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Fatigue Among Aviation Students and Time Management in Flight Training

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This study investigated the prevalence, causes, and consequences of fatigue among aviation students in Europe. It examined their self-awareness of fatigue, lifestyle habits, time management practices, and the role of mindfulness in mitigating fatigue-related impairment. A total of 188 participants completed an online survey comprising the Collegiate Aviation Fatigue Inventory (CAFI-II), the Cognitive and Affective Mindfulness Scale–Revised (CAMS-R), and the Epworth Sleepiness Scale (ESS). Quantitative analyses included descriptive statistics, correlation analysis, and multiple regression. Participants reported moderate levels of fatigue and limited awareness of its impact on performance. Common causes included insufficient sleep, high workload, and psychological stress. Fewer than half of the students received formal fatigue training. A statistically significant negative relationship was found between mindfulness, particularly the acceptance subscale, and daytime sleepiness. Fatigue also showed a positive correlation with performance-related impairments and variability in alertness. The findings suggest that fatigue remains an underrecognized yet critical safety issue among aviation students. Training programs should incorporate fatigue management and mindfulness education to improve awareness, build resilience, and support safe flight performance.

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Introduction

Fatigue is a critical safety concern in aviation, impairing alertness, decision-making, and situational awareness. This study investigates the prevalence, causes, and consequences of fatigue among European aviation students, focusing on their sleep habits, time management, and the potential protective role of mindfulness. While fatigue has been extensively studied in commercial and military aviation, research on flight training students, particularly within the European Aviation Safety Agency (EASA) regulatory framework, is limited.

Fatigue arises from multiple factors, including poor sleep quality, psychological stress, academic workload, and irregular schedules. Student pilots, often young and less experienced, face unique challenges balancing academic responsibilities with demanding flight training. Despite the risks associated with fatigue, it is frequently underrecognized and inadequately managed in flight training environments (Stokes & Kite, 2017; ICAO, 2016).

This study also examines mindfulness as a potential buffer against fatigue-related impairment. Mindfulness traits such as attention control, present-moment awareness, and acceptance may enable students to detect early signs of fatigue and adopt healthier coping strategies. Specifically, mindfulness may support sleep-supportive behaviors, which can reduce daytime sleepiness and improve alertness.

Problem Statement

Flight training programs require intensive academic and practical instruction, often without regulated limits on daily workload for students. Unlike commercial pilots, student pilots are not covered by mandated rest periods under FAA or EASA regulations, necessitating self-management of fatigue. This absence of structured rest requirements, combined with long training hours and suboptimal sleep, creates conditions that jeopardize both safety and learning outcomes (Levin et al., 2019).

Fatigue impairs judgment, reduces attention, and slows reaction times, which are critical deficits during flight operations. In the flight training context, fatigue can compromise academic performance and increase risk in high-stakes scenarios. Therefore, it is vital to understand how students experience fatigue and identify effective strategies to mitigate its effects.

Statement of the Purpose

The purpose of this study was to evaluate aviation students’ awareness of fatigue, its causes and symptoms, and the effectiveness of their coping strategies. It also assessed how lifestyle factors, including sleep hygiene, workload, and mindfulness, relate to fatigue and performance.

Specifically, the study aimed to:

1. Identify the most common causes and symptoms of fatigue experienced during flight training.
2. Explore the lifestyle changes students perceive as helpful in managing fatigue.

3. Determine the relationship between mindfulness and fatigue, with a focus on sleep-supportive behaviors.
4. Assess the association between fatigue and daytime sleepiness, measured by the Epworth Sleepiness Scale (ESS).

By addressing these questions, the study provides aviation training institutions with evidence-based insights to improve safety, educational practices, and student well-being.

Literature Review

Fatigue is a multifaceted condition that compromises performance and safety in aviation. Pilots and trainees must operate in environments that demand high levels of attention, precision, and decision-making under pressure. Marcus and Rosekind (2017) noted that fatigue reduces memory, communication efficiency, reaction time, and core competencies for safe flight operations.

Common contributors to fatigue in aviation include sleep deprivation, irregular schedules, academic pressure, and stress. Avers and Johnson (2011) distinguished between acute fatigue (short-term) and chronic fatigue (long-term), with the latter linked to reduced concentration, apathy, and irritability. Among students, poor time management and inexperience in balancing responsibilities often exacerbate these issues (Buboltz et al., 2010).

