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An exploration of the causes and effects of flight attendant fatigue in Turkish aviation

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ABSTRACT

The rapid growth in civil aviation operations in recent years has raised expectations from flight attendants. Their duties have been intensified, and flight attendants have become subject to physical and mental fatigue due to irregular sleep, inadequate rest time, and long working hours. This study investigates the causes and effects of fatigue among flight attendants of a Turkish airline company through a self-administrated questionnaire. The survey is run online to 152 flight attendants. The results show that the flight attendants have trouble falling asleep before flight duty. Before night flights and during layovers, the sleep duration is dramatically low. The results also reveal that factors related to scheduling, i.e., long duty days, night flights, consecutive working days, play an essential role in fatigue. Thus, airline companies should revise their scheduling practices. On balancing work and social life, men struggle more than women, and married flight attendants have more difficulty than single ones. The findings provide valuable insights for airline companies and policymakers to seriously manage fatigue-related factors to ensure the safety of aviation operations and the well-being of flight attendants.

Introduction

Civil aviation that relies on 24-hours flight operations significantly contributes to economic growth and supports many industries by creating new business opportunities. This dynamic nature of the airline industry also creates challenges for the employees of airline companies. Irregular working hours, frequent time zone changes, and heavy workload increase the level of fatigue among cabin crews. Some of these challenges make the life of flight attendants more difficult due to occupational health risks since their job requires long flight hours with quick turnarounds between flights, a high percentage of passenger loads, increased occupancy for international flights and new security procedures (McNeely et al., 2014).

From a global perspective, macro-economic downturn and increased price pressure from low-cost airlines have led many full-service airlines to find ways to reduce their costs. For instance, the minimum layover period has been decreased from 44 hours to 24 hours in the US Federal Aviation Administration's Flight Attendant Duty Time and Rest regulations. They have also changed the "reduced rest" provision from nine hours to eight hours. These changes have affected cabin crews through a high level of fatigue and inefficient service delivery since they are required to work long duty days, and flagrant violations of schedules create high levels of tiredness in them (Brown and Niehaus, 2009; Imm Ng et al., 2011). In this context, fatigue experienced by cabin crews poses a threat to health, safety, and performance. National Transportation Safety Board has admitted the hazard caused by fatigue in the aviation industry and has suggested putting limits on working hours (Lauria et al., 2006).

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Although flight attendants should primarily take care of the needs of passengers, they also show pre-flight safety performance. Before take-off and landing, they must give a cabin ready report to the cockpit. They also periodically check flight crew to confirm their health and safety. They inform pilots if there are any unusual noises or smells in the cabin. Moreover, they handle emergencies such as evacuating passengers out of the aircraft, giving instructions for using rafts and slides, in-flight firefighting, providing first aid and cardiopulmonary resuscitation, defibrillating passengers, and adhering to emergency landing procedures and handling emergencies. They ensure cabin and passenger safety during turbulence.

The fatigue of flight attendants has become vital because it threatens their ability to perform safety and security duties. As Nesthus et al. (2007) claimed that fatigue might cause flight attendants to forget to do significant security duties like disarming or engaging emergency exit doors and informing passengers about safety procedures. Fatigue may also have detrimental effects on alertness level in responding to an emergency case. Rosekind et al. (1996) proved that fatigue causes poor decision making, impairment in performance, slower reaction time, reduced levels of alertness, and poor communication skills. Since fatigue exposes a threat to safety-related performance and health of employees like cabin crews, some international prescriptive rules are introduced to manage fatigue. Although international laws control a certain level of fatigue, these rules only comprise maximum work hours and minimum hours of rest (Banks et al., 2009). However, other factors affect the level of fatigue. Cabon (2009) claimed that current international rules about fatigue management do not consider 24 hours operations, crossing multiple time zones, layover time, and circadian rhythms.

This study aims to contribute to the literature by its comprehensive approach to fatigue from the side of flight attendants. First, it explores the potential causes and effects of fatigue among flight attendants through a self-administered questionnaire applied to a sample of 152 flight attendants of a Turkish airline company. The survey focuses on sleep quality, fatigue experience, causes and outcomes of fatigue, and fatigue management strategies. Second, the study provides insights to airline companies and policymakers to take new measures to deal with fatigue-related risks.

The rest of the study is organised as follows: Section 2 provides information on the international regulations applicable to fatigue in aviation. Section 3 reviews the literature and develops the hypotheses. Section 4 provides the data and research methodology. Section 5 discusses the results, and finally, the last section concludes.

Literature Review

Regulatory and conceptual framework

International regulations on flight attendant fatigue

All civil aviation activities should be carried out safely, securely, and effectively. In this context, fatigue is an inevitable issue in the aviation industry. Pilots often operate in a difficult and stress-intensive environment, and flight attendants are tired of complex mission schedules that take long hours. Although international prescriptive rules usually manage fatigue problems, these rules are mostly related to the maximum number of work hours and minimum rest time. They do not cover other factors that may contribute to the fatigue, including round-the-clock operations, circadian rhythm disruptions, time of the flights, and time zone differences. The following section discusses the rules that apply to each factor influencing fatigue.

Working hour limitations

The International Civil Aviation Organization (ICAO) Regulation states that the operator must apply flight and duty time restrictions and rest requirement scheduling to minimise fatigue for its aircrew members (ICAO, 2013). Flight duty time (FDP) is one of the significant factors contributing to fatigue. Moebus (2008) suggested that FDP for a day should never be more than 13 hours within specific conditions. Nesthus et al. (2009) argued that the length of duty is one factor that increases flight attendant fatigue. Flight attendants must do pre-flight briefing and preparation. Thus, their commitment usually begins one hour earlier than flight crew. Standby rules also significantly contribute to flight attendant fatigue. Different standby duties (i.e., standby at home, in the airport or in a hotel) have various equivalents for the length of responsibility and can be considered half or full time working. Banks et al. (2009) found that some operators have regulations of maximum hour limits for standby duty and require accommodation facilities for convenient rest during standby. Nevertheless, most of the regulations do not have rules for maximum work hours during standby duty. Although standby duty does not include flight duties, flight attendants still spend time and energy on the job.

Sleep and rest requirements

The timing of the rest period and the duration of it is critical for fatigue management. Cumulative sleep deficit occurs in a person that gets sleep less than the recommended hours. Thus, they are likely to experience impaired brain function and cognitive performance. Therefore, cumulative fatigue occurs if flight attendants fly consecutive days with a minimum rest period (Piegon et al., 2010).

