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# Prevalence of fatigue among commercial pilots

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**Background** Short-haul pilots have largely been neglected in studies of fatigue, sleep loss and circadian disruption created by flight operations, but anecdotal evidence from pilots suggests that with the increasing amount of low-cost air travel, commercial pilots working short-haul operations may be becoming seriously fatigued.

**Aims** This study attempted to ascertain how much subjective fatigue short-haul pilots reported, and makes comparisons between low-cost and scheduled airline pilots.

**Methods** Pilots completed anonymous questionnaires (encompassing aviation factors, flight experience and a fatigue scale) posted on the Professional Pilots' Rumours Network website.

**Results** Data were collected from 162 short-haul pilots and statistical adjustment for operational factors was made. Seventy-five percent reported severe fatigue and 81% reported the fatigue to be worse than 2 years ago. Eighty percent considered their thought processes were reduced while flying. Severe fatigue was reported more frequently by low-cost airline pilots than scheduled airline pilots ($P = 0.05$) and fatigue ratings were higher in this group ($P = 0.03$). Pilots who reported regularly flying into their 'discretion' hours had lower physical and psychological health, and overall fatigue scores, and poorer self-rated general health. Flying into discretion time occurred no more frequently in low-cost airline pilots than scheduled airline pilots.

**Conclusions** Identifiable fatigue problems are reported by short-haul pilots, but this cannot be attributed solely to the work schedules of low-cost airlines as regular use of discretion time appears to be associated with fatigue regardless of airline.

**Key words** Aviation; fatigue; pilots; short-haul.

## Introduction

Fatigue is an important factor in aviation, and is associated with sleep loss and shift work. Long duty cycles can cause pilots to become inattentive, careless and inefficient [1]. Civil aircrew frequently experience loss or disturbance of sleep, transmeridian flight, irregular work–rest cycles and a variety of other job-related factors associated with this problem [1]. Fatigue management requires an understanding of the relationship between working conditions and fatigue. In one-third of all reports to the UK Confidential Human Factors Incident Reporting Programme reports pilots attribute incidents, errors or problems to fatigue. NASA's Aviation Safety Reporting System indicates that 21% of reported aviation incidents are fatigue related [2]. Fatigue has been cited as a cause in many aviation accidents and is a continuing problem facing crews flying aircraft of all sizes [3]. It is not affected by motivation, professionalism, training or status [4,5].

Aviation technology and operational demands have all evolved significantly, yet the human operator's need for sleep remains. Fatigue degrades most aspects of performance, including judgement, decision making, memory, reaction time, concentration, selective attention, fixation and mood [6,7]. Low arousal produced by sleep loss is accompanied by a greater performance decrement on simple rather than on complex tasks [6]. The technological simplification of the aviation process may contribute to this performance decrement.

Although individuals differ in the amount of sleep they require, studies suggest most require between 8 and 9 h sleep per night [8]. Shift workers generally sleep less than non-shift workers [9] and UK pilots claim to need 7.5 h sleep a night [10]. Sleep duration is influenced by sleep timing. Hence, pilots crossing time zones can develop cumulative sleep deprivation [11]. Continual disruption may lead to physical symptoms, with pilots reporting gastrointestinal and bowel problems.

Clear links are established between circadian rhythm and accidents with peaks at 02.00, 06.00 and 16.00 h, even after adjustment for traffic volume [12,13]. Field studies have consistently revealed that fatigue has complex and diverse causes, with 24-h duty/rest cycles, circadian