Research on student pilots confirms the pervasiveness of fatigue. Mendonça et al. (2019) found that over 50% of aviation students reported underperforming in training due to fatigue. Keller et al. (2019) observed that students most often attributed fatigue to poor sleep, extended duty hours, and high workload. While students were generally aware of fatigue management strategies such as napping or improving sleep hygiene, Romero et al. (2020) reported that these strategies were applied inconsistently.

Sleep plays a central role in fatigue mitigation. Inadequate rest disrupts cognitive functioning, impairs learning, and negatively impacts mood (Lund et al., 2010). Circadian misalignment, such as that caused by early morning or night flying, can further diminish alertness (ICAO, 2016). Additionally, sleep inertia, the grogginess experienced immediately after waking, may impair performance during early training flights (Vallat et al., 2019).

Mindfulness, defined as present-moment awareness coupled with non-judgmental acceptance, has been shown to enhance emotional regulation and cognitive control. In the aviation context, mindfulness may improve situational awareness and reduce stress (Shapiro & Weisbaum, 2020; FAA, 2020). Importantly, its underlying mechanisms, attention control (the ability to sustain focus on relevant stimuli) and acceptance (the capacity to acknowledge experiences without overreacting), can promote sleep-supportive behaviors, such as maintaining regular bedtimes and reducing pre-sleep rumination. These behaviors are associated with lower scores on the Epworth Sleepiness Scale (ESS), indicating reduced daytime sleepiness.

Although fatigue and mindfulness have been individually explored in aviation research, few studies have examined their interaction in the student pilot population, particularly in Europe.

This study addresses that gap by investigating how mindfulness may act as a protective factor against fatigue and sleepiness in flight training environments.

Research Questions

Descriptive Research Questions

1. What proportion of European aviation students report experiencing fatigue?
2. What do students identify as the primary causes of their fatigue?
3. What lifestyle adjustments do students believe would help them better manage fatigue?
4. What is the most common source of fatigue during flight training?

Inferential Research Questions & Hypotheses

5. Is there a statistically significant association between aviation students' levels of mindfulness and their reported daytime sleepiness (ESS scores)?

   H1: Higher mindfulness scores, particularly in attention control and acceptance, will be associated with lower daytime sleepiness.
   H0: There will be no statistically significant association between mindfulness scores and daytime sleepiness.

6. Is there a statistically significant correlation between fatigue levels (CAFI-II scores) and daytime sleepiness (ESS scores)?

   H1: Higher fatigue scores will be positively correlated with higher daytime sleepiness scores.
   H0: There will be no statistically significant correlation between fatigue scores and daytime sleepiness scores.

Methodology

This study used a cross-sectional, online survey design with a convenience sampling approach. Participants were aviation students enrolled in accredited European flight academies who were aged 18 years or older and currently engaged in flight training. Recruitment took place between March 3 and October 16, 2021, through direct email outreach to partner flight schools, which were asked to circulate the survey link among their students. The survey was conducted on Qualtrics and required approximately 15 minutes to complete. Participation was voluntary and anonymous; no personally identifying information was collected.

The study protocol received approval from the Social Sciences Ethics Review Board at the University of Nicosia (SSERB 00139). All participants were presented with an online informed consent statement detailing the study's purpose, estimated duration, confidentiality safeguards, and their right to withdraw at any time. Consent was implied by survey completion. A debriefing statement summarizing the research objectives and providing contact information for both the researcher and ethics board was displayed upon completion.

Measures

The survey contained three standardized psychometric tools and a demographic questionnaire.

1. **Collegiate Aviation Fatigue Inventory – II (CAFI-II)**
   The CAFI-II measures fatigue awareness, causes, lifestyle factors, coping strategies, impact on flight activities, and alertness. Items are primarily rated on Likert scales, with several open-ended questions. Internal consistency in the present sample was strong: fatigue awareness $\alpha = .76$ (95% CI [.71, .81]), causes of fatigue $\alpha = .75$ (95% CI [.69, .80]), and lifestyle $\alpha = .77$ (95% CI [.72, .82]).

