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Fatigue In Collegiate Aviation

Erik Levin
Purdue University, elevin@purdue.edu
FLAVIO COIMBRA MENDONCA MR
Purdue University, fmendonc@purdue.edu
Julius Keller
Purdue University, keller64@purdue.edu
Aaron Teo
ateo@purdue.edu

Fatigue Related Lifestyle Factors and Mitigation Strategies in Collegiate Flight Training

Caldwell, Mallis, Caldwell, Paul, Miller, and Neri (2009) pointed out the consistency among fatigue characteristics in different aviation environments. Fatigue is a workplace and safety hazard that usually results from a longer causal chain of events. Further, fatigue increases the likelihood of human error and accidents (Avers & Johnson, 2011; Dawson, Chapman, & Thomas, 2012; Dawson & McCulloch, 2005). Neurobehavioral aspects such as attention, cognitive efficiency, and mood are negatively affected by fatigue. Such factors could harm pilots by decreasing memory, reaction time, and judgement capabilities (Ashley, 2013; Choudhary, Kishanrao, Dhanvijay, & Alam, 2016; Gawron, 2017; Niederl, 2007). Previous fatigue research has focused on military and commercial aviation operations without bridging the gap to the training environment (Dawson, Cleggett, Thompson, & Thomas, 2017; Gander, Signal, Berg, Mulrine, Jay, & Mangie, 2013; Millar, 2012; Powell, Spencer, Holland, & Petrie, 2008). However, collegiate aviation pilots face similar challenges. They are likely exposed to occupational stresses, high task load from multiple flights, early starts, and late finishes as well as single-pilot operations

Flight schools are certified either under Title 14 Code of Federal Regulations (CFR) Part 61 or Part 141. Part 141 programs, due to their more regulated curriculums, must be approved by the Federal Aviation Administration (FAA) (FAA, 2019). One advantage of being certified as a Part 141 flight school is the opportunity to certify pilots with less flight time than a Part 61-certificated flight school (Mendonca & Carney, 2017). Consequently, student performance rates and higher accountability must be met (Aircraft Owners and Pilots Association, 2008; McDale & Ma, 2008). This exploratory study, the fourth of a series, investigated how pilots in an accredited collegiate Part 141 flight school perceive lifestyle factors that could assist in mitigating fatigue as well as how they rank their personal solutions relating to fatigue in general aviation operations. Students are not only affected by the fatiguing duties of a pilot but also the constraints of a full-time university education.

Literature Review

Causes and Symptoms of Fatigue in Aviation

The threat of fatigue to aviation safety requires more attention. In part, this is because, contrary to mechanical defects, evidence of pilot fatigue is difficult to identify and/or ascertain. Therefore, fatigue is infrequently considered as a contributing factor in accident or incident reports (ICAO, 2012a). Nevertheless, according to the National Transportation Safety Board (NTSB), from January 2000 through December 2018, a total of 85 general aviation aircraft accidents in which fatigue was cited as a causal factor occurred in the United States. Of those accidents, 82 resulted in fatalities, and 26 in destroyed aircraft (NTSB, 2018).

Behaviors conducive to fatigue mitigation include a healthy lifestyle, proper nutritional habits, physical exercise, and effectual time management (Australia Government Civil Aviation Safety Authority, 2012).

Fatigue is a multifactorial construct involving psychological, physiological, and emotional problems (Avers & Johnson, 2011; Fletcher, Hooper, Dunican, & Kogi, 2015; Shahid, Shen, & Shapiro, 2010). There are several causes and symptoms of fatigue. For instance, circadian misalignment, imposed by time zone changes, arises from the challenge to adjust to the human body's biological rhythms (Akerstedt, 2000; Caldwell & Caldwell, 2016; Dawson & Reid, 1997; Greenberg, Pluta, & DeConti, 2016). The major symptoms of fatigue encompass feelings of exhaustion, weariness, languidness, and the tendency to fall asleep (Caldwell, 2001; Dawson & Reid, 1997; Dawson & McCulloch, 2005; Dawson et al., 2012; Durmer & Dinges, 2005). Consequences of fatigue range from incorrect aircraft operations (e.g., altitude deviations) to deterioration of the central and peripheral visual fields (FAA, 2016a; Hartzler, 2014; Morris, Wiedbusch, & Gunzelmann, 2018). Additionally, fatigue presents obstacles to maintaining situational awareness (FAA, 2003, 2016b), and intensifies the risk of spatial disorientation illusions (U.S. Army, 2009). It frequently impairs both manual dexterity and intellectual processing, such as higher order thinking skills required by pilots. Interestingly, mental fatigue can be as harmful as fatigue resulting from manual labor (Ashley, 2013; Jeppesen, 2007; Robertson, Petros, Schumacher, McHorse, & Ulrich, 2006). The NTSB has issued advisories to reduce the safety risk posed by fatigue for nearly 50 years (Marcus & Rosekind, 2015).

