and recent illness
Length of flight 60 min.

The aircrew qualified their responses with the following comments:
Unsatisfactory seating position: unsatisfactory seat

Gazelle seat
Shape of seat
Armoured seat makes for uncomfortable flying position
Bad posture hands in asymmetrical position causing body to twist
Poor lumbar and back support and effects of seat harness
Firefly is very small and uncomfortable and I'm 6'4" tall
Ergonomics of gazelle seat location with reference to leg length, controls etc.
Lack of lumbar support rather than position
Abnormal lumbar posture, poor support

None of the issues were found when hands on in right hand seat in Lynx
Moor to do with poor posture
Crouch forward position
Seat too small for a 6’4” man
More seat design
Poor lumbar support in gazelle and head interaction in gazelle
Poor design on seat which leads to poor posture
Non adjustable seat with parachute present
Lack of support in lower back
Back position to maintain control of all controls
Seat too fat back, overextension to reach controls, so sit closer, happens on instrument flying mostly
I have to sit twisted in Lynx to fly cycles
Too upright, seat shape not good for my personal back shape
Hard to maintain correct posture
No space in Squirrel seat to place buttock i.e. can’t straighten back
Seat only adjust up and down so difficult with smaller legs
Seat of odd shape with little lower back support
Hunched over.
Gazelle seat
Seat makes you hunch forward giving poor posture (armoured seats are more comfortable)
Long reach and twist to operate collective at min pitch
No height adjustment on seat have vot lean forward for optimum vision
Independent seat adjustment no centered to instruments “helicopter hunch”
Lack of lumbar
Lack of support and cushioning
Gazelle no height adjustment on seat, Lynx no forward/ back adjustment
Poor seat design
Perceived requirement to slouch on seat to operate collective
Very poor rear ergonomic
Can’t adjust seat fully
You have to twist to fly it
Reclined seating position is not entirely comfortable
Squirrel seat found to be very uncomfortable for lower back, improved with flying experience
Leaning forward to get better visuals for a long time causes problems
Limited movement
Moved seat forward
Poor seat design
Lynx seat, helicopter hunch
The most ill fitting seat position in the lumbar support
Lack of lumbar lordosis

Length of flight comments: 20 minutes instrument flying

Back pain develops quickly in individual flight only when several flights are made each day

45 minutes if crouching

Mission type- student flying

IF flying position of head and shoulders, constantly looking down
Low level nav much worse
IF flying
IF flying
NVG
Low level
Happens on instrument flying mostly
Trial thermal imager
Instrument flying
Prolonged missions in France
Flying with body armour/chest plate in NI
Sorties involving prolonged hovering
Instrument flying
Operational sorties of similar profile
Long periods with body armour etc
Missions involved lots of hover
Frequent flying

Other: seat cushion unserviceable

Inadequate lumbar support
Insufficient lumbar support
Hard plastic seats

Table F11.
Proportion of NAP that have experienced back pain after flight.

Session	1	2	3	4	5	6
Pain	47 (40%)	26 (46%)	12 (52%)	10 (77%)	5 (83%)	1 (100%)
No pain	70 (60%)	30 (54%)	11(48%)	3 (23%)	1 (17%)	
No answer	18	3	2	1	1	

Table F12.
Total number of episodes of back pain reported after flight in NAP.

Session	1	2	3	4	5	6
1-3	15 (31%)	6 (23%)	3 (23%)	4(40%)	3 (60%)	
4-10	13 (27%)	5 (19%)	2 (15%)	2 (20%)		
10 +	20 (42%)	15 (58%)	8 (62%)	4 (40%)	2 (40%)	1 (100%)
No answer	87	33	12	4	2	

Table F13.
Episodes of back pain reported in the preceding year by NAP.

Session	1	2	3	4	5	6
Mean	3.4	3.6	1.9	5.4	0.8	10
Median	2	1.5	0.5	2.0	0.5	N/A
Range	0-20	0-20	0-10	0-25	0-2	N/A
Standard deviation	4.4	5.3	3.2	9.1	1.0	N/A
Number of responses	31	16	10	7	4	1

Table F14.
Factors that influenced back pain after flight in NAP.