2. **Cognitive and Affective Mindfulness Scale – Revised (CAMS-R)**
   The CAMS-R assesses mindfulness across four domains, attention control, present focus, awareness, and acceptance, via 12 items rated on a four-point scale (1 = "rarely/not at all" to 4 = "almost always"). Subscales in this sample demonstrated reliabilities ranging from $\alpha = .67$ to $\alpha = .79$ (95% CIs available upon request). Scores were calculated as the mean of all items; higher scores indicated greater trait mindfulness.

3. **Epworth Sleepiness Scale (ESS)**
   The ESS evaluates general daytime sleepiness across eight everyday situations, with items rated from 0 ("no chance of dozing") to 3 ("high chance of dozing"). Total scores range from 0–24, with ≥11 indicating excessive daytime sleepiness. Reliability in the present study was $\alpha = .74$ (95% CI [.68, .79]).

4. **Demographics**
   Nine questions captured age, gender, flight certifications, total flight hours, and other training-related details.

Primary Outcome and Power

The primary outcome for inferential analysis was daytime sleepiness as measured by the ESS total score. A post-hoc power calculation indicated that with $N = 188$, $\alpha = .05$, and power $= .80$, the study could detect correlations of $r \geq .20$ or small-to-moderate effects in regression models ($f^2 \geq .04$).

Data Analysis

Survey responses were exported from Qualtrics and analyzed using IBM SPSS Statistics (Version 22.0). Analyses were designed to address the six research questions. Fatigue levels were assessed using total scores from the Epworth Sleepiness Scale (ESS), with scores ≥ 11 classified as indicative of excessive sleepiness. Descriptive statistics and frequency analyses were applied to the Causes and Consequences of Fatigue Inventory–II (CAFI-II) to identify common fatigue triggers. Participants' rankings of coping strategies were analyzed by calculating mean ranks to determine the most preferred approaches.

Associations between mindfulness (as measured by the Cognitive and Affective Mindfulness Scale–Revised [CAMS-R]) and fatigue awareness were examined using multiple regression analyses. Pearson product–moment correlations were computed to assess the relationships between ESS scores, CAFI-II fatigue impact ratings, and alertness levels. All statistical assumptions, including normality, linearity, and homoscedasticity, were verified before conducting inferential tests. Cronbach's alpha coefficients with 95% confidence intervals for all scales are reported in the Methodology section.

Results

Demographics

A total of 188 aviation students completed the survey (age range = 18–54 years; M = 25.61, SD = 6.29). Most identified as male (77.7%), followed by female (20.7%), and 1.6% who preferred not to disclose. Participants held a range of certifications: Private Pilot License (PPL), Instrument Rating (IR), Airline Transport Pilot License (ATPL), Certified Flight Instructor (CFI), and Commercial Pilot License (CPL).

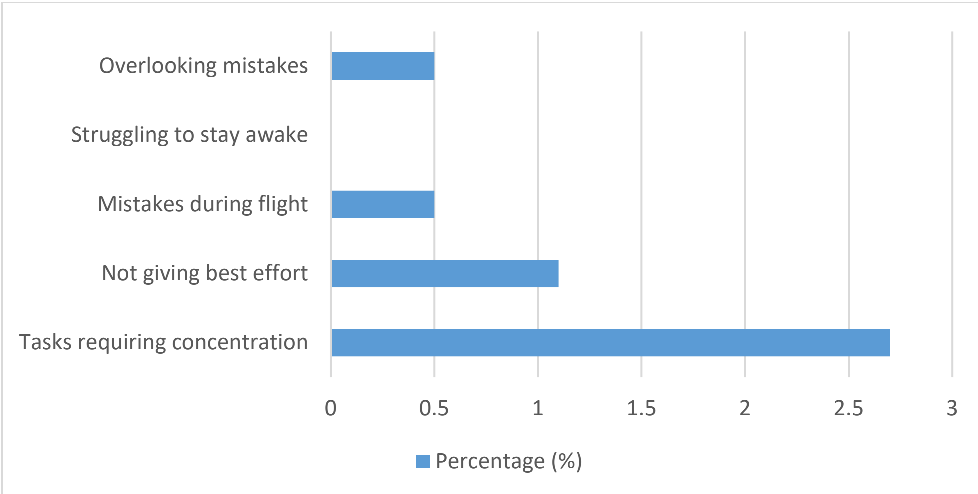
Table 1
Aviation Students' Rating (Training Program)