Fatigue Among Collegiate Aviation Pilots

Flight training has received little attention in fatigue research. Only transfers of knowledge gained in commercial and military aviation have been applied to general aviation without bridging the gap to the training environment. Yet, students are subject to unique causes of fatigue that other pilots generally do not experience, resulting from multiple responsibilities imposed by attending college full-time and inadequate sleep due to several issues (e.g., disruptive neighbors) in the university dorms (Keller, Mendonca, Teo, & Levin, 2019). Since flight training is the introduction of pilots into the aviation industry, it is essential to convey the highest level of training and safety standards (Adjekum, 2016; Ashley, 2013; Gao & Rajendran, 2017; McDale & Ma, 2008; Taylor, Watling, Teunissen, Dornan, & Lingard, 2016).

College brings about circumstances causing stress and sleep difficulty among students, unconsciously leading to habit patterns that are hard to interrupt. These include a lower quality of sleep, inadequate eating habits, and lack of physical exercise. Adverse effects comprise cognitive and psychomotor slowing and concentration losses or depression (Ashley, 2013; Buboltz, Brown, & Soper, 2001; Lack, 1986; Pilcher & Walters, 1997).

As a full-time student planning graduation within four years, most colleges require a minimum number of credit hours that translates to a 45-hour week (Nelson, 2010; Purdue University, 2018). In addition, a private pilot certificate requires a minimum of 40 hours flight time, expected to be accrued within one semester, while a commercial certificate requires 200 hours, scheduled for three semesters (Aviation Supplies & Academics, Inc., 2018). Considering an approximately 15-week semester, compliance with the course curriculum requires at least three hours of flight time per week raising the full-time student requirement to a 48-hour week. Consequently, students frequently sacrifice a healthy lifestyle, including recovery sleep time and adequate nutrition, for social and personal activities, family requirements, and especially academics (Keller et al., 2019). Those factors could cause fatigue (Dawson & McCulloch, 2005; Fletcher et al., 2015). Factors that could increase the levels of fatigue such as intense academic schedules clashing with extracurricular and social engagements, morning or night flights, and expectations about student performance rates find a new dimension in the collegiate aviation environment. Student pilots are not only expected to conduct safe and efficient flight operations, but also to handle intensive academic schedules in order to successfully earn a college degree. Further research in this area could benefit the entire aviation industry because today's students will be tomorrow's aviation professionals and teachers.

Fatigue Mitigation

Collegiate aviation programs, contrary to commercial aviation, are not governed as strictly in regard to fatigue management systems (Ashley, 2013; Gao & Rajendran, 2017; Government Accountability Office, 2018). A flight instructor's legal work limit of eight hours is frequently one of the few existing policies (Aviation Supplies and Academics, Inc., 2018). Collegiate aviation programs have recognized the shared responsibility of taking fatigue countermeasures at work and in personal time. Education of collegiate aviation students should encompass a well-balanced lifestyle, including sleep and rest time, physical activities, and nutrition (Fletcher et. al., 2015; Keller et al., 2019). Additional regulatory strategies have been implemented in some training programs, such as the prohibition against operating within certain hours at night during circadian lows. Further, management flexibility encourages an open reporting culture which will include fatigue risks (Dawson & McCulloch, 2005; Dawson et. al., 2017; Dittner, Wessely, & Brown, 2004). Some schools require pre-flight completion of a Flight Risk Analysis Tool (FRAT), considering factors such as the length of one's last sleep period and the time of day. Although this system is a useful method to deal with fatigued pilots, this approach requires honesty from respondents. A review of the Part 141 requirements indicates that aeronautical decision-making and judgment are elements of a Part 141 certificated flight school curriculum. Therefore, it is expected that education on fatigue identification and management be adequately covered during ground and flight training (Electronic Code of Federal Regulations, Title 14, Chapter I, Subchapter H, Part 141, 2019).

