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Correlation between jet lag syndrome and air travel fatigue

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ABSTRACT

Long-distance air travel causes travelers to experience travel fatigue. Jet lag syndrome is one of the factors that exacerbate fatigue from air travel. Fatigue can seriously impact travelers with a history of illness. Health emergencies resulting from travel fatigue can even lead to death. A cross-sectional study was conducted to identify the relationship between jet lag syndrome and air travel fatigue. The 117 people who had traveled in the past year had jet lag syndrome and did not meet the exclusion criteria were selected. The questionnaires used the circadian type inventory and the fatigue scale, and validity and reliability were tested. Multiple logistic regression was performed to determine the variables influencing air travel fatigue. The relationship between jet lag syndrome and air travel fatigue was analyzed using Chi-square analysis. Results of the study identified that 53.8% of respondents experienced severe fatigue, and 54.7% experienced severe jet lag syndrome. Jet lag syndrome correlated with air travel fatigue significantly ($p = 0.001$). Respondents with severe jet lag syndrome experienced severe fatigue. The findings from this study emphasize that addressing jet lag syndrome is necessary to reduce air travel fatigue for overall health.

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1. INTRODUCTION

Long-distance air travel makes travelers feel psychologically and physiologically disturbed. Psychological and physiological disturbances occur due to the long duration of travel exceeding 4 hours, changes in air pressure with an aircraft altitude of 8,000-12,000 feet, and passing through different time zones [1], [2]. The psychological and physiological disturbances that occur are called jet lag syndrome. Psychological symptoms of jet lag syndrome include anxiety, stress, mood swings, fear, emotional exhaustion, and tension. Physiological symptoms include increased sleep disturbances, digestive disorders, blood pressure, hypoxia, hyperventilation, and physical fatigue [3]. The symptoms experienced may vary in certain individuals. Fatigue is a common complex emotion felt on air travel.

Fatigue is described as extreme tiredness and stress due to sleep disturbances caused by the stress of flight. The fatigue experienced consists of short-term fatigue and long-term fatigue [4]. Short-term fatigue is associated with lack of sleep or rest, physical or mental overload, long working hours, and jet lag. Meanwhile, long-term fatigue is known as chronic fatigue due to various factors such as stress and working conditions. Fatigue describes as cognitive decline, decreased concentration, emotional changes, and affective decline [5], [6]. The symptoms of jet lag syndrome are not just a temporary inconvenience. Mild health problems can be exacerbated when passengers experience jet lag syndrome. Travelers experiencing jet lag syndrome with a medical history such as hypertension, can make matters worse, hypertension can increase before, during, or after travel [7]. Studies on travel duration and atmospheric pressure on blood pressure show a significant

relationship [8]. The long flight duration creates discomfort and stress, while the atmospheric pressure makes the body hypoxic. Prolonged stress and hypoxia cause an increase in blood pressure.

A study was conducted on 20 healthy individuals who experienced jet lag syndrome due to air travel to identify brain and neuroendocrine changes [9]. The study showed changes during jet lag relative to recovery, including decreased connectivity in the basal ganglia-thalamocortical network and increased functional connectivity between the medial temporal lobe subsystem and medial visual cortices. Lower melatonin levels and high levels of thyroid hormones during jet lag exhibited similar trends to brain activity in the right lingual gyrus. The study concluded that brain and neuroendocrine changes during jet lag are associated with jet lag symptoms. Other studies have indicated that changes in the body's circadian rhythm result in changes in cortisol levels [10].

Jet lag syndrome can interfere with a person's performance at work or even disrupt daily activities if the symptoms are severe. Jet lag and fatigue can also seriously impact someone who works with high concentration and high safety risks [11]. Decreased concentration due to jet lag syndrome and travel fatigue can also put travelers at risk of accidents [12]. Travelers who drive post-flight will be at high risk of injury and death on the road. Even travelers crossing the street can be at high risk. Lack of awareness or failure to recognize the effects of jet lag syndrome exposes travelers to fatal road traffic accidents.