Increasing working hours

In recent years, the number of long nonstop flights has risen significantly along with the passenger load. The total monthly flight hours have also increased and approached the limits of labour management agreements. Thus, an ideal work-rest balance is necessary

to avoid fatigue symptoms (Ono et al., 1991). In this frame, night and early morning work, long flight hours, and significant time differences disrupt the biological rhythms of individuals. Many factors, including long work hours, regular landings, and late debriefing hours, contribute significantly to high fatigue complaints.

Changes in circadian rhythms

Flight attendants frequently experience rapid changes in circadian rhythms due to their heavy workload and unstable working environment. Circadian rhythm changes occur when they are mildly compelled to alter their sleep or waking up time. The disrupted circadian rhythms are also associated with adverse mental health effects, including suicide (McNeely et al., 2018). Working schedules can include long night shifts or travel between time zones, among other factors contributing to sleep disruption. Thus, many flight attendants experience changes in sleep circadian during the biannual hourly time adjustment associated with the beginning and end of daylight.

Physical factors and health

Irregular work hours, inadequate sleep, irregular eating schedule and reduced consumption of nutritious food cause health risks for flight attendants and contribute to the rise in chronic disease. The physical effects of the atmosphere may also affect cabin crew and create physiological and psychological problems. These problems occur due to the exposure to high altitude, low pressure, low temperature, cosmic radiation, and speed (Lauria et al., 2006) and can make it difficult for flight attendants to create an efficient and safe flight, as well as may cause medical disorders and flight accidents.

Conceptual framework and literature review

Several factors affect flight performance in the aviation industry, but the most important one is fatigue. Fatigue can be defined as a condition caused by an impaired biorhythm and incomplete rest. Excessive fatigue arises from long-term tasks or tasks that should be fulfilled in a short time, while chronic fatigue occurs by the additional factors that cause fatigue over time. Both types of fatigue may cause unsafe flights and low performance (Lerman et al., 2012; Signal et al., 2014). In the literature, many studies have discussed several conditions that cause an increase in flight attendant fatigue, as mentioned in the following part:

i. *Commuting to work:* Many flight attendants reside in an area far from the main operating base. Therefore, they must leave home earlier and drive for a long time to reach the airport to perform flight duties. Hence, they start their daily lives 2-3 hours earlier than others (Brown and Whitehurst, 2012).
ii. *Body rhythm disturbance (jet lag):* Disruption of body rhythm is common for flight attendants flying long distances. The biological rhythm of the body consists of a 24-hours routine. The jet lag syndrome occurs when this routine is disturbed. They are also constantly subject to disturbance of body rhythms due to night shift work and regular time zone crossings (Whelan et al., 2003). These factors contribute to sleep disruption and make it difficult for flight attendants to sleep and stay awake during the flight (Mills and Kuohung, 2019).
iii. *Waiting at airports:* Flight attendants usually wait a long time at airports where they need to rest (Orasanu, 2017). They also have watch duties. On watch duty, they should be present in the company's office/waiting room at the airport in uniform. If a cabin crew member becomes unable to take a flight due to an excuse, the flight attendant on watch duty will be assigned to the task (Kızılcan and Demiral, 2021). This causes fatigue for them (Avers et al., 2011).
iv. *Monotonous missions:* Flight attendants flying and serving in the same aircraft and on the same routes for a long time are prone to boredom (Naeeri, 2020). Monotony and boredom can be harmful to health, are associated with high levels of fatigue, burnout, and depression, and may cause negative consequences (Harju et al., 2014 Ozel and Hacioglu, 2021).
v. *Night flights:* Flight attendants do not have regular working hours. They can take a flight at any time of the day. Accordingly, they must adjust their sleep and rest hours (Kızılcan and Demiral, 2021). Changing working hours, constant changes in sleep patterns, insomnia, night shifts and circadian rhythm problems may cause fatigue and burnout (Signal et al., 2014).

Empirical Review and Hypotheses Development

In this section, we develop hypotheses to examine the effect of demographic characteristics, i.e., age, gender, education, job position, experience, and marital status, on sleep duration, sleep disorder, difficulty in balancing work and social life, and physical pain, and working conditions.

Sleep duration

There are two main factors that cause fatigue: sleep loss and circadian rhythm disturbance. In aviation, fatigue is the human body's typical response to flight-related situations that reduce performance and mental abilities, such as poor sleep, shift work, and long hours of duty. Tired people react more slowly to situations that require rapid cognition or physical response (Griffith and Powell, 2012). Sleep duration may also vary depending on individual factors such as age, gender, body weight, emotional state, and lifestyle habits (Chen et al., 2006). Drawing on these discussions, we develop the following hypotheses:

H_1: Sleep duration on non-working days differs according to demographic characteristics.

H_2: Sleep duration before night flight differs according to demographic characteristics.

Sleep disorder

Sleep disorder is a health problem affecting the quality of life. Waking up without adequate rest, difficulty falling asleep, waking up frequently, frequently napping, and fatigue suggest sleep problems. One of the sleep disorders is sleep-onset insomnia, which refers to difficulty in falling asleep. It may occur with people that have difficulty relaxing in bed or whose circadian rhythm is not in sync due to factors like jet lag or irregular working schedules. Stressful lifestyle, physical inactivity, irregular bedtime, alcohol, and caffeine consumption are among the factors for falling asleep difficulty. This is more common in women, single or divorced individuals, unemployed and older people (Gureje et al., 2009). Thus, we propose the following hypotheses:

H_3: Difficulty in falling asleep differs according to demographic characteristics.

H_4: Difficulty in falling asleep before flight mission differs according to sleep quality.

H_5: Napping during flight missions differs according to sleep quality.

Difficulty in balancing work and social life

An ideal work-rest balance is necessary to preserve good health and avoid fatigue symptoms (Ono et al., 1991). According to Guest (2002), the determinants of work-life balance consist of two parts: individual and organisational factors. Work demands and non-work life culture constitute organisational factors, while individual elements include work personality, life and career stages, gender, and age. Thus, we propose the following hypotheses:

H_6: The difficulty of balancing work and social life differs according to demographic characteristics.

Physical pain

Pain arises as a biological response due to tissue damage. It also has a dimension related to genetic, emotional, cultural attributes, and individual factors. Therefore, individual differences are observed in pain experience and severity. The experience of pain also shows different characteristics according to the region and ethnic groups. This situation indicates that pain is a complex concept with biological and social-cultural-psychological aspects. Thus, we propose the following hypotheses:

H_7: Physical pain felt at the end of a flight differs according to demographic characteristics.

