Sleep Disorders Among Commercial Airline Pilots

Ahmed Alzehairi; Faris Alhejaili; Siraj Wali; Ibrahim AlQassas; Mansour Balkhyour;
Seithikurippu R. Pandi-Perumal

BACKGROUND: Over the next 20 yr, international market expansion will necessitate the production of new commercial airplanes and the recruitment of additional crewmembers and technicians. Research has proven that fatigue and lack of sleep are risk factors for impaired cognitive performance and human error. Pilots frequently report fatigue to their employers, which may be related to sleep disturbance. Airline pilots, in particular, often experience circadian desynchronization and other types of sleep disorders. Shift workers have been observed to be at higher risk of fatigue that affects their performance and alertness. In Saudi Arabia, sleep disorders among airline pilots are understudied and underreported. The primary objective of this study was to screen for and determine the risk of sleep disorders, fatigue, and depression among pilots.

METHODS: A cross-sectional epidemiological study with national commercial pilots was conducted from March 2019 to March 2020 using validated questionnaires to screen for the risk of sleep disorders, fatigue, and depression.

RESULTS: In total, 344 pilots participated in the study. Half the sample was at risk for insomnia and fatigue. Older and more experienced pilots were less likely to suffer impaired sleep quality, insomnia, sleepiness, fatigue, and depression. In total, 59 (17.2%) pilots were at high risk for sleep apnea.

CONCLUSION: The current study found that pilots were at risk of developing sleep disorders. A more robust and objective assessment is warranted for screening.

KEYWORDS: sleep disorders, aircrew safety, pilot screening.

Alzehairi A, Alhejaili F, Wali S, Al Qassas I, Balkhyour M, Pandi-Perumal SR. *Sleep disorders among commercial airline pilots*. Aerosp Med Hum Perform. 2021; 92(12):937–944.

Over the next 20 yr, international market expansion will call for tens of thousands of new commercial airplanes and the recruitment of more than two million flight crewmembers and technicians.[2] Research has proven that fatigue and lack of sleep are risk factors for impaired cognitive performance and human error.[4]

Airline pilots, in particular, are often subjected to circadian desynchronization (jet lag disorder) and other types of sleep disorders (insomnia, obstructive sleep apnea, and excessive sleepiness) due to intense work schedules, rapidly rotating shift schedules, and rapid time zone transitions.[1] Pilots with sleep disorders pose greater risks to crew and passenger safety. Human errors have been a causative factor in a variety of occupation-related accidents; fatigue could be a significant contributary factor for those accidents.

Pilots frequently report fatigue to their employers, which may be related to their sleep disturbances. Shift workers have been observed to be at higher risk of fatigue, affecting performance and alertness. Their lifestyle places them at higher risk of various mental and medical disorders.[7,18,22] Such reports are more frequent in low-budget airlines, for which pilots are more likely to work extra shifts. Pilots also have to endure discretionary periods whereby they work overtime to compensate for time delays in airports and due to technical aircraft issues.

From Environmental Sciences, Faculty of Environmental Sciences, King Abdulaziz University, the Sleep Medicine Research Group, Sleep Medicine and Research Center, King Abdulaziz University Hospital, International Medical Center, and the Faculty of Environmental Sciences, King Abdulaziz University, Jeddah, Saudi Arabia; and Somnogen Canada, Inc., Toronto, Ontario, Canada.

This manuscript was received for review in October 2020. It was accepted for publication in September 2021.

Address correspondence to: Faris Alhejaili, M.D., FRCCP, Assistant Professor of Medicine, College of Medicine, King Abdulaziz University, Consultant in Pulmonary & Sleep Medicine, Deputy Director, Sleep Medicine and Research Center, King Abdulaziz University Hospital, Jeddah 80215, PO Box 21589, Saudi Arabia; falhejaili@kau.edu.sa.

DOI: https://doi.org/10.2257/AMHP.5809.2021

Studies indicate that fatigue and the effects of sleep deprivation are more pronounced when performing routine tasks.[22] In addition, fatigue and poor sleep quality impair multiple levels of human performance, such as concentration, cognition, judgment, reaction time, mood, attention lapses, memory, and decision-making ability.[15]

Most sleep medicine experts agree that adults require an optimal sleep duration of 7–9 h of undisturbed sleep per day.[5] However, shift workers tend to sleep less than workers who have regular hours. This could explain why more than half of the pilots reported increased sleepiness at work and more than 90% complained of fatigue-related issues in a study conducted by Reis et al.[18]

Furthermore, shift-workers suffer from what is called shift work sleep disorder, an accumulative condition characterized by complaints of trouble sleeping, sleepiness during working hours, and fatigue that interferes with optimal performance.[7] Shift work sleep disorder is the result of changes in circadian rhythm, resulting in higher rates of anxiety, mood disorders, and reduced physical health.