Session	1[1]	2[2]	3[3]	4[4]	5[5]	6
Unsatisfactory seating position	18 (44%)	10 (45%)	6 (55%)	7 (70%)	2 (40%)	
Length of flight	17 (41%)	11 (50%)	4 (36%)	4 (40%)	2 (40%)	
Infrequent flying duties	3 (7%)	1 (5%)				
Recent illness/injury	5 (12%)	5 (23%)	3 (27%)	2 (20%)	2 (40%)	1 (100%)
Mission type	3 (7%)	5 (23%)				
Other						
Number of responses	41	22	11	10	5	1
No answer	94	37	14	4	2	

[1]Three pilots responded both seat position and length of flight, two pilots reported length of flight and mission type, one reported length of flight and recent illness, one reported length of flight and infrequent flying duties
Length of flight ranged from 10-90 min
[2]Two pilots reported both seating position and mission type, two reported seating position and length of flight, one reported seating position and recent illness or injury, one reported length of flight and mission type, one reported length of flight as well as infrequent flying duties and mission type, two reported length of flight and recent illness of injury, one reported recent injury and mission type
Length of flight 50-120 min
[3]Two pilots reported length of flight and recent illness or injury
Length of flight 60 min
[4]Two pilots reported seating position and length of flight, one reported seating position and recent illness or injury, one reported seating position, length of flight and recent illness or injury
Length of flight 40-180 min
[5]One pilot reported both length of flight and recent illness/ injury.
Length of flight 60 min

The aircrew made the following comments to clarity their responses:
Unsatisfactory seating position: Possible poor posture as a student pilot
Hunched over controls
Length of flight

If hunched forward
Crap seats in firefly, very uncomfortable
Lack of support and cushioning
Gazelle no height adjustment on seat, Lynx no forward/backwards adjustment
Due to wanting better visuals and leaning forward
Limited movement of armoured seats
Helicopter hunch
Legs do not sit directly in front of body when resting on yaw pedals
Poor seat design

Mission type: instrument flying
QHI duties
Trial flying
Prolonged mission
Operational sorties of long duration

Other: Not sure whether back pain is flying related or sport related but was instigated by prolonged seating in the Gazelle.

Table F15.
Severity of worst episode of back pain reported by NAP.

a) During flight

Session	1	2	3	4	5	6
Mean	4.0	4.6	5.1	4.7	5.2	4.0
Median	3	4	4.5	4	6	N/A
Range	1-9	2-9	2-9	3-8	3-8	N/A
Standard deviation	1.8	1.9	2.1	1.6	2.2	N/A
Number of responses	79	38	14	11	5	1

b) After flight

Session	1	2	3	4	5	6
Mean	3.2	4.3	3.9	5.1	4.2	4.0
Median	3	4	4	6	4	N/A
Range	0-9	1-9	0-8	1-9	2-6	N/A
Standard deviation	2.4	2.7	2.3	2.5	1.5	N/A
Number of responses	64	32	13	11	5	1

Table F16.
Average severity of back pain reported by NAP.

a) During flight

Session	1	2	3	4	5	6
Mean	3.0	3.6	2.8	3.1	3.8	4.0
Median	3	4	3	3	3	N/A
Range	0-6	0-8	0-4	2-6	3-6	N/A
Standard deviation	4.5	1.6	1.2	1.4	1.5	N/A
Number of responses	38	26	10	8	4	1

b) After flight

Session	1	2	3	4	5	6
Mean	3.0	3.5	3.3	3.0	2.8	
Median	3.0	5.0	3.0	2.0	2.0	
Range	0-8	0-9	1-7	1-7	2-4	
Standard deviation	1.8	6.5	5.2	2.4	1.1	
Number of responses	38	22	7	5	5	

Table F17.
Duration of symptoms for the worst episode of back pain in NAP.

