SHORT COMMUNICATION

Sleep Science

Aspects of work organization and reduced sleep quality of airline pilots

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ABSTRACT

Objective: To estimate the prevalence and association of work organization associated with poor sleep quality among airline pilots. **Methods:** 1234 airline pilots filled out an online questionnaire. Independent variables included demographic data, work organization aspects, health, and sleep information. A question derived from the Karolinska Sleep Questionnaire was used to obtain subjective sleep quality. Poisson regression with robust variance was performed. **Results:** The prevalence of poor sleep quality was 48.2%. Poor sleep quality was associated with high frequency of technical delays, ≥ 5 consecutive night shifts, moderate and great need for recovery after work, difficulty commuting to work, being insufficiently physically active and sleeping 6-8 hours and < 6 hours on days off. **Conclusion:** Pilots' daily work schedules, consisting of frequent delays, long working hours and perceived high work demands preventing adequate recovery were associated with poor sleep quality.

Keywords: Sleep; Sleep Initiation and Maintenance Disorders; Pilots; Work Schedules.

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INTRODUCTION

The profession of a commercial aviation pilot requires rigorous physical and psychological aptitude, involving the ability to work under a high level of responsibility, concentration, pressure for fast-decision making and adapting to operational changes[1]. Working conditions, such as irregular schedules, long work hours and working in different time zones, can cause exhaustion and permanent fatigue[2,3], leading to insufficient sleep and greater need for recovery after work[4]. Fatigue is also associated with factors related to the individual such as advanced age, poor health, low level of physical activity and consumption of alcoholic beverages[4].

In contrast with studies on fatigue, little is known about the sleep quality of airline pilots[5]. Sleep quality is a factor contributing to fatigue, where studies have shown that up to 90% of shift workers report sleepiness and fatigue[6]. Studies also reveal that working hours, especially night shifts, commonly worked by pilots, can affect sleep, decrease sleep quality and increase sleep disorders. A high prevalence of pilots perceive poor sleep quality[7,8]. In addition, other negative health consequences are associated with sleep-related problems, such as metabolic diseases, musculoskeletal and cardiovascular disorders, as well as impaired cognitive performance, reducing concentration and the ability to react to unexpected events[9]. In this context, the objective of the present study was to estimate the prevalence of and factors associated with poor sleep quality among airline pilots.

MATERIAL AND METHODS

A cross-sectional study was carried out in Brazilian commercial aviation pilots (captains and co-pilots) who flew national and international flights, affiliated to the Association of Civil Aviation Pilots (ABRAPAC). Approximately half of the pilots registered with the National Aviation Agency (ANAC) in Brazil belong to ABRAPAC. All member pilots (n=2530) were invited to participate in the study via e-mail and 1234 agreed to take part.

This investigation is part of the study "Chronic fatigue, working conditions and health of Brazilian pilots"[10]. The study was based on a convenience sample with 91% power, calculated *a posteriori* (G*Power program 3.1.4) with a confidence level of 95% (α=5%) to detect prevalence ratios ≥ 1.20 as significant using prevalence of poor sleep quality (48.2%) as a parameter.

The following independent variables were analyzed:

- Demographic data[1] (gender, age, education, marital status, children under 12 years old),
- Work-related aspects[1] (frequency of operational flight delays, commuting time between hotel and airport, difficulty commuting between residence and airport, start times on day and night shifts, finish times on afternoon and night shifts, years working night shifts, maximum number of consecutive work days and nights, flight hours per month),
- Sleep (sleep duration after day and night work, and on days off) - based on a question adapted from the Karolinska questionnaire[11],
- Health (need for recovery after work[12] - alfa de Cronbach 0,81), time engaged physical activity per week and self-perceived[13], diurnal preference – based on a question adapted from the Karolinska questionnaire[11].

The dependent variable of self-perceived sleep quality was evaluated by a single question: "In general, how do you rate your sleep?", adapted from the Karolinska sleep questionnaire[11], with response options "very good", "good", "neither good nor bad" and "quite/very bad". For this study, responses were dichotomized into good sleep quality (very good or good) and poor sleep quality (neither good nor bad or quite/very bad).