In Saudi Arabia, sleep disorders among airline pilots are understudied and underreported. The primary objective of this study was to screen for and determine the risk of sleep disorders, fatigue, and depression among pilots.

METHODS

Procedures

A cross-sectional epidemiological study on national commercial pilots was conducted from March 2019 to March 2020 using validated questionnaires to screen for the risk of sleep disorders, fatigue, and depression. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

The Unit of Biomedical Ethics of King Abdulaziz University Hospital reviewed and approved the research plan and its implementation. The study was also approved by the Institutional Review Board of King Abdulaziz University Hospital. The study objectives and procedures were explained to eligible patients, who were then invited to voluntarily participate after providing their consent. Informed written consent was obtained from all participants prior to the commencement of the study.

Subjects

The sample consisted of Airbus A320 pilots and copilots (first officers) of Saudi-based national air carriers. Subjects were excluded if they were still undergoing training or taking on management duties or if they were on leave for vacation or medical reasons. The selection process started by obtaining an official up-to-date pilot seniority list (accessible to all pilots through the intranet), which included all pilots, even those who were not yet qualified. After carefully reviewing the names on the seniority list, the names of the pilots who did not fit the selection criteria were excluded, and 468 active regular pilots (261 captains and 207 first officers), who represented 85% of the total number of Airbus A-320 pilots, were selected. Thus, only active airline pilots were targeted to participate in this study. This category of pilots was selected because they regularly experience the impact of occupational noise, flying duties, and sleep disruptions. Pilots who do not fly daily flights may not experience the same effect of the previous factors and may have different health and professional statuses.

The other category of A320 pilots included management pilots, instructor pilots, and check pilots (46 pilots representing 8%). This category contained pilots who were nominated instructor pilots or check airmen. This category did not meet the selection criteria and, therefore, was excluded.

Sample Size

From a total of 468 distributed questionnaires, 344 were completed, generating a response rate of 73.5%. Pilots were classified as either captain or first officer based on a preset airline classification system (professional qualifications, experience, and the total number of hours flown). For seniority, pilots were classified as either senior, intermediate, or junior based on the pilot's release date as a regular pilot after having completed all training requirements. Experience refers to the total number of years as an active pilot. Takeoff and landings (TOL) refers to the number of flights a pilot operates per month, while pairing refers to a group of flights a pilot operates during a duty period (pairing may start and end during one duty time in one day or may stretch over several consecutive duty times over more than one day). A pairing may be comprised of either domestic, international, or mixed flights (domestic and international flights). Duty time refers to the number of working hours per duty. It starts from the time pilots report for duty until 30 min after the last flight's block in time. Time of flight refers to whether the trip was operated during the day, at night, or both.

Instruments

Epworth Sleepiness Scale. Daytime sleepiness was subjectively assessed using the Epworth Sleepiness Scale (ESS). Respondents are asked to rate from 0–3 their chances of falling asleep while engaging in eight different activities. A score higher than 10 indicates excessive daytime sleepiness.[8]

Berlin questionnaire. This scale is used to assess obstructive sleep apnea risk factors among patients ages 18 yr or older. The questions are divided into three categories. Category 1 questions determine whether the subject snores or has had witnessed episodes of apnea. Category 2 questions assess daytime fatigue and sleepiness. Category 3 assesses the respondent's body mass index and history of hypertension. Positive responses in two or more categories indicate a high likelihood of obstructive sleep apnea.[13]

Pittsburgh Sleep Quality Index. The Pittsburgh Sleep Quality Index (PSQI) is an instrument used to assess the quality and pattern of sleep. Sleep is characterized as "poor" or "good" by evaluating seven domains: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction over the last month. Scoring of the answers is based on a 0 to 3 scale, with a higher score indicating worse quality of sleep in that particular domain. An overall score higher than 5 indicates poor sleep quality.[3]

Athens Insomnia Scale. The Athens Insomnia Scale (AIS) is a validated questionnaire that assesses insomnia severity. This eight-item questionnaire evaluates sleep onset, waking at night and early in the morning, sleep time, sleep quality, frequency and duration of complaints, distress caused by the experience of insomnia, and interference with daily functioning.[19]