Session	1	2	3	4	5	6
During flight	32 (44%)	14 (38%)	3 (20%)	1 (10%)		
< 2 hours	22 (31%)	9 (24%)	4 (27%)	3(30%)	1 (20%)	
2-11 hours	11(15%)	5 (14%)	5 (33%)	3 (30%)		
12-24 hours	4 (6%)	1 (3%)			1 (20%)	
1-4 days	6 (8%)	5 (14%)	1 (7%)	1 (10%)	2 (40%)	1 (100%)
More than 4 days	7 (9%)	7 (19%)	4 (27%)	4 (40%)	1 (20%)	
Number of responses	72	37	15	10	5	1
No answer	53	18	8	2	2	

Table F18.
Duration of average episode of back pain in NAP.

Session	1	2	3	4	5	6
During flight	41 (57%)	17 (49%)	5 (33%)	2 (20%)	1 (20%)	
< 2 hours	22 (31%)	11 (31%)	8 (53%)	3 (30%)	1 (20%)	
2-11 hours	8 (11%)	4 (11%)	1 (7%)	3 (30%)	1 (20%)	
12-24 hours	3 (4%)	3 (8%)		1 (10%)	1 (20%)	
1-4 days	2 (3%)	3 (8%)	1 (7%)		1 (20%)	1(100%)
More than 4 days	4 (6%)	1 (3%)		2 (20%)		
Number of responses	72	35	15	10	5	1
No answer	55	20	8	3	2	

Table F19.
Proportion of NAP that sought treatment for flight related back pain.

Session	1	2	3	4	5	6
Treatment	34 (38%)	18 (42%)	11 (65%)	7 (58%)	3 (60%)	1 (100%)
No treatment	56 (62%)	25 (58%)	6 (35%)	5 (42%)	2 (40%)	
No answer	45	16	8	2	2	

Table F20.
Clinician approached for treatment of back pain by NAP.

Session	1[1]	2[2]	3[3]	4[4]	5[5]	6
Doctor	30	15	11	5	3	
Physiotherapist	10	7	5	3	2	
Osteopath/Chiropractor	12	5	6	2	2	
Other	3	3	4	1		
Number of responses	34	17	11	5	3	
No answer	101	42	14	9	4	1

[1]Three pilots sought treatment from a military GP, the remainder from the SAM. Seven were treated by both the SAM and physiotherapist, three saw the SAM physiotherapist and osteopath or chiropractor, one saw the SAM and an acupuncturist, two saw the SAM and an osteopath or chiropractor, one saw the SAM, osteopath and an orthopaedic surgeon, one saw the SAM, osteopath and a back specialist.
Other: Consultant orthopaedic surgeon
Back specialist
Acupuncturist
[2]Four saw the SAM and physiotherapist, two saw the SAM and osteopath or chiropractor, one say the SAM, military GP, osteopath, chiropractor and acupuncturist, one saw the physiotherapist and acupuncturist.
Other: acupuncturist
Lumbar support fitting

[3]Two say SAM and physiotherapist, two saw the GP, three saw a doctor and chiropractor or osteopath, one saw SAM, physiotherapist, osteopath, chiropractor and had massage, two saw SAM, Physiotherapist, osteopath/chiropractor and acupuncturist.
Other: Massage
Acupuncturist
Lumbar support fitting
[4]Two saw SAM and physiotherapist, one saw doctor and chiropractor, one saw SAM physiotherapist and chiropractor, one saw GP and lumbar support fitting
Other: lumbar support fitting
[5]Two saw doctor, physiotherapist and chiropractor.

Table F21.
Proportion of NAP that received treatment for back pain.

Session	1	2	3	4	5	6
Treated	33 (49%)	19 (63%)	12 (71%)	7 (70%)	5 (100%)	
Untreated	34 (51%)	11 (37%)	5 (29%)	3 (10%)		
No answer	68	29	8	4	2	1

Table F22.
Proportion of NAP that have taken action to minimize or avoid flight related back pain.

Session	1	2	3	4	5	6
Action taken	48 (52%)	25 (58%)	13 (72%)	4 (40%)	4 (67%)	
No action	44 (48%)	18 (42%)	5 (28%)	6 (60%)	2 (33%)	
No answer	43	16	7	4	1	1

Table F23.
Proportion of NAP that have been grounded as a result of flight related back pain.