The variables were expressed as absolute and relative frequencies. The Chi-squared and Fisher's exact hypotheses tests were used for comparing proportions. Poisson regression with robust variance was employed to analyze the factors associated with poor sleep quality, allowing identification of both risk and protective factors in qualitative variables having a high prevalence (>10%) with lower bias in prevalence ratios. Based on the results of the hypotheses tests, independent variables with $p<0.20$ were tested on the multiple Poisson regression model in increasing order of statistical significance (forward stepwise technique). The models were adjusted for the variables gender, age, children under 12 years of age, education, BMI and marital status.

All tests were considered statistically significant when $p<0.05$. Data were analyzed using the STATA 12.0 program (Stata Corp, Texas, USA). The ethical issues related to research in humans were duly respected, and the project was approved by the Research Ethics Committee of the Federal Institute of Education, Science and Technology of São Paulo (protocol number 625158).

RESULTS

Pilots interviewed were predominantly male (97.1%), aged ≤ 39 years (52.4% - mean age 39.1, SD=9.8 years), had incomplete or complete higher or post-graduate education (79.7%), had a partner (84.7%), no children younger than 12 years (61.3%), were overweight or obese (67.2%) and held the position of national captain (51.7%), followed by national co-pilot (39.1%). Notably, 53.8% of the pilots did not reside near their work base, having an average commute time of 2 hours, 41 minutes (SD=2 hours, 2 minutes).

Almost half of the pilots (48.2%) reported poor sleep quality. A higher rate of poor sleep quality was observed among pilots who reported: frequent operational flight delays, difficulty commuting between residence and airport, starting morning shifts before 5:00h and finishing after 22:00h, working ≥ 7 consecutive days, ≥ 5 consecutive nights and flying ≥ 66 hours per month. A higher rate of poor sleep quality was also observed among pilots who needed a longer recovery after work, performed < 150 minutes of physical activity per week, had a self-perceived evening preference, and slept < 6 hours on work days and days off (Table 1).

Table 1. Work, health and sleep aspects according to self-perceived sleep quality, 2018.

VARIABLE	CATEGORY	GOOD QUALITY n (%)	POOR QUALITY n (%)	$\chi 2$ *p*-value
Work-related aspects				
Frequency of operational flight	Never, rarely, or sometimes	430 (67.2)	303 (51.0)	< 0.01
Delays	Frequently or always	210 (32.8)	291 (49.0)	
Commute time between hotel and	< 42 minutes	451 (70.7)	394 (66.7)	0.12
Airport	≥ 42 minutes	187 (29.3)	197 (33.3)	
Difficulty commuting between	Never or almost never	434 (67.8)	323 (54.4)	< 0.01
residence and airport	Sometimes	156 (24.4)	183 (30.8)	
	Frequently or always	50 (7.8)	88 (14.8)	
Start time of day shift	24:00-4:59h	92 (14.7)	128 (22.4)	< 0.01
	5:00-5:59h	294 (47.2)	289 (50.4)	
	6:00-6:59h	158 (25.3)	96 (16.7)	
	7:00-11:00h	80 (12.8)	60 (10.5)	
End time of afternoon shift	16:00-21:59h	230 (39.1)	173 (32.2)	0.01
	22:00-23:59h	287 (48.8)	274 (50.9)	
	24:00-6:00h	71 (12.1)	91 (16.9)	
Start time of night shift	14:00-21:59h	360 (59.8)	326 (58.6)	0.95
	22:00-23:59h	203 (33.7)	190 (34.2)	
	24:00-1:59h	22 (3.7)	22 (3.9)	
	2:00-4:59h	17 (2.8)	18 (3.3)	
End time of night shift	< 5:00h	319 (53.0)	278 (50.1)	0.67
	5:01-8:00h	213 (35.4)	210 (37.8)	
	8:01-12:00h	66 (10.9)	61 (11.0)	
	12:01-16:00h	4 (0.7)	6 (1.1)	
Years working night shifts	Does not work nights	359 (56.1)	317 (53.4)	0.19
	1-5 years	101 (15.8)	119 (20.0)	
	6-10 years	86 (13.4)	78 (13.1)	
	11-15 years	32 (5.0)	36 (6.1)	
	≥16 years	62 (9.7)	44 (7.4)	
Maximum number of consecutive	≤ 6 days	540 (84.9)	459 (77.9)	< 0.01
days worked	≥ 7 days	96 (15.1)	130 (22.1)	
Maximum number of consecutive	1-2 nights	130 (21.0)	74 (13.0)	< 0.01
nights worked	3-4 nights	351 (56.8)	318 (55.9)	
	≥ 5 nights	137 (22.2)	177 (31.1)	
Flight hours per month	≤ 65 hours	317 (50.0)	256 (43.7)	0.02
	≥ 66 hours	317 (50.0)	329 (56.3)	
Health and sleep aspects				
Need for recovery after work	Less need	295 (46.1)	97 (16.4)	< 0.01
	Moderate need	210 (32.8)	218 (36.7)	
	Greater need	135 (21.1)	279 (45.2)	
Weekly physical activity time	≥ 150 minutes	359 (56.2)	268 (45.2)	< 0.01
	< 150 minutes	280 (43.8)	325 (54.8)	
Self-perceived diurnal preference	Intermediary	91 (14.2)	50 (8.4)	< 0.01
	Morning	266 (41.6)	225 (37.9)	
	Evening	283 (44.2)	319 (53.7)	
Sleep duration after day shift	> 8 hours	70 (10.9)	36 (6.1)	< 0.01