Fatigue Severity Index. The fatigue severity index (FSI) is a validated tool used to assess fatigue among patients with a variety of medical and neurological disorders. It consists of nine items, each scored from 1 (strongly disagree) to 7 (strongly agree). The lowest score on this index is 9 and the highest is 63. The higher the score is, the more profound the fatigue and its effect on a person's daily activities.[10]

Visual Analog Fatigue Scale. The Visual Analog Fatigue Scale (VAFS) is composed of 18 items measured using a visual analog scale to assess fatigue. Participants are asked to rate items on a scale from 0 to 10.[12]

Patient Health Questionnaire. The Patient Health Questionnaire (PHQ) scale is a tool used to screen for major depressive disorder. It consists of nine questions, each scored from 0 to 3. Patients who score less than 4 are unlikely to have depression. The lowest possible score is 0, and the highest is 27. Higher scores suggest more severe depression.[9]

Analysis

The statistical analysis was performed with the Statistical Package for the Social Sciences (SPSS) version 22. Categorical variables are summarized and presented using tables. Numerical variables are presented as the means and standard deviations and were assessed with unpaired Student's *t*-tests, linear correlation coefficients, analysis of variance (ANOVA), Chi-squared tests, and logistic regression. The results were considered significant if the calculated *P*-values were less than 0.05.

RESULTS

In total, 344 pilots participated in the study. Most subjects were 30–50 yr of age (81.4%) and had a BMI less than 30 kg · m^{-2} (84.6%). Captains accounted for half the sample (47.4%), while first officers made up the other half (52.6%). In terms of seniority, 41.9% were senior pilots, 32.6% were junior pilots, and 25.6% were intermediate pilots. Most pilots had a duration of experience in aviation ranging from 5–15 yr (82.3%) (**Table I**). The quantity of work was reflected by the number of TOL per month. Most pilots had 30–45 TOL per month (84%), with a mean of 38.2 ± 5.1. A duty time of 8–14 h was observed to be the most prevalent in the studied sample (73.3%) and most flew day and night flights (73%). The majority of pilots operated domestic and regional flights (87.8%) and were scheduled for more than three flights per day (69.5%) (Table I).

Table I. Demographic Data of the Sample.

VARIABLE	*N*	%
Age, years		
<30	33	9.59
30–40	161	46.80
40–50	119	34.59
>50	31	9.01
Range	24–60	
Mean ± SD	40.241 ± 7.80	
BMI, kg · m^{-2}		
<30	291	84.59
>30	53	15.41
Range	19.02–49.01	
Mean ± SD	26.495 ± 4.371	
Rank		
Captain	163	47.38
First Officer	181	52.62
Seniority		
Senior	144	41.86
Intermediate	88	25.58
Junior	112	32.56
Experience, years		
<5	12	3.49
5–10	154	44.77
10–15	129	37.50
15–20	40	11.63
>20	9	2.62
Range	1–30	
Mean ± SD	10.965 ± 5.091	
TOL, number per month		
<30	22	6.40
30–35	65	18.90
35–40	87	25.29
40–45	137	39.83
>45	33	9.59
Range	24–49	
Mean ± SD	38.177 ± 5.074	
Pairing		
Domestic	42	12.21
Mixed	302	87.79
Duty time, hours		
<8	40	11.63
8–14	252	73.26
>14	52	15.12
Flights, number per day		
2	30	8.72
3	75	21.80
>3	239	69.48
Flight time		
Day	52	15.12
Night	41	11.92
Both	251	72.97

BMI: body mass index, TOL: takeoffs and landings.