	N	%
PPL	56	29.8
IR	40	21.3
CPL	13	6.9
ATPL	39	20.7
CFI	26	13.8
Other	14	7.4
Total	188	100

Fatigue Awareness

Participants most strongly endorsed: "My ability to carry out tasks requiring concentration has been decreased due to fatigue", "I have not given my best effort due to fatigue", and "I have made mistakes during flight activities because I was fatigued". Lower ratings were seen for struggling to stay awake or overlooking mistakes. Figure 1 presents item means and standard deviations.

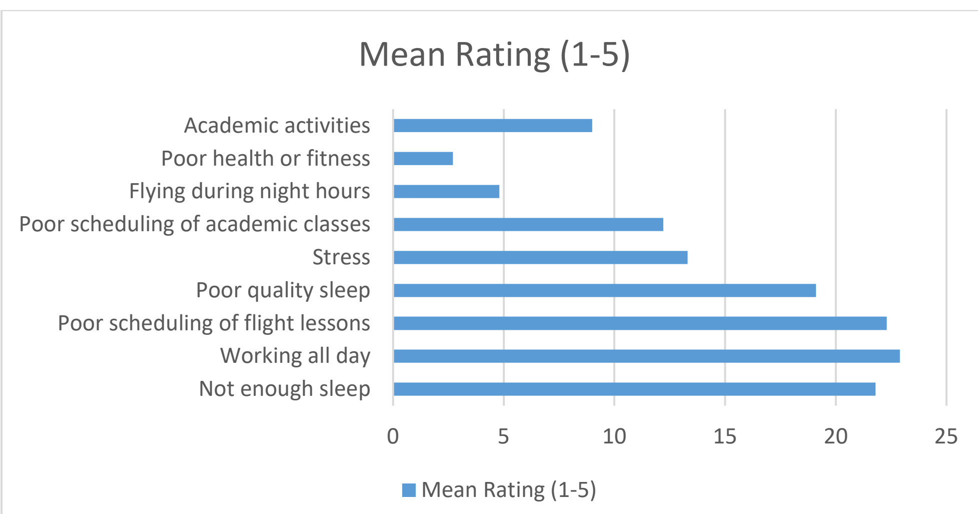
Figure 1
CAFI-II: Fatigue Awareness



Causes of Fatigue

Top contributors were insufficient sleep, full workdays, and poor scheduling of flight lessons. Stress, poor-quality sleep, and poor scheduling of academic classes were also notable. Figure 2 provides the full distribution.

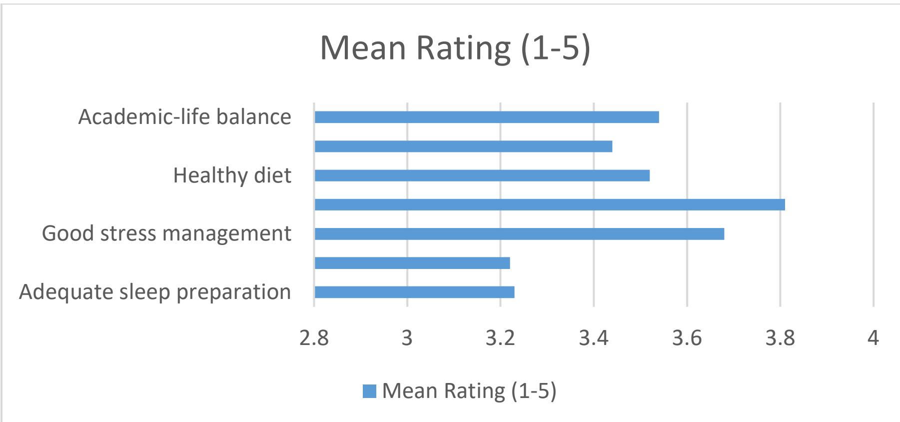
Figure 2
CAFI-II: Causes of Fatigue



Lifestyle

Participants reported moderate-to-good lifestyle habits, with the highest agreement for effective workload management (M = 3.81, SD = 0.76) and stress management (M = 3.68, SD = 0.93). See Figure 3 for full scores.