Working conditions

Irregular work hours, inadequate sleep, reduced consumption of nutritious food, and lack of rest cause elevated health risks and fatigue-related illnesses, including immune system problems (Naktiyok and Karabey, 2005). Besides, fatigue is more common in women, single or divorced individuals, and older people. Therefore, the effect of working conditions on the immune system differs according to demographic attributes. Hence, we propose the following hypotheses:

H_8: The effect of working conditions on the immune system differs according to demographic characteristics.

Research and methodology

Data

Data sample

The universe of this study consists of flight attendants. The sample covers 152 flight attendants of a civil Turkish airline company that lands and takes off at Istanbul Airport. We exclude all participants that are not flight attendants, i.e., ground crew, administrative staff, and flight crew. The participants are selected by a simple random sampling method. We collected primary data for our study by running a structured survey to the flight attendants. The survey was administered on the Internet using Google Forms. We run the survey from December 1, 2020, to February 1, 2021. Although 300 potential respondents were contacted, only 152 of them filled in the online questionnaire. The main reason for this low response rate was the Covid-19 pandemic. We had difficulty reaching participants. Another reason is the busy working hours of flight attendants that work in a dynamic and active industry. The survey consists of 32 questions on personal information, fatigue and sleep level of flight attendants drawing on previous studies (Rosekind, 2000; Wollmuth, 2017). The survey is composed of three sections:

i. Demographic information covering age, gender, education level, job position, experience, and marital status (6 questions).
ii. Sleep information assessing typical sleep patterns sleep problems and evaluations of flight attendants about their sleep quality (7 questions).
iii. Fatigue examines the respondents' assessments of fatigue sources, fatigue countermeasures, fatigue impacts, fatigue experiences, mitigating fatigue, and effectiveness of training to reduce fatigue (19 questions).

Method

We used SPSS for Windows v.28 to analyse the data in the study. The findings were checked at a 5% significance level and 90% and 95% confidence intervals. First, we examine the means, frequencies, and percentage distributions of the demographic characteristics

of the participants and their answers. Then, we conducted t-tests and one-way analysis of variance (ANOVA) to determine whether flight attendants' fatigue and sleep levels differ according to their demographic attributes.

Empirical Analysis and Findings

Descriptive statistics

This section summarizes descriptive statistics in terms of demographics, sleep, fatigue, and management.

Demographics

Table 1 presents the distribution of the demographic characteristics of participants (N=152). Majority of the participants (51 per cent) range between 25-and 30 ages (N=78), while the participants over the age of 41 covers the smallest group (N=9). In terms of gender, most of the participants are female (N=111), while in terms of marital status, 44 participants are married, and 108 of them are single. When we look at the educational background, most participants have a bachelor's degree (N=97). Among the remaining 29 participants, 25 have a college graduate degree, and 4 have a high school degree. Only 26 participants have a postgraduate degree. Most of the participants work as cabin crew (N=129). Besides, 15 cabin chiefs and eight pursers responded to the survey. We observe that the group sizes are getting smaller as years of experiences increase. Accordingly, the groups were sorted as <5 years of experience (N=86), 5-10 years of experience (N=47), 11-15 years of experience (N=9), and 16-20 years of experience (N=6) and over 21 years of experience (N=4).

Sleep

The participants were first asked about the hours of sleep they get on average on their days off duty. The results are: "less than 4 hours" (1 per cent), "4-6 hours" (6 per cent), "6-8 hours" (45 per cent) and "more than 8 hours" (48 per cent). Thus, 93% of the participants get a good sleep on their days off duty. The participants were also asked how many hours of sleep they usually get when they were at layovers with minimum rest time (12 hours or less). The results are: "less than 4 hours" (17 per cent), "4-6 hours" (46 per cent), "6-8 hours" (32 per cent) and "more than 8 hours" (5 per cent). These results indicate that a minimum rest time at layover of 12 hours is insufficient for flight attendants to get enough sleep and rest before returning to the flight mission. This is because 12 hours of rest time includes leaving the aircraft and airport, transportation to the hotel, sleeping, and preparing for returning flight. The preparation time for the female cabin crew also includes make-up and hairdressing.

Table 1: Demographics Results of the Survey

		N	%
Age			
	18-24	16	10
	25-30	78	51
	31-35	39	26
	36-40	10	7
	41+	9	6
Gender			
	Female	111	73
	Male	41	27
Education Level			
	High School Degree	4	3
	College Graduate Degree	25	16
	Bachelor's Degree	97	64
	Master's Degree	25	16
	Doctorate Degree	1	1
Job Position			
	Cabin Crew	129	85
	Cabin Chief	15	10
	Purser	8	5
Experience			
	<5 years	86	56
	5-10 years	47	31
	11-15 years	9	6
	16-20 years	6	4
	21 years and above	4	3
Marital Status			
	Married	44	29
	Single	108	71

Finally, the participants were asked how many hours of sleep they get on average before night-time flights. The results are: "less than 4 hours" (60 per cent), "4-6 hours" (14 per cent), "6-8 hours" (19 per cent) and "more than 8 hours" (7 per cent). This result shows that the flight attendants have difficulty sleeping before nighttime flights. This may have adverse effects on their performance. Table 2 shows the results for sleep duration on days off, layovers, and before night flight duties. Flight attendants have the most extended sleep duration on the days off duty. The sleep durations are shortened at layovers, and they have the shortest sleep durations before night flights.

Table 2: Sleep Duration on Days-off, Layover and Before Night Flights

Questions	**Less than 4**	**4 to 6**	**6 to 8**	**More than 8**	**Mean**	**Standard Deviation**
On your days off duty, what is the total amount of sleep you get on average?	1 0.7	9 5.9	68 44.7	74 48.7	3.42	0.63
When you are at layover with minimum rest time (12 hours or less), how many hours of sleep do you usually get?	26 17.1	69 45.4	49 32.2	8 5.3	2.25	0.80
How many hours of sleep you get on average before night-time flight?	91 59.9	21 13.8	29 19.1	11 7.2	1.73	1.00

Another question measures how often the participants have trouble falling asleep before flight duty. Table 3 shows the results. The responses indicate that only one percent of the participants "never" have troubles. Twenty-eight per cent of the participants have troubles "sometimes", 46 per cent of them have troubles "usually", and 24 per cent of them have troubles "very often" with falling asleep before flight duty. In line with this result, over 80 per cent of the respondents reported that they "never" get enough sleep (36 per cent) or "sometimes" get enough sleep (53 per cent), while 11 per cent "usually" get enough sleep and 1 per cent "always" get enough sleep before night-time or early morning flights. These results indicate that the participants mostly have trouble falling asleep and do not sleep enough. Considering that insufficient sleep may cause stress, decrease physical abilities, and thus, negatively affect the duties of flight attendants for safety, it should be seriously addressed by airline companies.

