



# Subjective Fatigue is Influenced by Duty Duration among Short-Haul Airline Pilots



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## INTRODUCTION

- Pilot fatigue associated with circadian rhythm disruptions (light/dark cycle) and disturbances of sleep/wake cycle is of concern in aviation operations. Crew members are often required to work irregular schedules. As a result, they can experience sleep loss and increased fatigue.
- We aimed to determine whether perceived fatigue levels varied by time of day, time awake at duty end, duty duration and sleep time obtained by pilots on the previous night.

## METHODS

### Participants

- N = 44 pilots (4 female), aged 30.8 ± 7.1 (mean ± SD).
- Flight hours: 1,000- 3,000 hours.
- Self-reported sleep need: 7.9 ± 0.7 (mean ± SD).

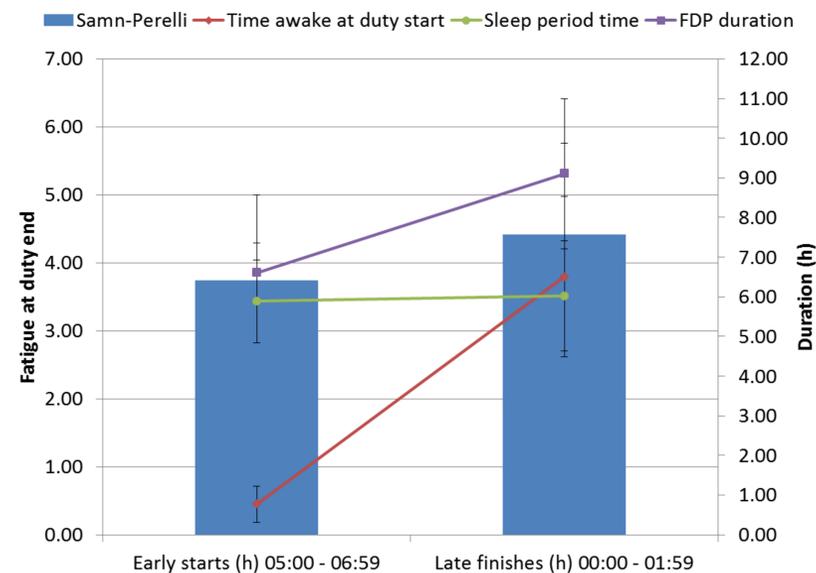
### Methods

- Pilots flew a roster consisting of a cycle of five days of short duty hours followed by four days off, five early duty followed by three days off, five midday starts with many sectors followed by three days off and then five late duties with finishes that generally ended during the night followed by four days off.
- Pilots completed several questionnaires about demographics, sleep and fatigue. They wore an Actiwatch throughout the study, completed a sleep diary within 30-minutes upon awakening and immediately before going to bed and completed a fatigue scale several times every day.
- Early starts (05:00-06:59 hrs) and late-finish (00:00-01:59 hrs) duties were examined to compare fatigue levels based on flight duty period (FDP), sleep time and time awake at duty end.

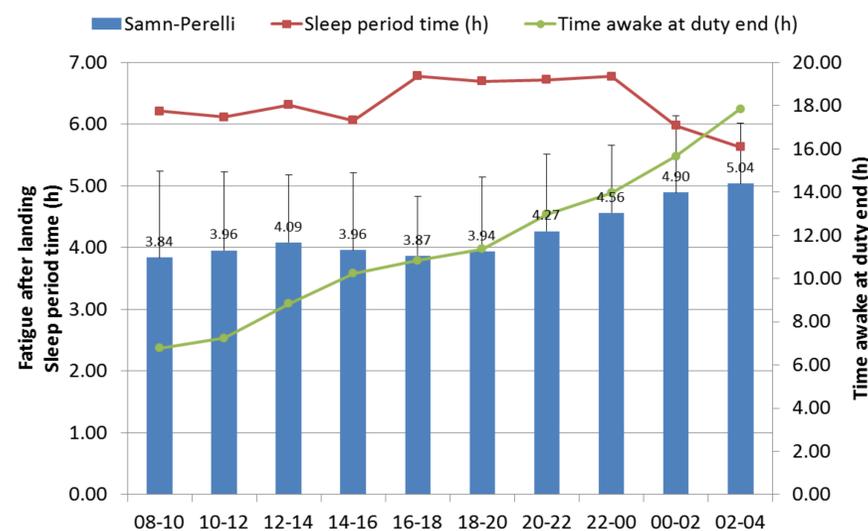
### Measures

- Actiwatch - a device that is watch-shaped and worn on the wrist of the non-dominant arm. They are useful for determining sleep patterns and circadian rhythms and may be worn for several weeks at a time.
- Sleep diary - enables subjects to input information 30 minutes after awakening, information throughout the day if taking naps, and before going to bed at night. Queries include time of waking, amount of sleep, time of naps, and quality of sleep.
- Samn-Perelli - is a subjective 7-point fatigue scale asking participants to rate their level of fatigue from 1 = "fully alert" to 7 = "completely exhausted, unable to function effectively".

## FIGURES



**Figure 1.** Mean pilot fatigue at duty end from early-starting (05:00 – 06:59) and late-finishing (00:00 – 01:59) flights.



**Figure 2.** Mean pilot fatigue by time of day, time awake at duty end and prior sleep time for all flights.

## RESULTS

- A significant difference of the fatigue level between early start and late finish duties as reported by pilots,  $F(1, 128) = 8.69, p < .01$ . At the end of the late-finish duties pilots' fatigue was higher ( $M = 4.42, SD = 1.34$ ) than that of pilots who started early ( $M = 3.74, SD = 1.26$ ; Figure 1).
- Independent t-tests found:
  - FDP duration was significantly longer for the late-finish duties,  $t(81.44) = -9.98, p < .001$ ;  $M = 9.10, SD = 1.89$  vs.  $M = 6.61, SD = .74$ .
  - The time awake at duty start was significantly longer for the late-finish duties,  $t(64) = -21.17, p < .001$ ;  $M = .77, SD = .45$  vs.  $M = 6.51, SD = 2.03$ .
  - No significant difference of pilots' sleep time.
- Linear regression with backward selection identified the duty duration as the main predictor of having an elevated Samn-Perelli score at the end of duty.
- Perceived fatigue levels increased significantly as a function of time of day ( $F(9, 632) = 7.48, p < .001$ ), reaching levels of moderate fatigue after 18 hours of being awake (Figure 2).
- Prior sleep time was shorter for duties that finished after 22:00 hrs.

## CONCLUSIONS

- Our results support the findings of a previous study (Vejvoda et al., 2014) which found that fatigue was higher after late duty relative to early duty suggesting that time awake and not prior sleep duration might be an important factor in elevated subjective ratings of fatigue.
- Duty duration was the main predictor of having higher perceived levels of fatigue at the end of duty.
- Fatigue increased in the late evening hours as the time being awake increased and was significantly influenced by time of day.
- Pilots slept less and were more fatigued when the duty ended late and time awake was high.
- Future research could focus on performance effects of duty times.

## REFERENCES

Vejvoda M, Elmenhorst EM, Pennig S, Plath G, Maass H, Tritschler K, Basner M, Aeschbach D. (2014). Significance of time awake for predicting pilots' fatigue on short-haul flights: implications for flight duty time regulations. *Journal of Sleep Research, 23(5):564-7.*

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