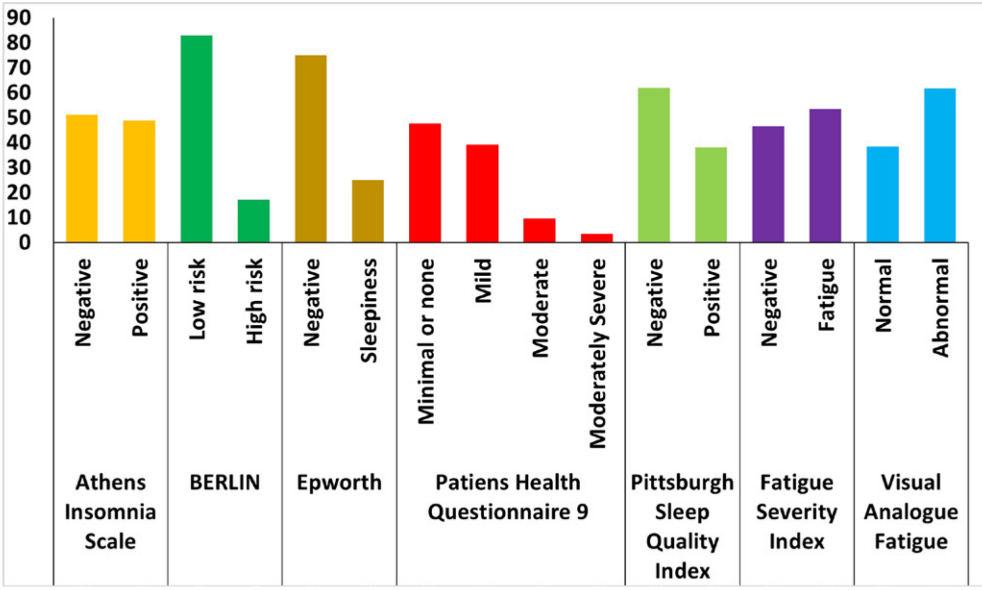

Fig. 1. Results of the standardized scales. AIS: Athens Insomnia Scale; PHQ-9: Patient Health Questionnaire 9; PSQI: Pittsburgh Sleep Quality Index; FSS: Fatigue Severity Index; VAFS: Visual Analog Fatigue Scale.

Half the sample was at risk for insomnia and fatigue based on the AIS, FSI, and VAFS. One-third were found to have impaired sleep quality and mild depression based on the PSQI and PHQ-9. Approximately one-quarter of the sample was at an elevated risk of having sleep apnea and reported increased sleepiness based on the Berlin and ESS scales, respectively (**Fig. 1**).

Older and more experienced pilots were less likely to suffer impaired sleep quality, insomnia, sleepiness, fatigue, and depression ($P < 0.001$). However, higher TOL and BMI were associated with higher risk of these adverse effects ($P < 0.001$) (**Table II**).

Pilots who were captains and had more seniority had lower mean AIS scores ($P < 0.001$). However, pilots who flew exclusively domestic flights and operated more than three flights per day had higher mean AIS scores ($P < 0.001$). In addition, pilots who operated both during the day and at night and worked shorter shifts (< 8 h) were observed to have higher mean AIS scores ($P < 0.001$) (**Table III**).

Pilots who were captains and who had more seniority had lower mean ESS scores ($P < 0.001$). On the other hand, pilots who flew exclusively domestic flights and operated more than three flights per day had higher mean ESS scores ($P < 0.001$). Likewise, pilots who flew both during the day and at night and worked shorter shifts (< 8 h) were observed to have higher mean ESS scores ($P < 0.001$) (**Table IV**).

Pilots who were captains and who had more seniority had lower mean PHQ-9 scores ($P < 0.001$). However, pilots who flew exclusively domestic flights and operated more than three flights per day had higher mean PHQ-9 scores ($P < 0.001$). Additionally, pilots who flew both during the day and at night and worked shorter shifts (< 8 h) were observed to have higher mean PHQ-9 scores ($P < 0.001$) (**Table V**). Similar findings were observed for sleep quality and fatigue according to the PSQI, FSI, and VAFS.

In total, 59 (17.2%) pilots were at high risk for sleep apnea. Older age and higher BMI were risk factors for sleep apnea ($P < 0.01$). Pilots who were captains and who were more experienced were at lower risk of sleep apnea ($P < 0.001$). A higher number of TOL and mixed pairing were additional risk factors ($P < 0.001$). Pilots who flew both during the day and at night and those who operated more than three flights per day were observed to be at higher risk for sleep apnea ($P < 0.01$).

Table II. Effects of Age, Experience, TOL, and BMI on Sleep Disturbance, Disorders, Insomnia, Fatigue, and Depression.

VARIABLE	AGE	EXPERIENCE	TOL, NUMBER PER MONTH	BMI
AIS				
r	−0.821	−0.633	0.797	0.862
P-value	<0.001	<0.001	<0.001	<0.001
Epworth				
R	−0.804	−0.638	0.766	0.842
P-value	<0.001	<0.001	<0.001	<0.001
PHQ-9				
R	−0.758	−0.613	0.798	0.882
P-value	<0.001	<0.001	<0.001	<0.001
PSQI				
R	−0.827	−0.614	0.808	0.855
P-value	<0.001	<0.001	<0.001	<0.001
FSS				
R	−0.794	−0.603	0.801	0.862
P-value	<0.001	<0.001	<0.001	<0.001
VAFS				
R	0.649	0.535	−0.762	−0.807
P-value	<0.001	<0.001	<0.001	<0.001

AIS: Athens Insomnia Scale, PHQ-9: Patient Health Questionnaire 9, PSQI: Pittsburgh Sleep Quality Index, FSS: Fatigue Severity Index, VAFS: Visual Analog Fatigue Scale, TOL: takeoffs and landings, BMI: body mass index.