We also asked the participants how often they use over-the-counter, prescription medication, or a supplement to help them fall asleep. The results in Table 4 are in line with the previous studies (Rosekind, 2000; Wollmuth, 2017). Despite sleep problems, most participants do not use medication to impair sleep quality. One reason may be the procedures of airline companies. Some companies have strict policies that forbid to use of medicines because of their side effects that may affect psychological and cognitive abilities and endanger flight safety.

Table 3: Results on Falling Asleep and Getting Enough Sleep

Questions	**Always**	**Usually**	**Sometimes**	**Never**	**Mean**	**Standard Deviation**
How often do you have troubles to fall asleep before flight?	37 24.3	70 **46.1**	43 28.3	2 1.3	2.06	0.76
Do you think that you get enough sleep before night time or early morning flights?	1 0.7	17 11.2	80 **52.6**	54 35.5	3.23	0.66

Table 4: Medication or Supplement Usage

Questions	**Very Often**	**Often**	**Sometimes**	**Rarely**	**Never**	**Mean**	**Standard Deviation**
How often do you use over-the-counter or prescription medication to help you fall asleep?	1 0.7	3 2.0	6 3.9	15 9.9	127 **83.6**	4.73	0.68

The results also indicate that most of the flight attendants (71 per cent) unwillingly nap during the flight. Since flight attendants have security roles that require immediate attention, being unable to respond to such cases is alarming. For instance, in an emergency case, napping may cause delays in responding. Similarly, there may be a risk of incomplete or late fulfilment of security duties such as tasks related to turbulence and cabin security before take-off and landing.

Overall, the respondents evaluate their sleep quality as “very good” (5 per cent), “good” (24 per cent), “fair” (53 per cent), “poor” (17 per cent) and “very poor” (1 per cent). According to these results, the general evaluation of the participants' sleep quality is average. One likely reason for the participants' "optimistic" assessment of the sleep quality despite their relatively high level of sleep problems may be that they assign different meanings to the sleep quality.

Fatigue

To measure the cause and effects of fatigue, we asked a series of questions to the participants. First, we asked them to select the factors that cause fatigue in civil aviation operations from a list of 10 items. Table 5 shows the results. The most often identified item is “minimum rest time layovers” in the top five choices by 14 per cent of the respondents. “Long duty days” is the second (13 per cent), “night flights” is the third (13 per cent), “consecutive days of working” is the fourth (13 per cent) and “4 legs flight duty” (12 per cent) is the fifth most selected factor.

Table 5: Top Five Factors that Cause Fatigue

Factors	**Frequency**	**Percent**
Minimum rest time layovers	119	14
Long duty days	111	13
Night flights	110	13
Consecutive days of working	110	13
4 legs flight duty	101	12

Flight attendants' “minimum rest period” at layovers is 12 hours or even less in some airline companies. This period begins just after the aircraft engine shuts down. The processes of leaving the plane, airport, and transportation to a hotel in another location are included within that minimum rest period. The preparation of flight attendants for the return flight is also included in the same layover period. The flight attendants are also recommended by their companies to sleep for 8 hours before each flight. Therefore, the flight attendants do not have enough time to sleep and rest.

The second and fifth selected factors, namely “long duty days” and “4 legs flight duty”, are related to each other. Due to the short flight time on domestic flights, 4-leg flight missions can be planned. However, flight attendants may be more tired than on a 2-legged international flight. The reason is that many tasks such as take-off and landing, boarding, and safety demonstration are repeated four times and the workload increases. Apart from this, one of the reasons for selecting the "long duty days" factor is long international flights and extended range (ER) flights. In ER flights, flight attendants always work on wide-body flights. On these flights, they offer service more than once in a single flight, and they also fly to a country in a different time zone.

“Consecutive days of working”, the third selected factor, also significantly increases fatigue. Crew planning department has the authority to plan a day flight after night flights connecting two days. According to international laws, such a plan can be made if “minimum rest time” is given. However, the sleep patterns and circadian rhythms of flight attendants returning from a night flight are disrupted, and flights take place without scheduled free days in a row. Thus, fatigue occurs.

Almost all participants (97 per cent) claimed that fatigue is a “moderate” or “serious” concern in civil aviation operations, and 99 per cent of the participants stated that fatigue is a “moderate” or “serious” safety issue when it occurs. Table 6 shows the results. They are in line with the previous studies (Ozel and Hacioglu, 2021; Rosekind, 2000; Wollmuth, 2017).

Table 6: Fatigue as a Concern and Safety Issue in Civil Aviation

Questions	**Serious**	**Moderate**	**Minor**	**Not at all**	**Mean**	**Standard Deviation**
In your opinion, to what extent is fatigue a concern in civil aviation operations?	134 88.2	13 8.6	4 2.6	1 0.7	1.15	0.47
When fatigue occurs, how significant a safety issue is it?	137 90.1	14 9.2	1 0.7	0 0	1.11	0.37

When we asked the participants to identify how fatigue affects their performance, they selected “tiredness” (89 per cent), “concentration” (70 per cent), “alertness” (68 per cent) and “errors” (55 per cent) as the most significant impacts. Other impacts were sorted as follows: “slow reaction” (55 per cent), “mood change” (47 per cent), “apathy” (43 per cent), “CRM skills” (42 per cent), “judgement” (33 per cent), “omissions” (27 per cent), “motor skills” (22 per cent) and “memory” (20 per cent). The results in Table 7 are in line with the findings of Wollmut (2017). These factors may cause security and emergency problems. For example, disarming and arming slides at aircraft doors before and after each flight is a task that requires attention. If this task is not executed correctly, the aircraft door opens, the slides explode, the flight operation disrupts, and the company incurs great costs. These effects may also

cause disruption of the duties of securing passengers and cabin before each take-off and landing, and a safe flight will not occur. Finally, in an evacuation case, cabin crews cannot perform perfectly, and mistakes may endanger human life.

Table 7: Impacts of Fatigue on the Performance of Flight Attendants

Question: In which of the following ways does fatigue affect your performance? (Select all that apply)	**Frequency**	**Percentage (%)**	**Cumulative Percentage (%)**
Alertness/attention	103	11.9	11.9
Omissions	41	4.7	16.6
Apathy	65	7.5	24.1
Judgement	50	5.8	29.9
Slow reaction	83	9.6	39.4
Errors	84	9.7	49.1
Concentration	106	**12.2**	61.4
Motor skills	34	3.9	65.3
Mood change	72	8.3	73.6
Tired/Sleepy	135	**15.6**	89.2
Memory	30	3.5	92.6
Crew resource management skills	64	7.4	100.0
Total	834	100.0	

In addition, more than half of the participants (62 per cent) stated that the most disruptive phase of flight by fatigue is landing (36 per cent) or descent (26 per cent). Table 8 shows the results. Since the descent and landing phases constitute the end of a flight mission, it is reasonable that the intensity of the answers is gathered in these two phases. Thus, the fatigue in these two phases may pose significant risk to flight safety.