The adverse effects that can occur due to jet lag syndrome are an important focus for prevention. Pre-flight health checks are necessary. However, pre-flight health checks are only carried out on at-risk groups or in the event of a pandemic or spread of disease. The lack of passenger knowledge regarding the impact of jet lag syndrome due to travel is a major factor in the failure of efforts to prevent jet lag syndrome. Various studies have been conducted to overcome this jet lag but have not found a truly significant effort in overcoming jet lag both pharmacologically and non-pharmacologically [13]. Passengers who traveled in different zones and experienced jet lag syndrome did not make efforts to overcome jet lag syndrome properly [14]. Passengers who experience fatigue and jet lag syndrome have a lifestyle that is not good for their health, namely irregular sleep patterns, not using relaxation techniques, and doing exercise that can increase fatigue.

Research on jet lag syndrome and air travel fatigue has been the focus of attention in recent years, but there is still a lack of comprehensive studies. Most previous studies have focused on analyzing the physiological effects of jet lag syndrome on the body, such as sleep disturbances and digestive problems, without exploring the accompanying psychological impacts. For example, one study found that long-distance air travel can cause physical and emotional distress, but did not investigate in depth how fatigue is experienced during travel. With the increasing number of international trips and awareness of travel fatigue, it is important to conduct more comprehensive research that not only assesses physiological aspects but also associates jet lag syndrome with psychological fatigue. This study is expected to provide new and in-depth insights into the relationship between jet lag syndrome and traveler fatigue, and its implications for passenger health. Therefore, it is important to understand air travel fatigue to prevent the adverse effects of jet lag syndrome. This study aims to determine whether there is an association between jet lag syndrome and air travel fatigue from October 2023 to January 2024.

2. METHOD

2.1. Study design and participants

This cross-sectional observational study was conducted in around Universitas Dirgantara Marsekal Suryadarma, East Jakarta, Indonesia, between October 2023 until March 2024. The selection of research time is because in that month many people travel by airplane. The questioners distributed for staff and student Universitas Dirgantara Marsekal Suryadarma. Researchers selected respondents who fit the inclusion criteria that have traveled by airplane within the last 1 year and have syndrom jet lag. Exclusion criteria is never traveled by airplane. This study was conducted on 117 people, the result of sample size calculation from Lemeshow’s formula. This research has ethics approval from research and community service institution, Universitas Dirgantara Marsekal Suryadarma (KET/UNSURYA/09/III/2023). The independent variable is jet lag syndrome and the dependent variable is air travel fatigue. Respondent characteristic variables as confounders are age, gender, education, reason for travel, duration of air travel, frequency of air travel, and duration of jet lag syndrome.

2.2. Measurements

2.2.1. Jet lag syndrome questionnaire

This research utilizes a questionnaire designed to identify jet lag syndrome, which is modified from the Circadian Type Inventory questionnaire [15]. The questionnaire describes how disruptive jet lag syndrome is to daily activities and the severity of the syndrome experienced. It consists of 10 statement items, each rate on a Likert scale ranging from 1 to 4. The scale uses the following ratings: 1 = never, 2 = rarely, 3 = often, and 4 = always. Respondents with high score indicate a more severe experience of jet lag syndrome. The

categorization for this questionnaire is a follow: a score of less than 19 (median) indicates a mild case of jet lag syndrome, while a score of 19 or more (median) indicates a severe case. The questionnaire was validated, and the measurement instrument shows reliability with a Cronbach's Alpha coefficient of 0.808.

2.2.2. The air travel fatigue questionnaire

The fatigue scale questionnaire measures air travel fatigue which is modified from a tourism fatigue scale [3]. This questionnaire assesses five different types of fatigue: physical fatigue, cognitive fatigue, affective fatigue, and motivational fatigue. It consists of 15 statement items, each rate on a Likert scale ranging from 1 to 4. The scale uses the following ratings: 1 = did not feel, 2 = slightly felt, 3 = moderately felt, and 4 = strongly felt. Respondents with high score indicate a more severe experience of air travel fatigue. The categorization for this questionnaire is a: a score of less than 20 (median) indicates a mild case of air travel fatigue, while a score of 20 or more (median) indicates a severe case. The questionnaire was validated, and the measurement instrument shows reliability with a Cronbach's Alpha coefficient of 0.943.