Table III. Effects of Seniority, Pairing, Duty Time, Flights per Day, and Flight Time on the Frequency of Insomnia According to the AIS.

ITEMS	*N*	AIS MEAN ± SD	*F* OR *t*	ANOVA OR *t*-TEST TEST VALUE	*P*-VALUE
Rank					
Captain	163	6.141 ± 5.600	*t*	−4.086	<0.001
First Officer	181	8.762 ± 6.232			
Seniority					
Senior	144	3.840 ± 2.385	*F*	61.606	<0.001
Intermediate	88	10.364 ± 7.953			
Junior	112	10.018 ± 5.185			
Pairing					
Domestic	42	12.381 ± 7.780	*t*	5.790	<0.001
Mixed	302	6.844 ± 5.483			
Duty time, hours					
<8	40	15.100 ± 7.544	*F*	65.928	<0.001
8–14	252	7.317 ± 5.091			
>14	52	2.673 ± 2.820			
Flights, number per day					
2	30	1.667 ± 0.661	*F*	48.145	<0.001
3	75	3.973 ± 1.896			
>3	239	9.368 ± 6.349			
Flight time					
Day	52	2.365 ± 1.941	*F*	40.866	<0.001
Night	41	4.293 ± 1.632			
Both	251	9.116 ± 6.297			

AIS: Athens Insomnia Scale; *t*: test value for *t*-test; and *F*: test value for ANOVA.

Table IV. Effects of Rank, Seniority, Pairing, Duty Time, Flights per Day, and Flight Time on the Risk of Developing Sleepiness According to the Epworth Scale.

ITEMS	*N*	EPWORTH MEAN ± SD	*F* OR *t*	ANOVA OR *t*-TEST TEST VALUE	*P*-VALUE
Rank					
Captain	163	7.675 ± 3.914	*t*	−4.750	<0.001
First Officer	181	9.663 ± 3.842			
Seniority					
Senior	144	6.174 ± 2.974	*F*	74.297	<0.001
Intermediate	88	11.148 ± 4.491			
Junior	112	10.089 ± 2.676			
Pairing					
Domestic	42	12.071 ± 4.754	*t*	6.098	<0.001
Mixed	302	8.255 ± 3.651			
Duty time					
<8 h	40	13.075 ± 4.554	*F*	88.980	<0.001
8–14 h	252	8.980 ± 3.043			
>14 h	52	4.115 ± 3.021			
Flights, number per day					
2	30	2.700 ± 2.292	*F*	87.116	<0.001
3	75	6.707 ± 1.412			
>3	239	10.109 ± 3.738			
Flight time					
Day	52	3.788 ± 2.071	*F*	83.508	<0.001
Night	41	7.049 ± 1.182			
Both	251	10.016 ± 3.689			

t: test value for *t*-test; *F*: test value for ANOVA.

Table V. Effects of Rank, Seniority, Pairing, Duty Time, Flights per Day, and Flight Time on the Risk of Developing Depression According to the PHQ-9 Scale.

ITEMS	*N*	PHQ-9 MEAN ± SD	*F* OR *t*	ANOVA OR *t*-TEST TEST VALUE	*P*-VALUE
Rank					
Captain	163	4.883 ± 4.007	*t*	−4.552	<0.001
First Officer	181	7.022 ± 4.639			
Seniority					
Senior	144	3.417 ± 2.465	*F*	55.175	<0.001
Intermediate	88	8.182 ± 6.212			
Junior	112	7.634 ± 2.944			
Pairing					
Domestic	42	10.476 ± 6.451	*t*	7.432	<0.001
Mixed	302	5.387 ± 3.738			
Duty time, hours					
<8	40	10.350 ± 5.825	*F*	46.646	<0.001
8–14	252	6.087 ± 3.855			
>14	52	2.288 ± 2.577			
Flights, number per day					
2	30	1.567 ± 1.870	*F*	60.200	<0.001
3	75	3.027 ± 1.636			
>3	239	7.502 ± 4.480			
Flight time					
Day	52	1.788 ± 1.684	*F*	58.615	<0.001
Night	41	3.024 ± 1.193			
Both	251	7.371 ± 4.431			

PHQ-9: Patient Health Questionnaire 9, *t*: test value for *t*-test and *F*: test value for ANOVA.