The participants also stated that short or medium-haul international flights make them exhausted the most (51 per cent). The second most exhausting flight type is long-haul (ER) international flights (39 per cent), and the least exhausting flight type is domestic flights (10 per cent). Table 9 shows the results. On short and medium-haul international flights, flight attendants usually perform more than one flight duty in a day, handling tasks related to take-off and landing more than once with excessive passenger service. But as flight attendants have to layover on transoceanic ER flights, they have opportunity to rest. Therefore, ER flights are less tiring than short and medium-haul flights, even if they have longer distances. The reason why the domestic flights are chosen as the least exhausting flight type may be attributed to the short and relatively easy passenger service. Excessive fatigue is caused by long-term tasks or tasks that should be executed in a short time (Papanikou et al., 2020).

Table 8: The Most Disruptive Phase of Flight by Fatigue

Question: In your opinion, which phase of the flight is the most affected by fatigue?	**Frequency**	**Percentage (%)**	**Cumulative Percentage (%)**
Taxi	18	11.8	11.8
Take off	5	3.3	15.1
Cruise	35	23.0	38.2
Descent	40	26.3	64.5
Landing	54	**35.5**	100.0
Total	152	100.0	

Table 9: The Most Exhausting Flight Type

Question: Which type of flight duty does make you more exhausted?	**Frequency**	**Percentage (%)**	**Cumulative Percentage (%)**
Domestic flights	15	9.9	9.9
Short or medium-haul international flights	78	51.3	61.2
Long-haul international flights	59	38.8	100.0
Total	152	100.0	

When the participants were asked whether they ever wanted not to fly due to fatigue, 12 per cent of them answered “no”, while the rest answered “yes” (87.5 per cent) (Table 10). This result is dramatic because it indicates that the majority of flight attendants have experienced fatigue at least once, and they had to go to flight duty.

Table 10: Unwillingness to Fly due to Fatigue

Question	Yes	No	Mean	Standard Deviation
Have you ever not wanted to fly because you were too tired?	133 **87.5**	19 12.5	1.12	0.33

When we looked at the physical symptoms that the participants felt the most after the end of duty, we observed two main symptoms: back pain (49 per cent) and foot pain (33 per cent). (Table 11). When the participants were asked how often they felt apathy or emotional exhaustion, half of them replied as "sometimes" (50 per cent), while the other half answered as follows: "rarely" (30 per cent), usually (18 per cent) and never (2 per cent) (Table 12). In line with this fact, when the respondents were asked whether it is hard to smile at the passengers on a bad day, they answered as follows: "rarely" (46 per cent), "usually" (30 per cent), "never" (15 per cent) and "always" (9 per cent) (Table 13). Most of the participants feel emotional exhaustion and exhibit superficial behavior such as smiling at passengers forcibly is evaluated as complying with the rules, not to help customers, but to keep their job (Grandey, 2003).

Table 11: Physical Symptoms Felt After Flight

Question: At the end of your duty, which physical symptom do you feel the most?	Frequency	Percentage (%)	Cumulative Percentage (%)
Back pain	75	**49.3**	49.3
Foot pain	51	**33.6**	82.9
Shoulder/elbow/wrist/hand pain	3	2.0	84.9
Joint pain	13	8.6	93.4
None of them	10	6.6	100.0
Total	152	100.0	

Finally, the respondents were asked to what extent their company showed concern for the employees' health. The answers were sorted as: "to a moderate extent" (57 per cent), "to a minimum level" (21 per cent), "to a great extent" (17 per cent) and "not at all" (5 per cent). Table 14 shows the results. Considering the importance of the possible effects of a problem arising from employee unhealthiness, airline companies should be more concerned about employees' health.

Table 12: Feeling Apathy or Emotional Exhaustion

Question	Usually	Sometimes	Rarely	Never	Mean	Standard Deviation
How often do you feel emotional exhaustion?	27 17.8	76 **50.0**	46 30.3	3 2.0	2.16	0.73

Table 13: The difficulty of Smiling Passengers

Question	Always	Usually	Rarely	Never	Mean	Standard Deviation
When you are having a bad day, is it hard for you that you have to smile to passengers most of the time?	14 19.2	46 30.3	70 **46.1**	22 14.5	2.65	0.83

Table 14: Company Concern for Employee Health

Question	To a great extent	To a moderate extent	To a minimum level	Not at all	Mean	Standard Deviation
To what extent, does your company show concern for employees' overall health?	25 16.4	87 **57.2**	32 21.1	8 5.3	2.15	0.75

Management

A series of two questions were asked to the participants to pick up from a list of fatigue mitigation techniques during pre-trip and post-trip. The top three strategies reported for pre-trip are caffeine (72 per cent), napping (58 per cent) and drinking plenty of water (55 per cent) (Figure 1). On the other hand, the top three strategies reported for post-trip are showering (88 per cent), napping (80 per cent) and drinking plenty of water (51 per cent) (Figure 2). When we compare the answers with the findings of Wollmuth, the participants use the same techniques for relaxation. According to the results, napping and drinking plenty of water before and after flight duty is among the top-three mitigation techniques. The fact that napping is a mainly selected factor presents consistency with the outcomes identified in the sleep section. Many flight attendants probably take naps, especially before night flight duties, because they cannot get enough sleep before night flights. Similarly, due to not getting enough sleep and disrupting circadian rhythm, flight attendants feel the need to take naps after the flight. The second commonly selected factor, "drinking plenty of water," may be attributed to the fact that the human body becomes dehydrated due to a lack of moisture during the flight. Therefore, the flight attendants should consume plenty of water not only during the flight but also before and after each flight duty.

Finally, the participants picked up the items from a list of twelve suggested methods of reducing fatigue in civil aviation operations. The results are presented in Table 15.