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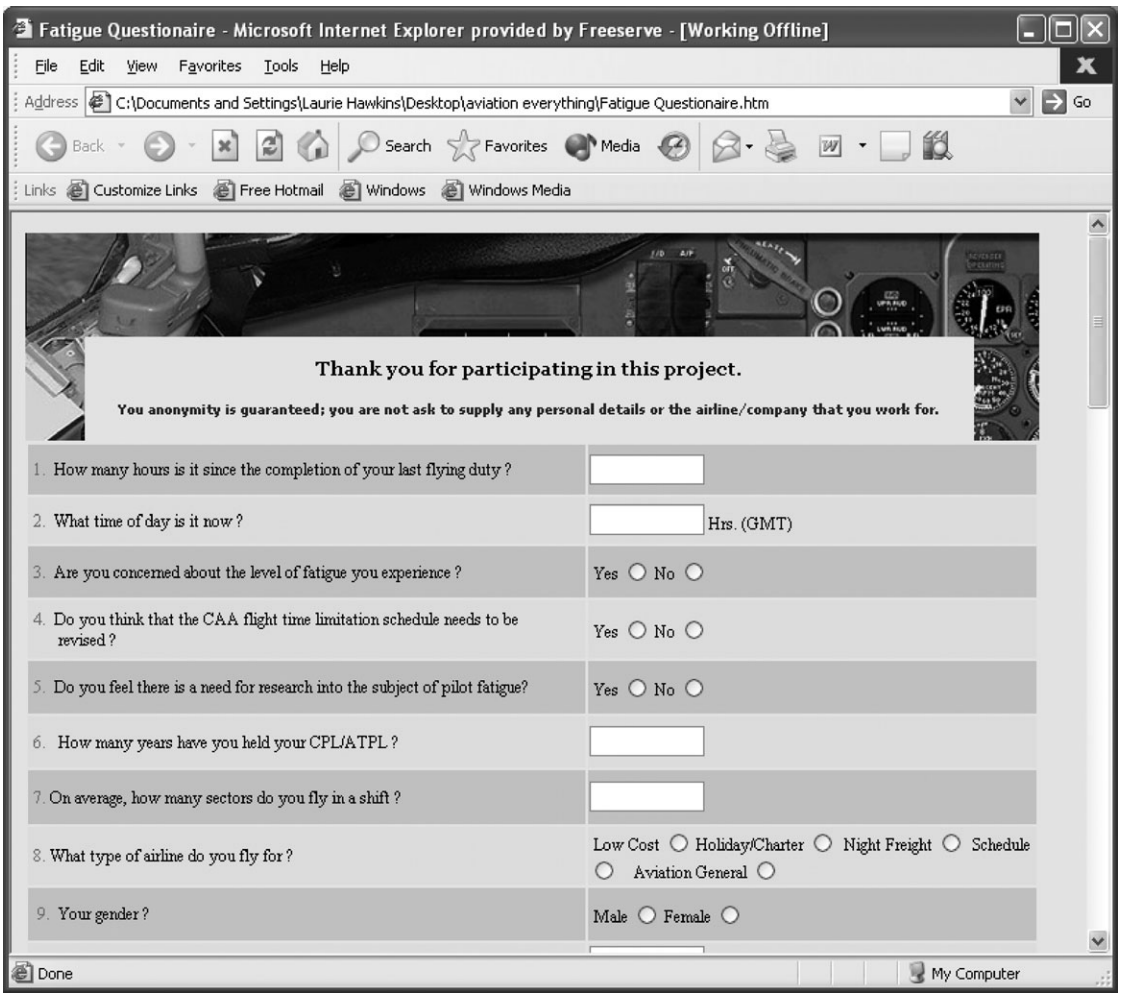


**Figure 1.** The PPRUNE screen-shot of the website questionnaire.

desynchronization and night-time flying all related to fatigue in long-haul operations [14]. Two consecutive night-time flying duties have been estimated to have the equivalent loss of 9.3 h of sleep [15]. The problems of the long-haul pilot in operating transmeridian sectors of extended length are relatively well researched, and the findings have been reviewed widely [15–19]. By comparison, the situation of the short-haul pilot has been less well studied, although it has been acknowledged that the types of fatigue in long-haul and short-haul operations will differ considerably [20]. It is possible that current flight duty time legislation which is based mostly on the experiences of long-haul pilots, may be inadequate to prevent the occurrence of potentially hazardous levels of fatigue in short-haul pilots [21].

This concern has been raised in the media by some pilots. Some former low-cost pilots claimed they no longer trusted airlines that harboured a culture in which pilots are required to work close to the legal maximum of flying hours. It was perceived that such pilots may make errors due to tiredness [22]. Increasingly, multi-sector airline flight crews working for low-cost airlines are being scheduled to work into their 'discretion periods' [23,24]. Discretion is an extended period of time needed to complete a duty, should it become necessary due to unforeseen circumstances such as aircraft delays. Shorter turn around periods (when aircraft are on the ground between flights) are being implemented for economic reasons and this can result in greater flying time. Flight time regulations allow a two-h maximum discretion period, with a further single hour that can be used for absolute emergencies only. Once discretion has been used, extra time must be given before the start of the next duty to allow an adequate rest period between flying.

In the competitive short-haul industry, long duty days, short night-time stopovers and shortened sleep episodes due to earlier report times may all serve to create and exacerbate flight crew fatigue [1,4,24]. The National Transportation Safety Board showed growing concern over the long hours worked by short-haul pilots, stating that it was 'clearly established that fatigued pilots with up to 19 hours waking time were more prone to make errors

of judgement in tactical decision making' [14]. Flight crews routinely report concern over fatigue, often admitting to having fallen asleep during flight [3], and that many pilots already work longer hours behind their controls than heavy goods vehicle drivers are allowed to [24].