Duty time did not appear to be a risk factor for sleep apnea (**Table VI**). However, multiple logistic regression showed that only BMI was a significant risk factor for sleep apnea [odds ratio 3.6 (2.2–5.7), $P < 0.05$]. Age, experience, seniority, TOL, rank, pairing, and flight time were not significant risk factors.

DISCUSSION

In this cross-sectional study involving 344 pilots, 48.8% of the sample had insomnia, 38.1% were found to have impaired sleep quality, 25% reported increased sleepiness, and 17.2% were at high risk of having obstructive sleep apnea. Moreover, 53.5% of the pilots were at risk for fatigue, while 39.2% had mild depression.

Furthermore, 48.8% of the sample had insomnia and one-third were found to have impaired sleep quality. This may be related to the work schedules of pilots.[17] Insomnia is related to decreased work ability. In a study performed in Brazil with 1234 aviation pilots who flew domestically and internationally, the ability to work was measured using an index called the work ability index. The index is based on individuals' self-perception of their ability to work. Researchers found that insomnia symptoms, poor sleep quality, excessive sleepiness, and a high risk of obstructive sleep apnea were associated with low to moderate work ability.[16]

Table VI. Effects of Age, BMI, Experience, Rank, TOL, Pairing, Duty Time, Flights per Day, and Flight Time on the Risk of Developing Sleep Apnea According to the Berlin Questionnaire.

	BERLIN						CHI-SQUARED	
	LOW RISK		HIGH RISK (*N* = 59)		TOTAL			
	N	%	*N*	%	*N*	%	χ^2	*P*-VALUE
Age, years								
<30	2	0.7%	31	52.5%	33	9.6%	161.007	<0.001
30–40	137	48.1%	24	40.7%	161	46.8%		
40–50	118	41.4%	1	1.7%	119	34.6%		
>50	28	9.8%	3	5.1%	31	9.0%		
Experience, years								
<5	4	1.4%	8	13.6%	12	3.5%	64.819	<0.001
5–10.	108	37.9%	46	78.0%	154	44.8%		
10–15.	127	44.6%	2	3.4%	129	37.5%		
15–20	37	13.0%	3	5.1%	40	11.6%		
>20	9	3.2%	0	0.0%	9	2.6%		
Rank								
Captain	141	49.5%	22	37.3%	163	47.4%	2.911	0.088
First Officer	144	50.5%	37	62.7%	181	52.6%		
TOL, number per month								
<30	22	7.7%	0	0.0%	22	6.4%	153.879	<0.001
30–35	62	21.8%	3	5.1%	65	18.9%		
35–40	86	30.2%	1	1.7%	87	25.3%		
40–45	112	39.3%	25	42.4%	137	39.8%		
>45	3	1.1%	30	50.8%	33	9.6%		
Pairing								
Domestic	23	8.1%	19	32.2%	42	12.2%	26.560	<0.001
Mixed	262	91.9%	40	67.8%	302	87.8%		
Duty time								
<8 h	12	4.2%	28	47.5%	40	11.6%	91.991	<0.001
8–14 h	222	77.9%	30	50.8%	252	73.3%		
>14 h	51	17.9%	1	1.7%	52	15.1%		
Flights, number per day								
2	30	10.5%	0	0.0%	30	8.7%	27.935	<0.001
3	74	26.0%	1	1.7%	75	21.8%		
>3	181	63.5%	58	98.3%	239	69.5%		
Flight time								
Day	51	17.9%	1	1.7%	52	15.1%	23.241	<0.001
Night	41	14.4%	0	0.0%	41	11.9%		
Both	193	67.7%	58	98.3%	251	73.0%		
BMI, $kg \cdot m^{-2}$								
<30	283	99.3%	8	13.6%	291	84.6%	275.704	<0.001
>30	2	0.7%	51	86.4%	53	15.4%		

TOL: takeoffs and landings; BMI: body mass index.

Approximately 25% of the sample reported excessive daytime sleepiness (EDS). This is in line with results published by Aljurf et al. in which one-third of the pilots complained of sleepiness.[1] It is also similar to the prevalence of sleepiness reported in the general population of Saudi Arabia of 20.5%.[6] In their study, Fatani et al. also report that occupation was not a risk factor for sleepiness and EDS was similar across different age groups.[6] In other words, sleepiness among pilots in our study does not seem to be pathological; however, considering the occupational risks involved, EDS should be avoided among pilots. Of note, our sample consisted of only male gender participants, which could have impacted the results. However, previous studies in the Saudi population did not show a significant difference in terms of EDS in different genders after correcting for the total hours of sleep.[6]