Session	1	2	3	4	5	6
Grounded	10 (10%)	7 (16%)	3 (19%)	4 (33%)	1(20%)	1 (100%)
Not grounded	86 (90%)	38 (84%)	13 (81%)	8 (67%)	4 (80%)	
No answer	39	14	9	2	2	

Table F24.
Duration of grounding for NAP.

Session	1	2	3	4	5	6
< 1 week	2 (25%)	2 (29%)	1 (33%)	1 (25%)	1 (100%)	
1-2 weeks	2 (25%)	2 (29%)		1 (25%)		1 (100%)
3-4 weeks	1 (12%)		1 (33%)	1 (25%)		
> 1 month	3 (38%)	3 (42%)	1 (33%)	1 (25%)		
No answer	127	52	22	10	6	

Table F25.
Proportion of NAP that agree that standard procedures for adjusting the seat allow them to achieve a good flying position.

Session	1	2	3	4	5	6
Agree	90 (78%)	33 (67%)	13 (68%)	7 (58%)	2 (40%)	
Disagree	26 (22%)	16 (33%)	6 (32%)	5 (42%)	3 (60%)	1 (100%)
No answer	19	10	6	2	2	

Aircrew experiencing difficulties with seat adjustment provided the following suggestions to improve flying position:

The Gazelle seat is uncomfortable

Gazelle seat uncomfortable have to sit hunched especially with NVG and on commanders side with GOA site

Lack of lumbar support

No lumbar support

Not a comfortable seat however lumbar cushion helps greatly

Use of moulded lumbar support

Lumbar position of squirrel seats is poorly shaped. Requires poor posture to be adapted in order to sit correctly.

Lumbar support

No lumbar lordosis use inflatable cushion

Insufficient lumber support

Service provided back support in uncomfortable due to twisty low spine. Goa sight

Seat requires adjustable lumber support

Lumbar support

Need to adjust lumbar support. Wear a lumbar support to improve it

Not adjustment but rather seat shape use cushion

Upright back lumbar area poor

No seat back adjustment

Seat has no back height adjustment top of seat back can interfere with back of flying helmet no seat back width adjustment

Good seat position means I cannot reach inst panel. I lock and unlock inertia reel after climb out and before landing

Not all aircraft in the fleet have seats in the same position (depends on a/c fit)
In between seat adjustment levels
To avoid hyperflexion of back seat has to be too close to controls for leg length
As said before the squirrel has no height adjustment the lynx is fine
Seat moves up and down angle of seat cannot be adjusted
Gazelle seat does not adjust
Adequate adjustment difficult in both Lynx & Gazelle due to limited seat movements
Lynx- vertical adjustment is ok but seat does not move fore and aft (pedals move instead) so have to lean forward to move look out
Only move up and down no lumbar support
Seat to small adjustments do not allow seat to go back enough
The seat in the lynx has poor movement for adjusting in the fore and aft plane
Only fore and aft adjustment
Seat is not adjustable fore and aft to bring body closer to controls
Not enough adjustment forward and aft
Gazelle seat does not have a varying height sector which means a hunch/slouch is required to fly
Gazelle no up/ down adjustment hold stick in wrong place lynx- no fwd/ back adjustment end up "reaching" for stick
No height adjust short legs, long body
The position is acceptable / satisfactory but not good due to limited range of movement of seat
Uncomfortable cause back pain after prolonged flight
Optimum control position lacks visibility
My position in relation to the controls is fine but my view feels restricted. I would like to be able to sit higher
Have short legs so have pedals close but have to have seat high for viewing purposes and it feels awkward
I need to lean forward during high work load times to have better visuals
Seem to be leaning forwards slightly the more i fly more the more used to it i become
Requirement to rest right hand on knee requires body to be hunched forwards
Seat positions are inadequate for people taller than 6'4"
Does not allow change of cyclic stick position relative to sitting position
It’s a terrible seat
Restricted with harness locked change from armoured to no armoured seat requres different position or posture
But does not debate back problems
Shape of Gazelle seat renowned as uncomfortable
The seat in a lynx is almost a wastelands after thought giving a poor seated posture
Have to move body position to reach the collective
No space to lock out buttocsk ie) cant straighten back (natural s- bend)
In squirrel yes, no in firefly
I have short legs so to get me, my arms and legs in the correct position is impossible in the lynx
I find myself slouching in the seat and having to correct my position