Figure 3
CAFI-II: Lifestyle



Personal Solutions

Most-endorsed coping strategies included improving schedule efficiency (M = 4.31, SD = 1.05), increasing sleep duration (M = 4.12, SD = 1.08), and taking scheduled breaks (M = 4.92, SD = 1.11). (Table 2)

Table 2.
CAFI-II: Personal Solutions They Use to Cope with Fatigue

	Minimum	Maximum	M	SD
More sleep	1	10	4.12	2.85
Efficiency in scheduling classes and flight activities	1	10	4.31	2.64
Scheduled breaks	1	10	4.92	2.42
Reduced workload	1	10	5.07	2.87
Self-awareness of fitness to fly	1	10	5.28	2.71
Guaranteed rest for a given amount of flying	1	10	5.35	2.65
Management of sleep preparation	1	10	5.44	2.61
Physical exercise	1	10	6.26	2.58
Healthy eating habits	1	10	6.90	2.70
Better management of non-work issues	1	10	7.35	2.94

Note: M= mean value, SD = standard deviation, 1=most important – 10= least important

Impact on flight activities & Time on activities

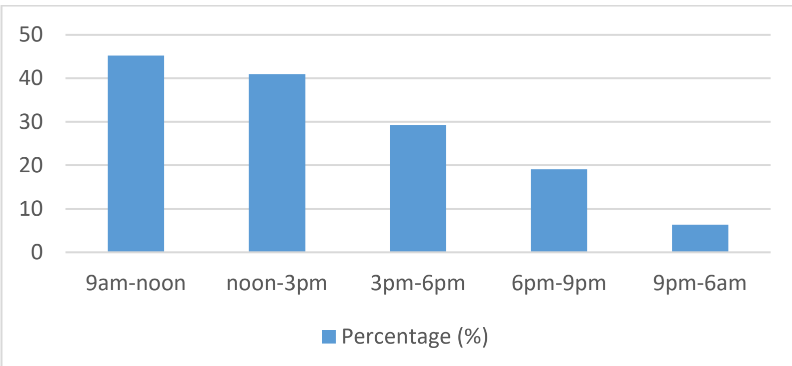
Average fatigue impact on flight activities was moderate (M = 2.49, SD = 0.92). Weekly work hours averaged 30.17 (SD = 15.99) during weekdays and 8.84 (SD = 5.28) on weekends.

Alertness

Morning (9:00 a.m.–12:00 p.m.) was the most alert period (45.2%), while night (9:00 p.m.–6:00 a.m.) was the least alert (6.4%). (Figure 4)

Figure 4.

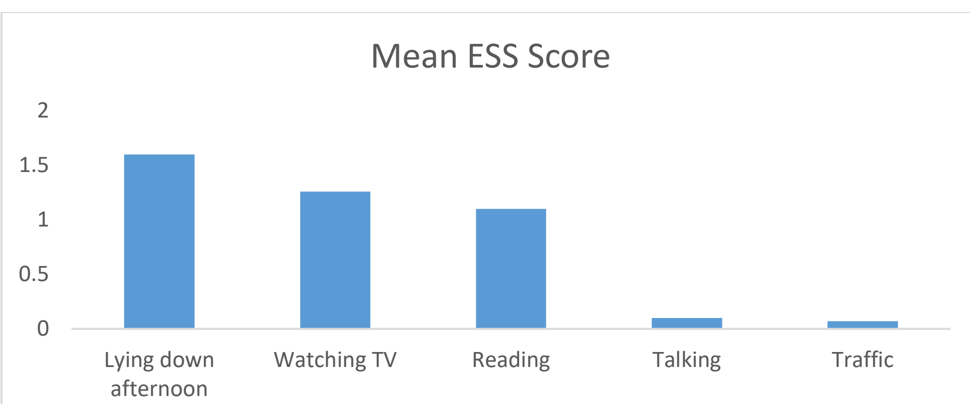
CAFI-II: Alertness Level



Epworth sleepiness scale (ESS)

Highest dozing likelihoods occurred while lying down in the afternoon (M = 1.60, SD = 0.88), watching TV (M = 1.26, SD = 0.70), and reading (M = 1.10, SD = 0.78). Mean total ESS score was 6.25 (SD = 3.16). (Figure 5)