Current FAA guidelines recommend the use of a personal checklist known as IMSAFE standing for illness (I), medication (M), stress (S), alcohol (A), fatigue (F), and emotion (E) to determine a pilot is physically and mentally ready for flying (FAA, 2016). The checklist reminds pilots that the combination of stress and fatigue can be extremely hazardous (Doskow, 2012; Dunbar & Gallo, 2015; FAA, 2017a; Learmount, 2011). It could be effective in assessing and mitigating risks because many aeromedical risks are combined in a memorable acronym that can be used with effective results during pre-flight briefings (Gelfand, 2013; Wright, 2017). Student pilots reported to both understand and apply this checklist in their flight training (Gao & Rajendran, 2017). However, the tool only warns of risks but does not offer mitigating strategies, rendering it less-effective as a real-time assessment tool (Wright, 2010). Additionally, self and organizational pressures may lead student pilots to proceed with the flight despite the identification of a high-risk situation due to fatigue (Keller et al., 2019).

Fatigue mitigation strategies are usually more effective when incorporated into one's daily lifestyle. This can be achieved by establishing nutrition habits, planning the day, engaging in physical activities, and by maintaining balance between work and free time activities. Also recommended are adherence to bedtime routines and avoidance of certain activities prior to bedtime, such as exercising or taking work to bed. Caffeine, another strategy to mitigate fatigue, can be used to increase alertness and awareness temporarily. Nonetheless, caffeine is only effective when consumption is limited. Furthermore, its effectiveness is usually followed by an even more noticeable decrease in awareness (Caldwell et al., 2009, 2016; Dawson et al., 2012; FAA, 2016c; ICAO, 2012a; Jean-Louis, Von Gizycki, Zizi, & Nunes, 1998). Studies by Caldwell (2001) and Wesensten, Belenky, Thorne, Kautz, and Balkin (2004) suggested that the use of medicine as a fatigue countermeasure should be avoided due to limited advantages opposed by possible side effects.

While many studies present alternatives to fatigue mitigation, their conclusion usually settles upon the insight that an adequate daily quantity and quality of sleep and rest opportunities are most beneficial to physical and physiological restoration (Dawson et al., 2012; FAA, 2008; Harrison & Horne, 2000; ICAO, 2012a; International Air Transport Association, 2015). Fatigue induced defaults cannot be overcome by experience, motivation or training in the long term, so personal lifestyle factors need to be modified (Caldwell, 2001; Dawson & McCulloch, 2005; FAA, n.d.; Fletcher et al., 2015; Goode, 2003; McDale & Ma, 2008; Wesensten et. al., 2004). The purpose of this study was twofold: to investigate how pilots in an accredited Part 141 flight school perceive lifestyle factors that could assist in mitigating fatigue, and to assess how they rank their personal solutions relating to fatigue in general aviation operations.

Methods

The researchers applied a mixed methods approach supported by a thorough literature review addressing fatigue identification and management in aviation (Ashley, 2013; Caldwell & Caldwell, 2016; Hor & Tafti, 2009; ICAO, 2003, 2012a, 2012b; McDale & Ma, 2008; Petrie et. al., 2004; Powell et al., 2008; Samn & Perelli, 1982; Sieberichs & Kluge, 2016; Taneja, 2007, Yen et. al., 2009). In addition, the researchers reviewed empirical information regarding fatigue causal factors in a college environment (Buboltz et al., 2001; Hicks & Pellegrini, 1991; Jean-Louis et. al., 1998; Lack, 1986; McDale & Ma, 2008). A survey questionnaire was then developed to investigate college aviation students' lifestyles and personal solutions concerning fatigue. The researchers tailored questions to flight students pursuing a college degree (Ashley, 2013). The outcome was the validation of the Collegiate Aviation Fatigue Inventory (CAFI) (Mendonca, Keller, & Lu, 2019).

The CAFI included five-point Likert rating scales, rank-order, and open-ended questions (see Appendix). Quantitative responses were analyzed using descriptive statistics. Qualitative data were analyzed using a content analysis approach in order to distill words into common themes (Jain, 2014; Popping, 2015). Using qualitative narrative data from the students' responses, researchers conducted a content analysis to identify the common themes (Patton, 2015). One researcher, an experienced pilot, researcher, and accident investigator made the initial classification. After that, the remaining members of the research team, all with experience in aviation safety and human factors, reviewed potential classifications independently until all researchers reached an agreement. Considering the high inter-rater reliability found in previous studies using this approach (Li et al., 2008; Mendonca, Huang, Fanjoy, & Keller, 2017), consensus classification was deemed appropriate for the study.