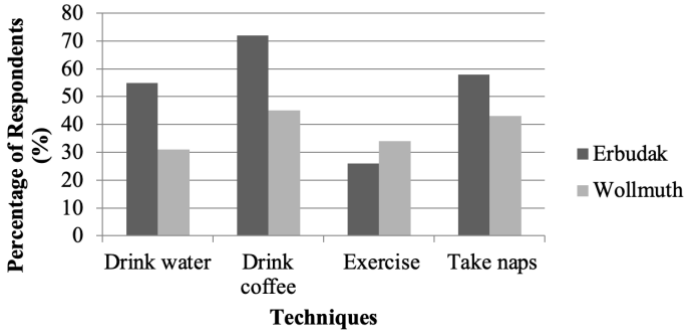

Figure 1: Pre-Trip Fatigue Mitigation Techniques

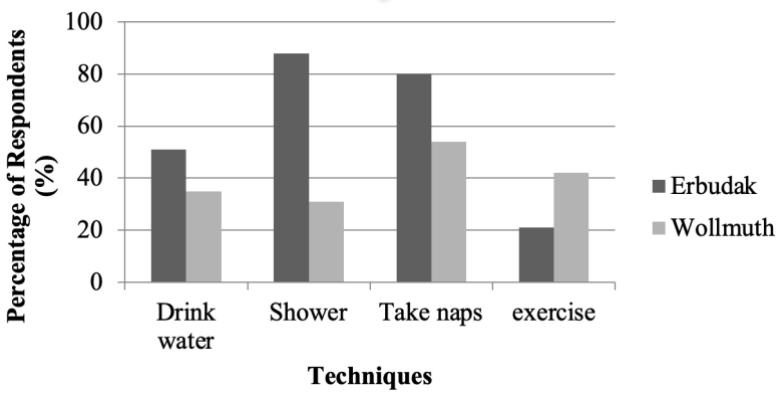

Figure 2: Post-Trip Fatigue Mitigation Techniques

Table 15: Methods Suggested by Participants to Reduce Fatigue in Civil Aviation

Methods	N	Percent	Wollmuth
Improve scheduling	121	80%	83%
Improve rest time	112	74%	80%
Reduce consecutive days	106	70%	71%
Train management about fatigue	103	68%	69%
Limit late night flights	92	61%	
Augment crews	88	58%	
Duty time limits	78	51%	85%
Limit early departure flights	68	45%	
Increase company support	58	38%	
Opportunity to switch duties between crew members	48	32%	
Improve days off	38	25%	
More effective training about fatigue to crew-members	12	8%	

In the survey, we asked the flight attendants to suggest reducing fatigue in civil aviation operations from a list of options. Table 16 shows the results. The top three most selected methods are "improve scheduling" (13.1 per cent), "improve rest time" (12.1 per cent) and "reduce consecutive days" (11.5 per cent). The findings indicate that the most selected suggestions are all about scheduling. It is mentioned that if the minimum rest time is applied, the crew planning department can publish flight plans in which a daytime flight follows a night flight and vice versa for consecutive days. To prevent such scheduling practices, reducing consecutive days of flight plans, improving rest times between flights and at layovers and improving scheduling, in general, will help airline companies to reduce the fatigue experienced by the employees.

Table 16: Methods Suggested by Participants to Reduce Fatigue in Aviation

Question: In your opinion, which changes could be done to reduce fatigue in civil aviation operations? (Select all that apply)	**Frequency**	**Percentage (%)**	**Cumulative Percentage (%)**
Duty time limits	78	8.4	17.0
Improve scheduling	121	**13.1**	46.4
Improve rest time	112	**12.1**	55.8
Improve days off	38	4.1	62.9
Train management and crew planning department about fatigue	103	11.1	89.8
More effective training about fatigue to crew-members	12	1.3	97.6
Augment crews	88	9.5	98.0
Limit early departure flights	68	7.4	100.0
Limit late night flights	92	10.0	77.1
Reduce consecutive days	106	**11.5**	88.5
Increase company support	58	6.3	94.8
Opportunity to switch duties between crew members	48	5.2	100.0
Total	924	100.0	

Test results for demographic characteristics

Gender

The mean value of female flight attendants that have difficulty in balancing work and social life is lower than that of male flight attendants (2.59>2.29).

Table 17 shows the results. The work and social life balance show a significant difference as p=0.009 df150<0.05 at the 95% confidence interval. This result indicates that men have more difficulty balancing work and social life than women, supporting our sixth hypothesis (H_6). Although this result might be surprising, men struggle as much as women to balance work and social life. They carry household affairs and give care to children. The changing roles in social life and working in a job that requires staying away from home can make it hard to maintain healthy work and social life for men.

Table 17: Independent t-Test for the Gender of Flight Attendants

Questions	**Gender**	**N**	**Mean**	**Standard Deviation**	**Df**	**T**	**P**
On your days off duty, what is the total amount of sleep you get on average?	Female	111	3.46	0.61	150	1.442	0.151
	Male	41	3.29	0.68			
How many hours of sleep you get on average before night time flights?	Female	111	1.64	0.95	150	-1.651	0.104
	Male	41	1.97	1.12			
How often do you have troubles to fall asleep before flight duty?	Female	111	2.06	0.80	150	-0.072	0.942
	Male	41	2.07	0.64			
How often do you find it difficult to balance your work and social life?	Female	111	2.59	0.60	150	2.629	**0.009***
	Male	41	2.29	0.68			
At the end of your duty, which physical symptom do you feel the most?	Female	111	1.9	1.18	150	0.104	0.918
	Male	41	1.88	1.26			
Do you think that your immune system is affected negatively due to working conditions?	Female	111	1.20	0.40	150	-0.61	0.543
	Male	41	1.24	0.43			

Table 18: ANOVA Test Results for Age

Questions	Age	N	Mean	Standard Deviation	Df	t	P
On your days off duty, what is the total amount of sleep you get on average?	18-24	16	3.25	0.577	4 147	0.583	0.676
	25-30	78	3.41	0.633			
	31-35	39	3.49	0.556			
	36-40	10	3.30	0.949			
	41 +	9	3.56	0.726			
How many hours of sleep you get on average before night time flights?	18-24	16	1.56	0.964	4 147	2.648	**0.036***
	25-30	78	1.65	0.965			
	31-35	39	1.67	0.927			
	36-40	10	2.10	0.994			
	41 +	9	2.67	1.414			
How often do you have troubles to fall asleep before flight duty?	18-24	16	1.81	0.834	4 147	0.544	0.704
	25-30	78	2.09	0.759			
	31-35	39	2.13	0.695			
	36-40	10	2.10	0.994			
	41 +	9	2.00	0.707			
How often do you find it difficult to balance your work and social life?	18-24	16	2.63	0.500	4 147	0.511	0.728
	25-30	78	2.46	0.638			
	31-35	39	2.56	0.680			
	36-40	10	2.40	0.699			
	41 +	9	2.67	0.707			
At the end of your duty, which physical symptom do you feel the most?	18-24	16	2.38	1.628	4 147	1.213	0.308
	25-30	78	1.81	1.163			
	31-35	39	2.03	1.224			
	36-40	10	1.50	1.527			
	41 +	9	1.67	1.000			
Do you think that your immune system is affected negatively due to working conditions?	18-24	16	1.25	0.447	4 147	0.101	0.982
	25-30	78	1.19	0.397			
	31-35	39	1.23	0.427			
	36-40	10	1.20	0.422			
	41 +	9	1.22	0.441			

Age

There is a significant difference between the age and the sleep time before night flight duty as p=0.036 df4-147<0.05 at the 95% confidence interval. The average sleep time before night flight duty of flight attendants aged between 25-and 30 is lower than the average sleep time of those over 41 years old (Table 18). This result supports our second hypothesis (H_2) and shows that young cabin crews still try to adopt irregular working hours and may have sleep anxiety due to the stress of not getting enough sleep before night flights.