Figure 5
Epworth Sleepiness (ESS)



Mindfulness (CAMS-R)

Corrected CAMS-R scoring produced: attention (*M* = 9.31, *SD* = 1.97), present focus (*M* = 8.94, *SD* = 1.82), awareness (*M* = 8.18, *SD* = 1.94), and acceptance (*M* = 9.25, *SD* = 2.01). The total mindfulness score was *M* = 35.68 (*SD* = 5.22), which is consistent with a 12-item, 4-point scale. Internal consistency was acceptable (α = .743–.719). (Table 3)

Table 3
Mindfulness scale (CAMS-R)

	Minimum	Maximum	M	SD	Scale Range (M)	Cronbach's alpha*
Attention	4.0	12.0	9.31	1.97	3-12 (7.5)	.743
Present focus	3.0	12.0	8.94	1.82	3-12 (7.5)	.589
Awareness	3.0	12.0	8.18	1.94	3-12 (7.5)	.615
Acceptance	3.0	12.0	9.25	2.01	3-12 (7.5)	.719
Mindfulness (Total)	nan	nan	8.92	0.08		

Correlations

Table 4 shows Pearson correlations among key variables (n = 188 per cell). Each cell includes the 95% confidence interval and exact p-value. Higher mindfulness (total and subscales) was significantly associated with lower ESS scores (e.g., total mindfulness: r = −.27, 95% CI [−.40, −.13], p = .001) and lower fatigue awareness.

Table 4
Correlations (Partial Example)

Variables	Mindfulness (Total)	Fatigue impacts flights	Alertness level
Mindfulness (Total)	1.0	-0.216	-0.459
Fatigue impacts flights	-0.216	1.0	0.414
Alertness level	-0.459	0.414	1.0
ESS	-0.271	0.284	0.295
Fatigue training	-0.082	-0.081	0.034
Fatigue awareness	-0.428	0.553	0.495
Acceptance	0.722	-0.193	-0.352
Awareness	0.777	-0.195	-0.35
Present focus	0.684	-0.182	-0.291
Attention	0.767	-0.069	-0.359

Multiple Regression Analysis

After removal of three influential cases (Cook's distance > 4/n), collinearity improved (all VIF ≤ 5.92). A hierarchical regression predicted ESS from:

- Step 1: demographics (gender, age), not significant.
- Step 2: training and workload variables — $\Delta R^2 = .06$, p = .041.
- Step 3: mindfulness variables — $\Delta R^2 = .10$, p = .004.

In the final model ($F(6,178) = 5.21$, $p < .001$, adjusted $R^2 = .12$), higher acceptance predicted lower ESS ($B = -0.38$, $SE = 0.11$, $\beta = -.25$, $p = .001$), whereas greater fatigue impact on flight predicted higher ESS ($B = 0.77$, $SE = 0.24$, $\beta = .23$, $p = .002$). Residual plots confirmed normality and homoscedasticity. (Table 5)

Table 5
Multiple Regression Analysis

Variable	B	Std. Error	Beta	t	p	Tolerance	VIF
Model 1							
(Constant)	5.693	3.047		1.868	0.063		
Attention	0.094	0.147	0.059	0.643	0.521	0.565	1.796
Present Focus	0.05	0.144	0.029	0.347	0.729	0.687	1.457
Awareness	-0.151	0.15	-0.093	-1.005	0.316	0.559	1.789
Acceptance	-0.279	0.13	-0.179	-2.141	0.034	0.687	1.455
Fatigue awareness	0.059	0.055	0.104	1.073	0.287	0.505	1.982
Lifestyle	-0.026	0.061	-0.036	-0.431	0.667	0.696	1.437
Alertness level	0.063	0.059	0.096	1.073	0.285	0.601	1.664
Work per week Mon-Fri	-0.015	0.016	-0.078	-0.982	0.328	0.755	1.325
Work per weekend Sat-Sun	0.032	0.047	0.053	0.667	0.506	0.754	1.326
Socializing time per week Mon-Fri	-0.041	0.039	-0.102	-1.063	0.289	0.518	1.929
Socializing time per weekend Sat-Sun	0.066	0.061	0.097	1.078	0.283	0.597	1.676
Fatigue training	0.46	0.459	0.074	1.004	0.317	0.894	1.118
Fatigue's impact on flight	0.458	0.296	0.135	1.546	0.124	0.634	1.578
Gender	-0.813	0.526	-0.115	-1.546	0.124	0.876	1.142
Age	0.034	0.039	0.068	0.87	0.385	0.777	1.287
Approx. total logged flight time	**0.0**	**0.0**	**0.025**	**0.319**	**0.75**	**0.793**	**1.261**
Model 2							
(Constant)	7.885	1.284		6.14	0.0		
Acceptance	-0.382	0.109	-0.245	-3.489	0.001	0.966	1.035
Fatigue's impact on flight	0.767	0.239	0.225	3.207	0.002	0.966	10.35