2.3. Research analysis

The description analysis examines the age, gender, education, reason for travel, duration of travel, frequency of travel, and duration of jet lag syndrome. Categorical variables were presented as counts and percentages, while continuous variables using mean, standard deviation, minimum, maximum, and 95% confidence interval. We used Chi-square analysis to assess the correlation between jet lag syndrome and air travel fatigue. Additionally, we performed multiple logistic regression analyses to identify the primary factors influencing air travel fatigue. A p-value of less than 0.05 was considered statistically significant. The statistical package for the social sciences (SPSS) version 27.0 was utilized for analysis.

3. RESULTS AND DISCUSSION

One hundred and seventeen participated in this study. Male participants were slightly outnumbered females, comprising 64.1% of the total. Most participants were academy of levels education (67.5%). The most common reason for traveling is to visit family (23.9%). Table 1 shows the characteristics of these respondent. Table 2 shows the mean scores of ages, duration of air travel, frequency of air travel, and duration of jet lag syndrome. The average age of the participants is 36.91±9.68 years old. The participants are in the adult stage, with a minimum age of 21. The average duration of air travel is 4.4±4.12 hours, the average frequency of air travel is 3.46±6.66 times per year, and the average duration of jet lag syndrome is 7.29±12.27 hours.

Table 3 presents the levels of jet lag syndrome and air travel fatigue. The majority of participants experienced severe jet lag syndrome (54.7%). The majority of participants experienced severe air travel fatigue (53.8%). Table 4 shows the relationship between jet lag syndrome and air travel fatigue using the Chi-square test. The findings in Table 4 revealed a significant correlation between jet lag syndrome and air travel fatigue ($p<0.001$). Participants with mild jet lag syndrome experienced mild fatigue (69.8%), while those with severe jet lag syndrome experienced severe air travel fatigue (73.4%).

Table 1. Respondent characteristics: gender, education, and reasons for travel (N = 117)

Variable		N	%
Gender	Male	75	64.1%
	Female	42	35.9%
Education	High school	38	32.5%
	Academy	79	67.5%
Reasons for travel	Work	55	47%
	Family	28	23.9%
	Travel	16	13.7%
	Others	18	15.4%

Table 2. Respondent characteristics: age, duration of travel, frequency of travel, and duration of jet lag syndrome (n = 117)

Variable	Mean±SD	Maximum	Minimum	95% Confidence interval
Age (year)	36.91±9.68	64	21	35.133-38.68
Duration of air travel (hour)	4.4±4.12	20	0	3.64-5.15
Frequency of air travel in one year (times)	3.46±6.66	45	0	2.24-4.68
Duration of jet lag syndrome (hour)	7.29±12.27	72	0	5.051-9.545

Table 5 shows the result of multiple logistic regression analysis. The results show that the Odds Ratio (OR) of jet lag syndrome is 8.519 with 95% CI, namely 3.377 to 21.491, meaning that severe jet lag syndrome will have a chance of respondents experiencing severe air travel fatigue, namely 8.519 times compared to mild jet lag syndrome. The variable duration of jet lag syndrome has an OR value of 1.038 with 95% CI 0.996 to 1.082, meaning that respondents who have long-duration jet lag syndrome will have a chance of respondents experiencing severe air travel fatigue by 1.038 times compared to those who have short duration of jet lag syndrome. The variable gender has an OR value of 0.279 with 95%CI 0.109 to 0.730, meaning the respondents who are female will have a chance of respondents experiencing severe air travel fatigue.

Table 3. Decriptive of jet lag syndrome and air travel fatigue (N = 117)

Variable		N	%
Jet lag syndrome level	Mild	53	45.3%
	Severe	64	54.7%
Air travel fatigue level	Mild	54	46.2%
	Severe	63	53.8%

Table 4. The correlation tet lag syndrome with air travel fatigue (N = 117)

Variable	Air travel fatigue				Total	Odds ratio (95% CI)	P value
	Mild		Severe				
	N	%	N	%			
Jet lag syndrome						6,393	0.001*
Mild	37	69.8%	16	28.5%	53	(2.852-14.332)	
Severe	17	26.6%	47	73.4%	64		

*p<0.05 significance

Table 5. The results of multiple regression analysis

Variable	B	SE	Wald	p-value	Odds Ratio	95% CI
Jet lag syndrome	2.142	0.472	20.589	0.001	8.519	3.377-21.491
Gender	-1.275	0.490	6.771	0.009	0.279	0.107-0.730
Duration of jet lag syndrome	0.507	0.651	0.436	0.075	1.038	0.996-1.082
Constant	0.507	0.651	0.436	0.436	1.661	

The results showed that there was more male participation in this study compared to females. Male and female gender differences in studies related to jet lag syndrome appear in the sleep disturbance section, women are more sensitive to sleep disturbances in the first five days of jet lag syndrome [16]. Few studies have evaluated this parameter. The gender link to the jet lag syndrome is biological clock disruption or circadian rhythm disruption. Gender-specific differences in jet lag are significantly associated with affected health problems such as diabetes, while in women, it is associated with sleep disorders, psychopathology, and metabolic syndrome [17]. This research shows that genders suffer from jet lag syndrome and air travel fatigue.