The target population consisted of 350 pilots enrolled in a Midwestern university's accredited Part 141 flight school and a partner FBO. Student pilots were required to be at least eighteen years old and to have flown in the previous six months in order to participate in the study.

Validation of the Instrument

The CAFI was validated following empirical procedures. The assessment was reviewed for validity and usability by six faculty members who are not only experienced pilots and researchers, but also teach undergraduate and graduate level courses. The faculty members suggested modifications concerning organization, grammar, syntax, and appropriateness as suggested by Borg and Gall (1989). They further helped to modify some questions that were ambiguous and had different connotations. After the necessary changes, a pilot test was conducted with a group of twenty-four collegiate flight students who represented the typical intended participants. The student's comments and suggestions were used to render the CAFI more understandable and readable as suggested by DeVon et al. (2007), and Sartori (2009). Following initial survey runs, a Cronbach's alpha was completed to test for internal consistency. The Lifestyle subscale consisted of seven items ($\alpha = 0.76$) indicating a medium to high reliability (Field, 2009). The final survey (CAFI) was then approved by the Institutional Review Board (IRB) (see Appendix).

Procedures

In order to reach a larger number of flight students and instructors, the CAFI was distributed through Qualtrics® secure servers for reliability, privacy, and confidentiality considerations. An invitation letter preceeding the CAFI explained the purposes of the research study and its importance to aviation safety. In addition, the cover letter informed participants that their identity would remain anonymous and confidential, and that participation was completely voluntary. Furthermore, the purpose of the study, specific procedures, and benefits of participating were explained. To foster trustworthiness, the cover letter also explained that this study was conducted by members of the flight training program to improve aviation safety. The researchers sent two reminder emails asking participants to complete the CAFI. Since all participants were pilots, it was assumed that they would be interested in helping the researchers conduct a study to enhance safety. Between August and November 2018, 146 survey attempts were recorded, which represents a 42% response rate. However, not all participants answered each of the questions. After completion, participants were eligible to enter a drawing for one of three $50.00 gift certificates.

Results

The demographics section of the CAFI (see Appendix A) was completed by 122 participants. Ninety-seven percent of the respondents were younger than thirty-five years. Ninety-seven percent of the participants were male, while only three percent were female. About 95% of the participants were students in the university's flight program. Approximately 93% of the respondents had less than 500 flight hours. The distribution of participant between the four years of college was relatively even (see Table 1).

Table 1
Participant's Demographics

Age	
18-25	92.62%
26-35	4.92%
36-45	1.64%
46-55	0.82%
Total flight time	
0-250	68.03%
251-500	25.41%
501-1000	6.56%
Enrollment status	
Freshman	18.03%
Sophomore	22.95%
Junior	26.23%
Senior	21.31%
Graduate Student	6.56%
Other	4.92%
Certificate/ratings held	
Student	17.43%
Private	25.08%
Commercial	16.21%
Instrument	17.74%
Multi-engine	8.87%
CFI	8.87%
CFI-Instrument	1.83%
ATP	0.31%

The first part of the CAFI was completed by 125 participants. This section, which had seven questions, queried participants about their perceptions of personal lifestyle factors that could help prevent fatigue (Akerstedt, 2000; Caldwell & Caldwell, 2016; Civil Aviation Safety Authority, 2012; Dawson & Reid, 1997). The participants' responses could range from "strongly disagree" to "strongly agree." Approximately 66% of the respondents indicated that they were not getting a fully adequate quantity or quality of sleep each night. About 62% of the respondents expressed that preparation for sleep was a factor they were not specifically cognizant of (see Figure 1). Approximately half of the participants pointed out that to some degree they did not exercise regularly. Moreover, more than 50% of the respondents indicated they did not have a proper and adequate healthy diet. Interestingly, almost 57% of participants reported they were good at managing stress.