Discussion

This study investigated fatigue, mindfulness, and time management among European aviation students, offering a rare and focused insight into how lifestyle, awareness, and coping strategies affect performance in a collegiate aviation context. While fatigue in commercial and military aviation has been widely studied, student pilot populations, especially in Europe, have received comparatively little attention (Goode, 2003; Stokes & Kite, 2017). This research addressed that gap, examining four core areas: fatigue awareness, fatigue triggers, lifestyle habits, and mindfulness.

The reliability of the tools used was acceptable to strong. The Collegiate Aviation Fatigue Inventory (CAFI-II) demonstrated excellent internal consistency for the fatigue awareness ($\alpha = .896$) and causes of fatigue ($\alpha = .864$) subscales, and good consistency for the lifestyle subscale ($\alpha = .755$). The Cognitive and Affective Mindfulness Scale – Revised (CAMS-R) also showed acceptable reliability ($\alpha = .721$), with individual subscales ranging from $\alpha = .589$ to $\alpha = .743$.

The findings indicated that fatigue is a significant factor in the lives of aviation students. Many reported reduced ability to concentrate (M = 2.31), diminished effort (M = 2.24), and flight-related errors (M = 2.21) attributed to fatigue. These findings are consistent with previous studies by Romero et al. (2020) and Keller (2019), who linked fatigue to impaired attention, poor decision-making, and reduced situational awareness. Similar results were reported by Goode (2003), who showed that fatigue increases accident risk in aviation, and Caldwell (2012), who emphasized the detrimental effects of inadequate sleep on flight performance.

Importantly, 92% of participants reported never falling asleep during training flights, which aligns with general safety standards. However, 51% admitted to continuing flight training despite feeling extremely fatigued. Even more concerning, 78% reported making unnoticed errors during flight activities, raising the possibility that supervising instructors may also have been fatigued. These findings underscore the safety implications of unmanaged fatigue in training environments, echoing ICAO’s (2016) call for embedding fatigue education and management strategies into training.

Fatigue Triggers and Training Demands

Sleep deprivation was identified as the most prominent trigger of fatigue. This aligns with prior research by Romero et al. (2020), who emphasized that aviation training environments, due to high mental and physical demands, often contribute to chronic fatigue. Participants highlighted insufficient sleep, poor sleep quality, workload intensity, and inconsistent scheduling as major contributors to their fatigue. Van Dongen et al. (2011) similarly found that irregular work-rest cycles lead to cumulative performance degradation, even when individuals believe they are coping.

Students also reported moderate impacts of fatigue on flight activities (M = 2.49). Although most indicated fatigue rarely or sometimes interfered with flight performance, the fact that some reported frequent or constant interference demonstrates the need for targeted interventions. Students also noted fatigue symptoms such as impaired decision-making (M = 1.93) and difficulty staying awake (M = 1.38) during training, signaling fatigue’s direct impact on performance and safety.

Work-life imbalance was another central theme. Many students averaged over 30 hours of work during weekdays and additional hours during weekends, with limited time allocated to rest or social activities. This imbalance is especially concerning in high-stakes fields such as aviation, where cognitive readiness and alertness are essential. Keller (2019) recommended implementing prescriptive models to ensure that time for academics, flight training, rest, and personal well-being is effectively balanced.