Table F26.
Overall comfort of the aircraft seat (NAP)

Session	1	2	3	4	5	6
Mean	5.1	4.3	4.6	4.6	4.6	4.0
Median	5	5	5	5	5	N/A
Range	1-9	1-7	3-6	3-7	4-5	N/A
Standard deviation	1.7	1.5	0.9	1.2	0.6	N/A
Number of responses	118	49	17	11	5	1

Comfort was rated on a scale of 1-9 (bad to good).

The aircrew provided the following comments regarding seat comfort and possible sources of improvement:

Nature of helicopter flying position one hand low on collective other hand high on cyclic
Seat not in line with controls so spine twisted in addition to flexed (helicopter hunch)
low position of seat belt, twist in spine caused by help controls
The torso twist to fly easily
Poor design of seat and controls and my height
Poor seat design and ergonomics
Seat shape and control position
Lh seat control position
Position you have to achieve to reach controls
Posture related
Flying posture
Helicopter hunch
Slight bend to left for collective
Having to occasionally hunch
Cockpit ergonomics
Height of seat above pedals
The need to bend down to reach collective
Poor ergeronimical posture
Poor ergonomics
As the seat is high I tend to lean forward right side only causing shoulder pain
Old seats and poor ergonomics of seat (especially armoured seat)
Slope of the seat
Reach for collective
Reach for collective
General position
Hunch position at controls
Helicopter seats are in general too upright
Back support seems a little to vertical causing you to lean forward slightly
Too much of an upright position
Seat too upright

A little up right
Scanning position on instrument flying
Very little cushioning/ very upright seat no flex in back support / have to lean over instruments
General twisting and stretching
Reclined position
Difficulties with reach
Gazelle seat does not adjust
Lack of fore/ aft movt
Not enough support and adjustment
Slight twist to left for right hand seat and no lumber support
Poor cushioning poor back support
No support of lumbar spine
Front seat with no lumbar support
Seating position lack of lumbar support
Poor lumbar support and poor upper seat belt mounting position causing belts to pull down on shoulders
Lack of lumbar support during extended periods of flight
The back rest
Too narrow and small, lack of lumbar support, lack of adjustment
Poor back support/ position
Lack of lumbar support and twisting of body
Lack of lumbar support
Height of back support
Lack of lumbar support
Lack of lumbar support
Loss of normal lumbar position/ shape
Poor lumbar support
Lack of lumbar support
Lack of lumbar support
Lack of lumbar support
No lumbar support
Lack of support
Poor shaping to fit body contours
Lack of lateral support narrowness of backrest
Rear of the seat- no lower back support
Gap in lumber area
Having to hunch no real back support
Armoured seats wings are restricting, non-armoured seats lack support
Lack of contouring on seat / armour on armoured seat
Poor/worn out seat cushions. Lack of lumbar support
Numb bottom during prolonged flights
Too rigid
Rigidity of seat

Vibration / lack of padding
Lack of cushioning
Poor seat cushion
A hard seat
Seat is too hard
Poor seat cushions and back cushions
Thin seat cushion
Seat cushion
Hard plastic seat
Poor quality/ worn cushion
Poor seat cushion in seat pan
Poor seat cushions and back cushions
Not very padded for obvious safety reasons
Anterior ridge of seat
Gazelle - ridge at top of seat and poor seat position (lynx and gazelle)
Front edge of seat hollow digs in
Don’t know
Long periods of flying
Long periods
Too long on seat
Length of time on seat
Seats qual soft
Pain, seat design and weight of NVG
Already present back pain
Existing back problem
Lower back pain
The parachute and lifetime of slouching
The length of my legs
Lynx armoured seat
Position
Seat shape
Poor seat
Slightly high
Armoured seats carrying weapons
There is but I can't give a reason I don’t have one

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