Marital status

The work and social life balance show a significant difference at the 90% confidence interval (p=0.066 df150<0.10) (Table 19). This result indicates that married flight attendants have more difficulty balancing work and social life than single ones, supporting our sixth hypothesis (H_6). This finding is reasonable since married people are expected to have more responsibilities in social life than single people, especially if they have kids. Flight attendants do not only work outside of regular working hours but also at the weekends and national holidays. Thus, their flight schedule usually collides with other households' off-days.

We also asked participants, "Do you think your immune system is affected negatively due to working conditions?". The results were remarkable. The majority of the flight attendants' (78.9%) said "Yes". Working conditions, including physical conditions and interpersonal relationships, make flight attendants prone to a weak immune system. In terms of physical ailments, they always work indoors, in a cabin with pressurized air and are exposed to constant noise and radiation. In terms of interpersonal relationships, they contact other cabin crews and passengers. Moreover, disruption of circadian rhythm due to working at night and flying to countries in different time zones weaken the immune system.

The t-test results on the negative effects of working conditions on the immune system show a significant difference at the 90% confidence interval (p=0.062 df150<0.05) with the marital status of the flight attendants. This finding indicates that the immune system of married flight attendants is negatively affected by working conditions more than single ones. This result supports our eighth hypothesis (H_8). One plausible reason is that married flight crew could not rest enough off-days due to their responsibilities.

Educational level

We detected no significant difference between education level and the questions related to sleep and fatigue.

Work experience

We found no significant difference between the work experience and the questions related to sleep and fatigue.

Job position

There is a significant difference between the job position and sleep time before night flight duty (p=0.028 df2-149<0.05) at the 95% confidence interval (Table 20). The average sleep time of cabin chiefs before night flight duty is higher than the average of pursers. This finding supports our second hypothesis (H_2). Cabin crews and pursers have different tasks and go through various flight duties. Pursers always work in wide-body aircraft and become like a manager of all other cabin crews. Since wide-body aircraft usually fly to distant destinations in different time zones, the average sleep time of pursers before night flights could be less than cabin chiefs and crew.

Table 19: Independent t-Test Results on the Marital Status of Flight Attendants

Questions	**Marital Status**	**N**	**Mean**	**Standard Deviation**	**df**	**T**	**P**
On your days off duty, what is the total amount of sleep you get on average?	Married	44	3.43	0.661	150	0.214	0.831
	Single	108	3.41	0.627			
How many hours of sleep you get on average before night time flights?	Married	44	1.61	0.970	150	-0.961	0.338
	Single	108	1.79	1.024			
How often do you have troubles to fall asleep before flight duty?	Married	44	2.14	0.852	150	0.729	0.467
	Single	108	2.04	0.722			
How often do you find it difficult to balance your work and social life?	Married	44	2.36	0.750	150	-1.851	**0.066***
	Single	108	2.57	0.583			
At the end of your duty, which physical symptom do you feel the most?	Married	44	1.86	1.069	150	-0.203	0.839
	Single	108	1.91	1.257			
Do you think that your immune system is affected negatively due to working conditions?	Married	44	1.11	0.321	150	-2.131	**0.062***
	Single	108	1.25	0.435			

Sleep quality

There is a significant difference between sleep quality and the finding related to the trouble falling asleep before night flight duty (p=0.006 df df4-147<0.05) at the 95% confidence interval (Table 21). This result indicates that flight attendants whose sleep quality is good have less trouble falling asleep before flight duty than flight attendants whose sleep quality is terrible. This finding supports our fourth hypothesis (H_4) and shows that flight attendants that have trouble falling asleep before flight duty are aware that their sleep cycle is disrupted, and their sleep quality is affected negatively.

Table 20: ANOVA Test Results for Job Position

Questions	Job Position	N	Mean	Standard Deviation	df	t	P
On your days off duty, what is the total amount of sleep you get on average?	Cabin Crew	15	3.75	0.488	2	1.320	0.270
	Cabin Chief	129	3.32	0.641			
	Purser	8	4.00	0.744	149		
How many hours of sleep you get on average before night time flights?	Cabin Crew	15	1.75	1.060	2	3.666	**0.028***
	Cabin Chief	129	1.68	0.955			
	Purser	8	1.00	1.408	149		
How often do you have troubles to fall asleep before flight duty?	Cabin Crew	15	1.75	0.743	2	0.097	0.908
	Cabin Chief	129	1.88	0.774			
	Purser	8	2.00	0.641	149		
How often do you find it difficult to balance your work and social life?	Cabin Crew	15	2.75	0.488	2	1.889	0.155
	Cabin Chief	129	2.56	0.651			
	Purser	8	2.00	0.641	149		
At the end of your duty, which physical symptom do you feel the most?	Cabin Crew	15	1.25	1.424	2	0.919	0.401
	Cabin Chief	129	1.72	1.203			
	Purser	8	2	0.535	149		
Do you think that your immune system is affected negatively due to working conditions?	Cabin Crew	15	1.25	0.488	2	1.754	0.177
	Cabin Chief	129	1.72	0.408			
	Purser	8	2.00	0.000	149		

Table 21: ANOVA test Results for Sleep Quality

Questions	Sleep Quality	N	Mean	Standard Deviation	df	t	p
How often do you have troubles to fall asleep before flight duty?	Very good	7	2.57	1.134	4	3.811	**0.006**
	Good	36	2.36	0.683			
	Fair	81	2.00	0.689	147		
	Poor	26	1.77	0.815			
	Very poor	2	1.50	0.707			
Have you ever unintentionally slept during flight ("nodded off)?	Very good	7	1.14	0.378	4	1.700	0.153
	Good	36	1.25	0.439			
	Fair	81	1.37	0.486	147		
	Poor	26	1.15	0.368			
	Very poor	2	1.00	0.000			

In the survey, we asked participants, "Have you ever unintentionally slept during a flight ("nodded off)?". Majority of the participants (78 per cent) stated that they had unintentionally slept during the flight. The findings indicate that there is no significant difference between "unintentionally sleeping during flight" and "sleep quality". Although Hypothesis 5, "Napping during flight mission differs according to the sleep quality", was not supported, the result shows that the flight attendants whether their sleep quality is good or bad have nodded off due to working conditions. In this sense, extreme fatigue can cause such cases, like unintentionally sleeping during a flight, to happen even if the sleep quality is good.