This study examined how short-haul operations are performed in relation to flight time limitations and discretion periods and looked for any differences in reported fatigue in those operating for scheduled and low-cost airlines. This study also investigated if other operational factors such as the number of sectors (take-offs and landings) affected pilot fatigue.

## Methods

The study was granted ethical clearance by the student-projects sub committee of the local UK National Health Service research ethics committee. Fatigue levels in short-haul pilots were recorded by use of an anonymous Internet-based questionnaire hosted for 4 weeks on the Professional Pilots' Rumours Network (PPRUNE—www.pprune.com) website. The PPRUNE website directed pilots to the on-line questionnaire page via a link, asking pilots:

> Are you a short-haul commercial pilot?
>
> Will you take 5 minutes to complete a survey about flight time limitations?

The questionnaire (Figure 1) contained the 11-item chronic fatigue scale (CFS) which is used to detect severe fatigue at a point in time in cross-sectional studies. It gives physical, psychological and global fatigue scores, as well as a binary classification of whether respondents are likely to be severely fatigued or not [25]. Pilots were also asked a range of questions about any tiredness symptoms such as 'Do you feel sufficiently tired while flying that your judgement is affected?' and 'Do your tiredness levels feel any different from two years ago?'. Pilots were asked to give details on their usual flight duties, such as the number of sectors (single period of flight) per duty and aircraft information. The number of hours between ending the last flying duty and completion of the questionnaire, duration of duty and the time of day (GMT) when completing the questionnaire, and pilot location were recorded for statistical adjustment purposes in subsequent data analyses.

## Results

Use of the word 'fatigue' was deliberately avoided to reduce the likelihood of any fatigued-biased respondents taking part. A total of 162 pilots responded. All performed short-haul operations for low-cost airlines (34%, $n = 55$), scheduled airlines (58%, $n = 94$) or in 'general aviation' operations (8%, $n = 13$). The mean age of all pilots was 38.3 years (SD 9.1, range = 21–59). Ninety-four percent ($n = 152$) were male, with a mean age of 38.3 years (SD 9.2). The females had a mean age of 27.9 years (SD 8.1). Age was normally distributed in the sample (Kurtosis −0.5), and was not significantly different between the sexes ($P = 0.88$). Hours between ending the last flying duty and completion of the questionnaire ranged from 0 to 504, with a mean duration since last duty of 32 h (SD 52). The pilots had held a Commercial Pilot's Licence or an Airline Transport Pilot's Licence for a mean duration of 11.9 years (SD 8.2, range = 1–39). Seventy-six percent ($n = 123$) were flying aircraft fitted with Electronic Flight Information Systems. Forty-seven percent ($n = 77$) were flying aircraft capable of performing semi-automatic or automatic landings. The mean number of sectors typically performed by pilots in a single duty was 4 (SD 2, range = 1–20). With only 8% of the sample belonging to general aviation, we excluded such pilots. The general aviation group was excluded from analyses comparing short-haul and scheduled airlines, as their duties can be a combination of both such schedules.

Twenty-one percent ($n = 34$) reported regularly flying into their discretion periods; 69% did not and 10% did not record a response. When asked if they had flown into discretion time on their most recent duty, 24% had, 66% had not and 10% did not record a response. The mean global fatigue score on the fatigue scale was 17.8 (SD 5.0, range = 2–31) and this was normally distributed (Kurtosis −0.9). Table 1 shows how many pilots were classified with severe fatigue (binary score ≥4) as well as responses to other specific items about fatigue symptoms. Odds ratios (ORs) were calculated for those classified as severely fatigued, and the results are shown in Table 2.

Comparisons between low-cost and scheduled airlines pilots were made using *t*-tests and chi-square tests (with Yates' correction for continuity of smaller samples). This is shown in Table 3. Table 4 shows the comparisons between those who regularly flew into discretion time and those who did not. Comparisons are adjusted for

**Table 1.** Fatigue responses from short-haul pilots

| Fatigue measure | Response | *n* | % |
|---|---|---|---|
| Severe fatigue on the CFS (score ≥4) | Yes | 121 | 75 |
| | No | 41 | 25 |
| 'Fatigue levels worse than 2 years ago?' | Yes | 131 | 81 |
| | No | 23 | 14 |
| | Not sure | 8 | 5 |
| 'Feel tired with impaired judgement while flying?' | Yes | 129 | 80 |
| | No | 31 | 19 |
| | Not sure | 2 | 1 |
| 'Concerned with the level of fatigue you experience?' | Yes | 127 | 78 |
| | No | 35 | 22 |

the time of day of questionnaire completion, duration of duty and the number of hours since ending the most recent duty.