The estimated prevalence of obstructive sleep apnea in Saudi Arabia is 8.5% (12.8% in men and 4.8% in women).[21] We found that 17.2% of the pilots in this study were at increased risk for obstructive sleep apnea compared to 29.3% reported by Aljurf et al.[1] Pilots who are at high risk of obstructive sleep apnea should undergo diagnostic polysomnography. Furthermore, according to multiple logistic regression, only BMI was a risk factor for obstructive sleep apnea [odds ratio 3.6 (2.2–5.7), $P < 0.05$]. We elected to categorize the study subjects into two groups of either obese or not obese, which included overweight and normal weight subjects as the total percentage of the obese group was only 15.4%. When separating the groups into three categories of obese, overweight, and normal, the results were similar, showing only the obese group to be at risk of having obstructive sleep apnea.

This is consistent with the findings of a study conducted with commercial airline pilots in the Gulf Cooperation Council (GCC) by Aljurf et al. in 2017, which showed that 68.3% of the pilots experienced severe fatigue and 67.4% reported making mistakes due to fatigue.[1] The United States Air Force provides guidelines to avoid fatigue in aircrew members. These include cockpit naps lasting up to 45 min, providing crew bunks or other onboard rest facilities, scheduling appropriate duty times that ensure adequate time for rest, and employing alert management strategies as appropriate. Worldwide, countries are shifting to fatigue risk management systems (FRMS), which manage and decrease the risk of fatigue for aviation pilots.[4]

In our study, 39.2% of the pilots had mild depression, 9.6% had moderate depression, and 3.5% had severe depression, as determined with the PHQ-9. This is similar to findings reported by Aljurf et al., who found that 34.5% of the sample was at risk of depression according to the hospital depression and anxiety scale.[1,23] In the study 'Flying into depression,' O'Hagan et al. reported that pilots who spent more time on duty per week were twice as likely to report feeling depressed or anxious.[14] In addition, fatigue and sleep disturbances caused by shift work were found to be risk factors associated with depression.

We found that more experienced pilots and those with a higher rank had relatively lower risks for sleep disturbances, fatigue, and depression. This finding is in agreement with the findings published by Pellegrino and coworkers, in which they identified experience and higher rank as protective factors against low to moderate work ability.[16] We hypothesize that this may be due to the adaptation of pilots to the nature of their occupation and the effect of concomitant shifts on the circadian rhythm. This could also be because senior pilots are entitled to flight schedule privileges.

In a study that examined sleep time during long-range commercial flights, researchers found that there was no shift in circadian rhythm. They concluded that post-trip sleep duration recovery occurred within 1–2 d.[11] In our study, we found that pilots who exclusively operated domestic flights, flew both during the day and at night, and worked shorter shifts (< 8 h) had reduced sleep quality. We hypothesize that shorter shifts and schedules that include day and night flying times may have more profound effects on the circadian rhythm.

Limitations of the current study include the sample size and the fact that data were collected with questionnaires rather than by objective assessments. As such, inferences and general observations can be made, but definitive conclusions cannot be drawn. Moreover, our sample consisted of pilots operating regional and domestic flights and did not include those operating long-haul flights. Finally, concerns about job security may alter respondents' answers to questionnaires. According to the European Cockpit Association, up to 80% of pilots may avoid filing a fatigue report due to fears of suspension or disciplinary action from employers.[20] Thus, regulations should be in place to ensure pilot autonomy and job security when reporting fatigue.

Given the impact of pilot wellness on flight safety, as the aviation industry continues to grow, we recommend the performance of studies with larger sample sizes to investigate sleep, fatigue, and mood disorders among pilots. Pilot wellness is key to aviation safety. The current study found that pilots were at risk of developing sleep disorders, fatigue, and depression. The factors associated with a lower risk included experience, rank, and seniority, while the factors related to more strenuous schedules were associated with an elevated risk. A more robust and objective assessment is warranted for screening. The study authors recommend that leaders and policymakers in the Saudi aviation industry revise pilots' work schedules and develop and implement FRMS to mitigate the risks.

ACKNOWLEDGMENTS

The research group would like to acknowledge Mrs. Walaa Abuzahra, Research Coordinator, Sleep Medicine and Research Center (SMRC), and the sleep technicians at SMRC for their useful contributions and dedication to this research.

Financial Disclosure Statement: The authors have no competing interests to declare. This project was funded by the Deanship of Scientific Research (DSR) at King Abdulaziz University, Jeddah, under grant no. (RG-2-140-40). The authors, therefore, acknowledge with thanks the technical and financial support from the DSR.