Mindfulness and Fatigue

Mindfulness was examined as a potential buffer against fatigue. While overall mindfulness levels were moderate (M = 8.92), only the "acceptance" dimension showed a significant predictive relationship with lower daytime sleepiness. This finding suggests that students who can acknowledge and accept their internal experiences, without judgment, may be better equipped to manage fatigue. Furthermore, higher attention scores were negatively correlated with fatigue, indicating that enhanced focus and awareness may support resilience.

These results support earlier work by Meland et al. (2015) and Shapiro and Weisbaum (2020), who noted that mindfulness improves cognitive flexibility and situational awareness, both of which are critical for managing fatigue in complex environments like aviation training. Recent workplace studies (Hülsheger et al., 2015) also show that mindfulness interventions reduce fatigue, improve concentration, and enhance safety-related performance, suggesting similar potential benefits for aviation students.

Limitations

While the study offers valuable insights, several limitations must be acknowledged:

1. **Incomplete Responses**: Not all participants answered every item. Although the sample size remained relatively robust (N = 188), some analyses may lack full statistical power.
2. **Instrument Validity**: Minor wording modifications in CAFI-II to fit a European audience could have influenced response interpretation or scale validity, though reliability remained acceptable.
3. **Self-Report Bias**: All data were collected via self-report, which may introduce social desirability bias or inaccurate recall. Participants may have underreported fatigue symptoms or overestimated coping abilities.
4. **Sample Scope**: While the sample size is sufficient for initial insights, broader generalizability is limited. Future studies should aim for a larger and diverse pool of student pilots across more countries and training environments.

Despite these limitations, the study presents one of the few in-depth examinations of fatigue and mindfulness among European aviation students. It offers a critical foundation for both academic research and practical policy development in aviation training.

Conclusions

This study found that many aviation students experience symptoms of fatigue that can impact flight performance, academic achievement, and mental well-being. Despite moderate levels of mindfulness and relatively low reported levels of excessive daytime sleepiness (ESS M = 6.25), the findings highlight systemic concerns, such as poor scheduling, insufficient rest, and inconsistent fatigue awareness.

Notably, nearly half of the participants (47.9%) reported receiving no formal fatigue training, and many exhibited limited awareness of fatigue's impact on performance. Students cited poor flight scheduling, lack of sleep, academic pressure, and psychological stress as key fatigue triggers. These conditions can erode both flight safety and learning outcomes.

The study also established statistically significant correlations between fatigue and variables such as mindfulness, lifestyle, and sleepiness. Specifically, higher acceptance and attention levels were associated with lower sleepiness, while fatigue-related impairments were more common among students with poor alertness and high self-reported stress.

Recommendations

To promote safety and well-being, the following recommendations are proposed:

For Flight Schools and Institutions:

- **Implement Fatigue Education**: Integrate mandatory fatigue awareness modules into flight training programs. These should cover sleep hygiene, circadian rhythms, and risk factors (ICAO, 2016).
- **Enhance Scheduling Practices**: Establish policies that ensure students are not overloaded with academic and flight duties in a compressed timeframe.
- **Adopt Fatigue Risk Management Systems (FRMS)**: Use predictive and reactive models to identify fatigue risks, collect self-reports, and adjust training as needed.
- **Promote Mindfulness Training**: Incorporate brief mindfulness programs to help students manage stress, improve focus, and enhance self-regulation (Hülsheger et al., 2015).

For Students:

- **Prioritize Sleep and Recovery**: Develop consistent sleep routines and limit caffeine, screens, and other disruptions before bed.
- **Balance Responsibilities**: Use time management tools to distribute workloads evenly and allocate time for recovery and personal well-being.
- **Engage in Regular Physical Activity**: Maintain a healthy lifestyle to build physical and mental resilience.
- **Conduct Self-Evaluations**: Use tools like the IMSAFE checklist (Illness, Medication, Stress, Alcohol, Fatigue, Eating) before flights to assess readiness.

Suggestions for Future Research

To build upon these findings, future research should:

1. Use mixed methods (qualitative and quantitative) to explore how fatigue affects decision-making and mental health.
2. Expand sample sizes and geographic diversity to compare fatigue experiences across regions and training systems.
3. Investigate how technological solutions, such as fatigue-monitoring wearables, can aid in real-time awareness and prevention.

4. Assess the long-term benefits of mindfulness and stress-management training in improving flight safety and student retention.

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