## Discussion

This study has demonstrated that three-quarters of the pilots studied were operating despite feeling severely fatigued. The majority of the pilots believed they were fatigued, and that their fatigue was worse than it previously had been. The posting of this questionnaire on the PPRUNE website introduces a possible source of bias to this study. The survey was highlighted on the PPRUNE website as a survey concerning flight time limitations and not concerning fatigue, and we anticipate that this may have reduced the possibility of those respondents with strong issues concerning pilot fatigue from being over-represented in the sample. There are ~99 000 registered users of the PPRUNE website and about half of those are pilots. The age and sex proportions of our sample are comparable with the general PPRUNE-user population.

The researchers monitored the uniqueness of the IP addresses of respondents to ensure questionnaires were not completed more than once (from the same computer). Cross checking of the CFS data was also performed to look for any similarity in 'extreme' responses. No such incidents of this nature were observed. It is likely that commercial pilots would be concerned that knowledge of their fatigue status or concerns about fatigue could be harmful and this should reduce the likelihood of over-reporting.

We propose that this form of data collection is a useful method of studying this highly responsible occupational group who wish to remain anonymous. Other studies looking at fatigue have commonly used combinations of self-reports and physiological measures, including background questionnaires and pilots' logbooks [26]. This method may limit the external validity (generlizability) of the results, which may need cautious and sensible interpretation, but we believe that both under and over-reporting are not likely.

**Table 2.** ORs associated with classification of severe fatigue

| Factor | OR | 95% CI lower–upper |
|---|---|---|
| Concerned about fatigue | 11.1 | 4.6–26.7 |
| Fatigue worse now than 2 years ago | 10.2 | 3.8–27.3 |
| Believe general health is now poorer | 7.5 | 2.2–25.8 |
| Has to use discretion regularly | 5.7 | 1.3–25.5 |
| Believe a revision of regulations needed | 5.3 | 2.3–12.7 |
| Believes judgement is affected when flying | 4.6 | 2.0–10.6 |
| Used discretion on last duty | 2.9 | 0.1–9.0 |
| Believe more research is needed into pilot fatigue | 2.1 | 0.3–13.4 |
| Regular changing of duty times | 1.4 | 0.7–3.0 |
| Male[a] | 0.7 | 0.7–0.8 |
| Found air traffic control to be generally uncooperative | 0.7 | 0.2–3.8 |

[a]Sex = Male was found to be 'protective' as all eight female pilots were classified as fatigue cases.

**Table 3.** Comparisons between low-cost and schedule operations pilots

| Measure | Low-cost pilots $n = 55$ | Scheduled pilots $n = 94$ | $t$ or $X^2$ |
|---|---|---|---|
| Age | 39.8 (SD 8.0) | 37.9 (SD 9.8) | 1.21 |
| Licence years | 11.6 (SD 6.9) | 11.8 (SD 8.9) | 0.15 |
| Auto-landing equipment used | 49 (89%) | 70 (74%) | 3.74[a,*] |
| Male | 51 (93%) | 88 (94%) | 0.00[a] |
| Uses discretion regularly | 12 (22%) | 21 (27%) | 0.37 |
| Used discretion on last duty | 13 (24%) | 23 (29%) | 0.47 |
| Sectors normally flown per duty | 3.0 (SD 1.0) | 4.0 (SD 2.5) | 2.20* |
| Regular changing of duty times | 27 (49%) | 51 (55%) | 0.55 |
| Concerned about fatigue | 48 (87%) | 71 (76%) | 2.28[a] |
| Believes more research is needed | 53 (96%) | 90 (97%) | 0.00[a] |
| Revision of regulations needed | 48 (87%) | 73 (78%) | 1.24[a] |
| Physical fatigue score (CFS) | 12.9 (SD 3.4) | 11.7 (SD 3.2) | 2.03* |
| Psychological fatigue score (CFS) | 6.2 (SD 2.1) | 5.7 (SD 1.8) | 1.69 |
| Total fatigue score (CFS) | 19.1 (SD 5.1) | 17.4 (SD 4.6) | 2.08* |
| Fatigue cases | 47 (85%) | 66 (70%) | 3.60[a,*] |
| Believes general health is now poorer | 14 (25%) | 27 (29%) | 0.18 |
| Fatigue worse now than 2 years ago | 50 (94%) | 73 (82) | 2.89[a] |
| Judgement impaired when flying | 49 (89%) | 71 (77%) | 2.51[a] |

[a]Denotes chi-square testing using Yates' continuity correction.