Finally, we asked participants to choose the type of fatigue management training they took from their company. 91.4% of the participants took online training. Since the ratio of participants that took other course types is very low (8.6%), it is obvious that a meaningful difference could not be derived from our sample.

Conclusions

The aviation industry has shown remarkable growth over the last decades, leading to increased airline operations. In parallel to this progress, fatigue has become a severe concern that threatens employees' job performance and well-being, including pilots and flight attendants. Although many studies focus on fatigue experienced by pilots, there are relatively few studies investigating the influence of fatigue on flight attendants that belong to a significant occupational group in terms of several duties they perform and the physically demanding working conditions they are exposed to. They do not only provide service to passengers but also, they perform tasks

related to safety and security during flight operations. Thus, fatigue acts as a significant factor that affects the safety of flight operations and the health of flight attendants.

This study examines the causes and effects of fatigue on flight attendants by using a structured survey in line with similar prior studies (e.g., Avers et al., 2009; Banks et al., 2012; Chung and Chung, 2009; Ono et al., 1991; Van Den Berg et al. 2019). The survey consists of 32 questions categorized into three sections: demographics, sleep quality and fatigue. The survey was available for a period of 60 days, from December 2020 to February 2021, and primary data was collected from 152 flight attendants.

The flight attendants that participated in the survey were relatively young, mostly aged between 25-and 30. Majority of them were female and currently working as cabin crew. We primarily examined the sleep habits of the participants. The results show that more than half of the participants sleep less than 4 or 6 hours when they are at layovers with minimum rest time. Moreover, although airline companies suggest flight attendants sleep a minimum of 8 hours before flights, 60 per cent of them sleep less than 4 hours before night flight duties. In line with these results, almost all participants declared that they had trouble falling asleep before flight duty. The findings demonstrate that flight attendants are constantly exposed to sleep deprivation due to irregular working hours. In addition, over 70 per cent of the flight attendants stated that they had unwillingly slept during the flight. This is important since insufficient sleep may cause human error-based accidents that endanger flight safety. Therefore, it is not surprising to find out that the flight attendants mainly selected tiredness, concentration, alertness, and errors as the impacts of fatigue in our survey.

The results also show that most of the participants (87.5 per cent) do not want to fly due to fatigue. This finding indicates how common is fatigue among flight attendants. Regarding physical symptoms, flight attendants are affected by job-related physical pains. Majority of the participants suffer from back and foot pain. Flight attendants also feel emotional exhaustion at different levels. These results indicate that pain due to working conditions, emotional exhaustion, and intense interpersonal relationships with customers increase flight attendants' fatigue.

The results for demographic characteristics also produce meaningful results. Young flight attendants have more difficulty falling asleep before night flights than their elder colleagues. This finding indicates that flight attendants adopt the profession to gain more experience. Hence, fatigue is expected to occur more commonly among young cabin crews. In balancing work and social life, male cabin crews have more difficulty than female ones. Although this finding is surprising, it supports the changing roles of gender in society. In recent decades, men have had a more active role in family affairs, and women more actively participate in work-life than before. The results also show that married flight attendants have more difficulty balancing work and social life. This finding is evident because the schedule of flight attendants is irregular in the airline industry that relies on 24-hour operations. Thus, balancing social life and household responsibilities is more challenging for married flight attendants. Most married flight attendants stated that their immune system is negatively affected by working conditions. This finding shows that difficulties in balancing work and social life and the effects of physically demanding working conditions negatively affect the immune system. Remarkably, 80 per cent of the flight attendants claimed that their immune system is negatively affected by working conditions. This finding should be seriously taken into consideration by the airline companies.

Finally, as indicated in the previous studies (Rosekind, 2000; Wollmuth, 2017), fatigue and sleep habits are highly correlated. The results show that the difficulty of falling asleep before flight duty differs according to sleep quality. Cabin crews with good sleep quality more easily fall asleep before a flight than cabin crews with terrible sleep quality. However, regardless of how flight attendants assess sleep quality, over 70 per cent of the participants have unwillingly slept during the flight. Given the fact that flight attendants carry out significant duties that are subject to safety, nodding off due to exhaustion and fatigue should be treated with special care by the airline companies.

Implications of the study

In civil aviation, fatigue has become a serious issue that threatens the safety of airline operations. The top five most selected factors that cause fatigue by the flight attendants were minimum rest time layovers, long duty days, night flights, consecutive days of working and four legs of flight duty. All these factors are related to scheduling. Therefore, airline companies should revise their scheduling practices. Current international rules only comprise the maximum hours of work and minimum hours of rest to control the level of fatigue. However, there are other significant factors that influence the level of fatigue. Current rules on fatigue management do not consider 24 hours operations, crossing multiple time zones, recovery and layover time, and circadian rhythms. For airline companies to change scheduling practices, policymakers should follow a more comprehensive approach to fatigue management by imposing additional international rules that help manage the factors that cause fatigue.

Limitations of the study and future research

We acknowledge that this study has some limitations. We collect the data during the Covid-19 pandemic. Although we asked participants to consider the working conditions before the pandemic to protect the validity of the results, their answers might be affected by the psychological environment of the pandemic. In addition, the Covid-19 crisis has made it difficult to reach the participants. Out of 300 potential respondents that were contacted, only 152 of them responded to the online questionnaire. This low response rate is a limitation since a small sample size can be less effective in producing meaningful results than a large sample size. Finally, we collected primary data directly from the flight attendants. It is possible that there might be some self-reported biases due to the individual differences. Thus, such differences may have affected the results. Future research may extend the scope by using

larger samples and considering the influence of changing working conditions during the Covid-19 pandemic. Finally, our study used a single location, Istanbul, and a single airline company, to collect the data. Future studies may apply the same survey in different areas and to several airline companies to validate the findings of this study.

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Institutional Review Board Statement: Ethical review and approval were waived for this study since the research does not deal with vulnerable groups or sensitive issues.

Data Availability Statement: The data presented in this study are available upon request from the corresponding author. The data are not publicly available due to privacy.

Conflicts of Interest: The authors declare no conflict of interest.

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