Authors and Affiliations: Ahmed Alzehairi, DBA, Environmental Sciences, and Mansour Balkhyour, Ph.D., Faculty of Environmental Sciences, King Abdulaziz University, Faris Alhejaili, FRCPC, and Siraj Wali, FRCPC, Sleep Medicine Research Group, Sleep Medicine and Research Center, King Abdulaziz University Hospital, and Ibrahim AlQassas, M.D., International Medical Center, Jeddah, Saudi Arabia; and Seithikurippu R. Pandi-Perumal, FRCPC, Somnogen Canada, Inc., Toronto, Ontario, Canada.

REFERENCES

1. Aljurf TM, Olaish AH, BaHammam AS. Assessment of sleepiness, fatigue, and depression among Gulf Cooperation Council commercial airline pilots. Sleep Breath. 2018; 22(2):411–419.
2. Boeing. Pilot and Technician Outlook 2020–2039. Chicago (IL): Boeing; 2020.
3. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989; 28(2):193–213.
4. Caldwell JA, Mallis MM, Caldwell JL, Paul MA, Miller JC, Neri DF. Fatigue countermeasures in aviation. Aviat Space Environ Med. 2009; 80(1):29–59.
5. Consensus Conference Panel, Watson NF, Badr MS, Belenky G, Bliwise DL, et al. Joint consensus statement of the American academy of sleep medicine and sleep research society on the recommended amount of sleep for a healthy adult: methodology and discussion. Sleep. 2015; 38(8):1161–1183.
6. Fatani A, Al-Rouqi K, Al Towairky J, Ahmed AE, Al-Jahdali S, et al. Effect of age and gender in the prevalence of excessive daytime sleepiness among a sample of the Saudi population. J Epidemiol Glob Health. 2015; 5(4, Suppl. 1): S59–S66.
7. Jehan S, Zizi F, Pandi-Perumal SR, Myers AK, Auguste E, et al. Shift work and sleep: medical implications and management. Sleep Med Disord. 2017; 1(2):00008.
8. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. Sleep. 1991; 14(6):540–545.
9. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med. 2001; 16(9):606–613.

10. Krupp LB, LaRocca NG, Muir-Nash J, Steinberg AD. The fatigue severity scale. Application to patients with multiple sclerosis and systemic lupus erythematosus. Arch Neurol. 1989; 46(10):1121–1123.
11. Lamp A, McCullough D, Chen JMC, Brown RE, Belenky G. Pilot sleep in long-range and ultra-long-range commercial flights. Aerosp Med Hum Perform. 2019; 90(2):109–115.
12. Lee KA, Hicks G, Nino-Murcia G. Validity and reliability of a scale to assess fatigue. Psychiatry Res. 1991; 36(3):291–298.
13. Netzer NC, Stoohs RA, Netzer CM, Clark K, Strohl KP. Using the Berlin Questionnaire to identify patients at risk for the sleep apnea syndrome. Ann Intern Med. 1999; 131(7):485–491.
14. O'Hagan AD, Issartel J, Nevill A, Warrington G. Flying into depression. Workplace Health Saf. 2017; 65(3):109–117.
15. Paterson JL, Dorrian J, Ferguson SA, Jay SM, Dawson D. What happens to mood, performance and sleep in a laboratory study with no sleep deprivation? Sleep Biol Rhythms. 2013; 11(3):200–209.
16. Pellegrino P, Marqueze EC. Aspects of work and sleep associated with work ability in regular aviation pilots. Rev Saude Publica. 2019; 53:16.
17. Pellegrino P, Moreno CRC, Marqueze EC. Aspects of work organization and reduced sleep quality of airline pilots. Sleep Sci. 2019; 12(1):43–48.
18. Reis C, Mestre C, Canhão H, Gradwell D, Paiva T. Sleep complaints and fatigue of airline pilots. Sleep Sci. 2016; 9(2):73–77.
19. Soldatos CR, Dikeos DG, Paparrigopoulos TJ. Athens insomnia scale: validation of an instrument based on ICD-10 criteria. J Psychosom Res. 2000; 48(6):555–560.
20. Titelbach A. Barometer on pilot fatigue. Brussels (Belgium): European Cockpit Association; 2012.
21. Wali SO, Abalkhail B, Krayem A. Prevalence and risk factors of obstructive sleep apnea syndrome in a Saudi Arabian population. Ann Thorac Med. 2017; 12(2):88–94.
22. Wickens CD, Hutchins SD, Laux L, Sebok A. The impact of sleep disruption on complex cognitive tasks: a meta-analysis. Hum Factors. 2015; 57(6):930–946.
23. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand. 1983; 67(6):361–370.