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

**Table 4.** Comparisons between pilots who do and do not regularly fly into discretion

| Measure | Regularly flies into discretion, $n = 34$ | Does not fly into discretion, $n = 111$ | $t$ or $X^2$ |
|---|---|---|---|
| Physical fatigue score | 13.4 (SD 3.6) | 11.6 (SD 3.3) | 2.59** |
| Psychological fatigue score | 6.7 (SD 2.3) | 5.6 (SD 1.8) | 3.04*** |
| Total fatigue score | 20.2 (SD 5.5) | 17.3 (SD 4.7) | 3.02*** |
| Fatigue cases | 31 (91%) | 80 (72%) | 4.28[a]* |
| Believes general health is now poorer | 16 (47%) | 27 (24%) | 6.44** |
| Fatigue worse now than 2 years ago | 30 (88%) | 89 (80%) | 0.19[a] |
| Judgement is impaired when flying | 27 (79%) | 91 (82%) | 0.00[a] |

[a]Denotes chi-square testing using Yates' continuity correction.

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

A biopsychosocial interpretation of the ORs associated with severe fatigue status suggests that those pilots who are 'concerned about fatigue', 'feel more fatigued than before' and who 'believe their health is poorer now than before' are likely to be the pilots who score sufficiently high on the CFS to qualify for 'severe fatigue'. We found that those reporting this had ORs for severe fatigue status of 11.1, 10.2 and 7.5, respectively. However, regularly flying into discretion time, feeling a revision of FLTs is due and a belief of impaired judgement when flying also had raised ORs for severe fatigue (OR 5.7, 5.3 and 4.6, respectively, with CI of 1.3–25.5, 2.3–12.7 and 2.0–10.6, respectively). This suggests that it is not just the belief that one is suffering from a condition (fatigue) that is associated with increased reporting but that procedural and operational factors may play a role too.

Our results can be translated into operationally relevant considerations that could help maintain safe aviation in the short-haul industry whereby reducing human error will reduce the number of accidents [27]. The role of fatigue may be underestimated. This study shows that many modern day short-haul commercial pilots report severe fatigue. The potential for more accidents with pilots operating when fatigued is high. The issue of managing fatigue in aviation operations must move beyond current regulatory schemes that are based upon long-haul flying while ignoring the increasing demands of commercial short-haul flying. A range of approaches could be considered incorporating research, scientific data and the experience of those flying. While global demand for aviation operations continues to grow, safety resources will probably need to develop too. The Royal Aeronautical Society [28] argued that safety is in danger of being exchanged for profit, and declared that 'current profits are derived from cost reduction, rather than revenue improvement'. Attempts to play down the important role of pilot fatigue in short-haul operations may delay any effective action while risk of fatigue may continue to increase [29].

Effective action against fatigue could be achieved by sharing education, strategies, technology and design from long-haul studies such as the '40 minute in-flight rest opportunity' that is proven to reduce the effects of fatigue [30]. In Australia, Qantas, the Civil Aviation Safety Authority and the Australian and International Pilots Association are currently conducting the largest study on pilot fatigue involving airlines, safety authorities and pilot's associations together, and is due for completion in 2006. Similarly, a project that provides flexibility of choice of flight times in pilots' own environments has been operating in New Zealand since 2001, as a joint venture between NASA, the New Zealand Civil Aviation Authority and Air New Zealand [31]. Results showed operational decisions about layover time, flight lengths and rest periods based on the performance and expertise of their own aviators has had tangible benefits to many pilots, including reduced fatigue and lower reliance on hypnotic medication. This also demonstrated that broader approaches to the management of fatigue are available and feasible [31].

Our study suggests that further work should be undertaken to examine the role of discretion-time flying and fatigue in short-haul pilots. It is therefore important that all accident prevention research units working with pilots explore all avenues and work together to implement strategies and effectively link human factors and fatigue information. For aircrew, working hours restrictions may need to be related to the time of day or night they start work and whether long- or short-haul flying. Articles in the United Kingdom have referred to increased pilot fatigue [19,24] but no changes have yet been made in the short-haul industry.

## Conflicts of interest

None declared.

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