Continuation Table 1.

	6-8 hours	529 (82.8)	446 (75.1)	
	< 6 hours	40 (6.3)	112 (18.8)	
Sleep duration after night shift	> 8 hours	113 (17.7)	81 (13.7)	< 0.01
	6-8 hours	382 (59.7)	301 (50.7)	
	< 6 hours	145 (22.6)	211 (35.6)	
Sleep duration during days off	> 8 hours	459 (71.9)	367 (62.0)	< 0.01
	6-8 hours	176 (27.6)	207 (34.9)	
	< 6 hours	3 (0.5)	18 (3.1)	

The bivariate model revealed that the factors frequent operational flight delays, sometimes or often having difficulty commuting between residence and airport, starting the morning shift very early and finishing the evening shift very late, working ≥ 7 consecutive days, working ≥ 5 consecutive nights, flying ≥ 66 hours per month, greater need for recovery after work, evening preference, engaging in < 150 minutes of physical activity per week, sleeping < 6 hours after day and night shifts and on days off were associated with poor sleep quality. On the adjusted multiple model, the factors frequent operational flight delays, often having difficulty commuting between residence and airport, working ≥ 5 consecutive nights, greater need for recovery after work and sleeping < 6 hours on days off were associated with poor sleep quality (Table 2).

DISCUSSION

The work organization of airline pilots and situations that increase the likelihood of fatigue, worsen the sleep quality of these professionals. Sleep disturbance is also highly prevalent in shift and night work, and may be more important than other health problems[7]. Excessive fatigue and sleep disturbances can also have negative effects on other aspects of work, such as a decline in work performance and increases in errors, work accidents and absenteeism[14].

A greater need for recovery after work was associated with a higher probability of poor sleep quality, suggesting that piloting is a high-stress activity that leads to fatigue which consequently affects sleep[6,8].

The long working hours can promote physical and mental exhaustion among these professionals, impairing sleep quality. Flights that start very early and end very late, as well as night flights that cause circadian desynchronization, contribute to excessive drowsiness and lead to unintentional sleep at work and increased risk of accidents[1]. Working five or more consecutive nights may indicate long working hours and lead to sleep deprivation. Folkard and Tucker[15] showed that the risk of accidents when working four consecutive nights was 36% higher than for a single night's work. To reduce the risk of accidents and chronic fatigue among pilots, Rodionov[16] suggested they make only two consecutive night flights.

According to current regulations - Law 13475 of August 8, 2017, the working day is counted between the time of arrival at the workplace, which must be at least 30 minutes before the flight time, and ends 30 minutes after engine shutdown[17]. Thus, operational delays lengthen the pilot´s working day, who may already be at their limit. In addition, operational delays can reduce the productivity of working hours, leading to pilots having to work overtime[1,18].