The research indicates that while most air travelers are adults, there are also respondents who are elderly, around 64 years old. It's important to pay extra attention to the health conditions of elderly travelers. Although the study doesn't show direct link between age and fatigue from air travel, the elderly should still take precautions and prepare accordingly. Fatigue from air travel can worsen the health of elderly individuals with existing health issues. Jet lag and travel fatigue can also worsen sleep disorders in elderly, so it's suggested to provide psychological examinations or health consultations for at-risk group [18]. Elderly individuals with a history of illness should plan their travel carefully to minimize potential issues during air travel.

It is important to consider having a doctor or medical personnel accompany the trip and ensure that necessary medication is provided [12]. Elder individuals with a history of illness may experience exacerbated jet lag syndrome and air travel fatigue, or their pre-existing condition may worsen. Medical personnel devote significant educational efforts, especially during peak air travel seasons such as religious festivals or long holidays, when people take time off to visit family in distant places by airplane. Most air travel is for personal reasons rather than work-related, especially to visit family. In Indonesia, where there are numerous religious holidays and anniversaries, many people use collective leave to travel long distances to visit family.

Respondents with a history of past and current illnesses are at high risk of experiencing health problems during their travels. Good planning for long-distance air by air travel for at-risk groups. Research has shown that air travel is part of the risk for people with a history of asthma, as air travel can worsen conditions such as hyperbaric hypoxia, increased heart rate, and even hypertension [19], [20]. Travelers with asthma may experience jet lag and travel fatigue, which can exacerbate asthma symptoms. Optimal asthma

control before air travel is essential. Before traveling, the asthma management plan should be reviewed. Patients should carry asthma medications such as oral corticosteroids and inhalers. Travelers with asthma should have a self-management plan in the event of an exacerbation occurring during travel. Other risk groups, such as travelers with chronic heart disease, are at high risk of in-flight decompensation with sudden cardiac arrest or death [21]. Travel fatigue and post-flight jet lag syndrome also threaten to worsen the disease. The majority of respondents in this study did not make efforts to prevent jet lag syndrome before traveling, but made efforts to reduce jet lag syndrome when they felt it. Therefore, there needs to be good planning related to health before traveling, including the consumption of medicines.

Good travel planning is important not only for the elderly but also for other high-risk groups such as children and infants. Parents and flight crew or aircraft medical personnel need to consider the presence of child passengers or infants who may experience jet lag syndrome and travel fatigue. Parents with young children can tell the flight crew to provide good food for their child, consider food allergies, manage health problems due to air pressure at high altitudes from ground level, and especially manage jet lag syndrome after the trip [22]. A child or infant with a health condition may require medical attention during the trip and necessary medication. Emergencies during travel may occur due to overexertion of the child. The symptoms of illness experienced by children during the trip are generally fever and the emergency that occurs is epilepsy [23]. Children need to be well-prepared for travel especially those with certain diseases or congenital diseases such as autism, attention deficit hyperactivity disorder (ADHD), asthma, heart disease, or disabilities.

Respondents in this study have all experienced jet lag during air travel. The majority of the symptoms felt were more than one symptom and some even experienced more than two symptoms. Symptoms of jet lag syndrome that have been experienced by respondents include fatigue, drowsiness, impaired concentration, mood swings, headaches, nausea, difficulty sleeping, constipation, and others. Someone who has hypertension and diabetes when experiencing symptoms of jet lag syndrome will be at risk of increasing blood pressure and blood sugar [1], [24], [25]. The study explains that a person who has a disease will be at high risk of deteriorating health when experiencing jet lag syndrome so prevention is better than cure. Thus, air travel preparations need to be carefully designed for high-risk groups.