Another factor associated with poor sleep quality among the pilots studied was commuting time. Since most pilots worked far from their residence, the average time spent commuting was 2 hours and 41 minutes. This factor, associated with very early morning shifts, late night shifts, as well as long working hours, extend pilots wake time and reduce rest time between work shifts or during time off[1,2,19]. Even on days off, a substantial percentage of pilots reported sleeping less than eight hours. Several epidemiological studies have shown that sleep deprivation and short sleep are risk factors for health[20].

During days off, the pilots were unable to increase sleep duration, thus contributing to chronic sleep restriction and poor self-perceived sleep quality. Moreover, these professionals were unable to perform enough physical activity to improve sleep quality. Irregular working hours may be a relevant factor promoting sleep restriction and a sedentary lifestyle, leading to poor sleep quality[21].

The design of the present study precluded the determination of cause and effect for the variables assessed. However, the high number of participants (about 1/4 of all Brazilian pilots[a]) provided good internal reliability for the factors associated with poor sleep quality among Brazilian commercial aviation pilots.

CONCLUSION

Pilots' daily work schedules, consisting of frequent delays, long working hours and perceived high work demands preventing adequate recovery were associated with poor sleep quality. Further studies are needed to investigate the association between poor sleep quality and health, performance and flight safety.

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Table 2. Work, health and sleep factors associated with poor sleep quality, 2018.

VARIABLE	CATEGORY	Bivariate PR (95% CI)	Multiple*# PR (95% CI)
Work-related aspects			
Frequency of operational flight	Never, rarely, or sometimes	1	1
Delays	Frequently or always	1.40 (1.25-1.57)	1.14 (1.01-1.28)
Difficulty commuting between	Never or almost never	1	1
residence and airport	Sometimes	1.26 (1.11-1.43)	ns
	Frequently or always	1.49 (1.28-1.73)	1.19 (1.04-1.38)
Start time of day shift	7:00-11:00h	1	
	24:00-4:59h	1.36 (1.08-1.69)	
	5:00-5:59h	1.16 (0.93-1.42)	
	6:00-6:59h	0.88 (0.68-1.13)	
End time of afternoon shift	16:00-21:59h	1	
	22:00-23:59h	1.14 (0.98-1.30)	
	24:00-6:00h	1.31 (1.09-1.56)	
Maximum number of consecutive	≤6 days	1	
days worked	≥ 7 days	1.25 (1.09-1.42)	
Maximum number of consecutive	1-2 nights	1	1
nights worked	3-4 nights	1.31 (1.07-1.59)	ns
	≥ 5 nights	1.55 (1.26-1.91)	1.33 (1.09-1.62)
Flight hours per month	≤ 65 hours	1	
	≥ 66 hours	1.14 (1.01-1.28)	
Health and sleep aspects			
Need for recovery after work	Less need	1	1
	Moderate need	2.06 (1.69-2.50)	1.96 (1.60-2.41)
	Greater need	2.73 (2.26-3.27)	2.38 (1.94-2.91)
Weekly physical activity time	≥150 minutes	1	1
	< 150 minutes	1.26 (1.11-1.41)	1.17 (1.05-1.32)
Self-perceived diurnal	Indifferent	1	
Preference	Morning	1.29 (1.01-1.64)	
	Evening	1.49 (1.18-1.89)	
Sleep duration after day shift	> 8 hours	1	
	6-8 hours	1.35 (1.02-1.77)	
	< 6 hours	2.17 (1.63-2.87)	
Sleep duration after night shift	> 8 hours	1	
	6-8 hours	1.05 (0.87-1.27)	
	< 6 hours	1.41 (1.17-1.71)	
Sleep duration during days off	> 8 hours	1	1
	6-8 hours	1.22 (1.07-1.37)	1.16 (1.03-1.31)
	< 6 hours	1.93 (1.59-2.33)	1.59 (1.31-1.93)

*Adjusted for gender, age, having children < 12 years of age, education, BMI and marital status
#Area ROC = 0.73
ns = not significant

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