The average trip duration was 4.4 hours with a standard deviation of 4.115 hours. Respondents reported having traveled by air for more than 8 hours. The duration of travel according to research is one of the factors that affect fatigue [26]. However, in this study, the duration of the trip had no effect because the average respondent did not travel long distances. The average frequency of travel was 3.46 times per year, indicating that most respondents were travelers. All respondents who experienced jet lag reported an average jet lag duration of 7.298 hours after air travel. The results of the analysis showed an association between the duration of jet lag and fatigue due to air travel. This is due to the significant variation in jet lag experience among respondents. Respondents who experience longer jet lag will be at risk of experiencing fatigue due to heavier air travel [27]. Although the severity of jet lag syndrome experienced by the majority of respondents was low, there were still respondents who experienced high jet lag syndrome severity.

Jet lag syndrome has a significant relationship with air travel fatigue. Respondents who experienced jet lag syndrome with high severity experienced air travel fatigue with high levels of fatigue. The jet lag syndrome causes fatigue to worsen. Air travel fatigue is caused by the long duration of the trip and other travel afterwards, and some even go straight to work without taking a break. Air travel fatigue experienced can include body discomfort, aches, headaches, lack of appetite, difficulty sleeping, nausea, and vomiting, and indigestion [28]. A highly influential factor in air travel fatigue is jet lag syndrome. Jet lag syndrome occurs due to the circadian disruption caused by air travel in different time zones. This fatigue can hurt health, decrease performance, decrease decision-making, and decrease concentration power, which can be at risk of accidents at work or while traveling [29], [30]. The effect of jet lag syndrome on air travel fatigue is significant.

Efforts to reduce jet lag syndrome are necessary because they can significantly reduce jet lag syndrome and reduce fatigue due to air travel. However, the results of the systematic review show that jet lag syndrome has not received a good treatment strategy, for example, sleep therapy and healthy food. There is no evidence of appropriate pharmacological and non-pharmacological interventions in managing jet lag syndrome and fatigue due to air travel [1], [31]. Fatigue management includes prevention and control strategies such as getting enough sleep before the next activity and taking medications that can improve sleep and medications that can improve performance and stamina [30]. The systematic review study showed that travelers reported important knowledge about jet lag syndrome and travel fatigue, had experienced jet lag syndrome and travel fatigue, and reported management strategies used to reduce jet lag syndrome and travel fatigue [32]. Therefore, it is very important in travel management as an effort to reduce jet lag syndrome.

4. CONCLUSION

The results of this study show a significant correlation between jet lag syndrome and fatigue caused by air travel. Individuals experiencing severe jet lag tend to feel more intense fatigue, which can worsen pre-existing health conditions, particularly for those with chronic illnesses such as hypertension and diabetes. This highlights the importance of careful travel planning and the implementation of preventive strategies, such as maintaining regular sleep patterns, consuming healthy food, and using appropriate medication to reduce the negative effects of jet lag. This research has broad implications for the airline industry and healthcare professionals, particularly in terms of efforts to prevent and manage jet lag. Airlines can provide passengers with more detailed information on jet lag management, while healthcare practitioners can offer more focused advice to patients with chronic conditions regarding the management of travel fatigue.

However, this study also has several limitations. The data used is largely based on self-reported traveler experiences, which may contain subjective bias. Other factors such as the type of flight, cabin conditions, and the long-term effects of jet lag have not been fully investigated. Therefore, future research should broaden its scope by incorporating objective data, such as biological measurements of sleep disturbances and fatigue. Further studies should also consider other factors that may influence jet lag, such as flight duration, cabin pressure, and the impact on travelers with diverse health conditions. Such steps are expected to provide a deeper understanding of the relationship between jet lag and travel fatigue, as well as their impact on health.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration. This research was conducted by a team of researchers consisting of experts in public health and aviation health, who collaborated to examine the relationship between jet lag syndrome and fatigue caused by air travel. Each team member made significant contributions, ranging from study design, data collection, and analysis, to writing and publishing the research findings.

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Imelda Avia	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓		
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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

ETHICAL APPROVAL

This study was approved by the Research Ethics Committee of Universitas Dirgantara Marsekal Suryadarma with approval number KET/UNSURYA/09/111/2024. Written informed consent was obtained from all participants prior to their inclusion in the study.

DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

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