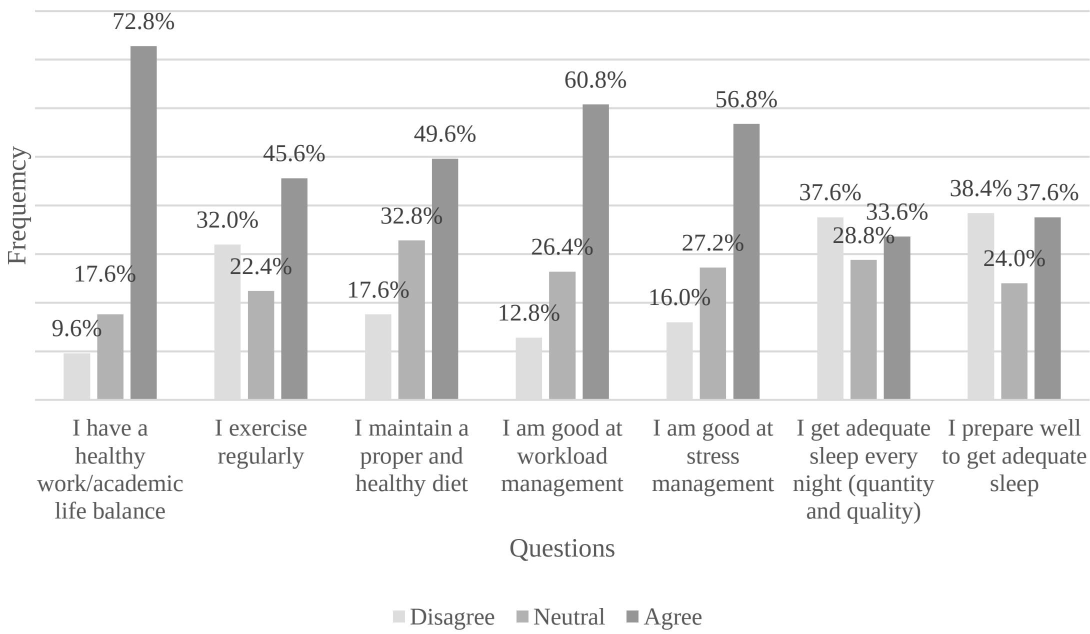

Figure 1. Lifestyle Chart. The graphs for "disagree" and "agree" include both the strongly disagree and strongly agree survey responses, respectively, to simplify graphic depiction.

In this section, respondents were posed an open-ended question as to which other factors inhibited their quality and quantity of sleep. Ninety participants answered this question. The researchers analyzed responses for frequent occurrence of themes (Jain, 2014; Popping, 2015). Content analysis was used to identify consistencies in qualitative responses (Patton, 2015). Consensus classification was used among the research team to classify patterns and themes more accurately (Li et al., 2008; Mendonca, Huang, Fanjoy, & Keller, 2017). One of the themes revealed by respondents was that socializing hindered their quality and quantity of sleep. Additionally, in many instances electronic devices would, often unconciously, delay respondents' bedtime. Loosing track of time was also reported when attempting to complete the large amount of school assignments. Several respondents attested to be plagued by solicitude of the consequences of not completing their assignments. For instance, one respondent revealed "I sleep well knowing I have all of my homework completed. When I don't have everything completed that needs to be done, I sit there and stress out." Respondents' sleep was frequently inhibited because they postpone their homework until late in the evening due to other commitments. After working on these assignments until midnight they often have to wake up in time for a 7:30 a.m. class. Furthermore, participants illustrated that dorm environments were not conducive to a comfortable good night's sleep due to noise, roommates' disrupting activities, bright light, or lack of air conditioning.

Although fatigue is a common threat to all humans, complexity in understanding fatigue remains due to biological, psychological, and social differences (Fletcher et al., 2015). The second part of the survey was completed by 124 participants. Participants were asked to rank ten potential solutions to mitigate fatigue, as reviewed in the literature, on a scale from one to ten, with one being the most conducive to fatigue prevention. These data are summarized below in the order of the importance assigned by participants (see Table 2).

Table 2

Personal Solutions to Prevent Fatigue

Solutions to Prevent Fatigue	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
More Sleep	48	23	10	2	6	6	2	2	2	0
Reduced Workload	17	11	19	15	10	5	6	7	6	3
Efficiency in scheduling of classes and flight activities	7	13	15	12	11	13	10	9	7	2
Scheduled breaks	4	14	8	13	15	15	14	4	8	5
Self-awareness and fitness to fly	10	10	10	11	7	6	15	15	10	5
Management of sleep preparation	4	14	10	10	12	12	12	15	5	7
Guaranteed rest for a given amount of flying	5	7	15	11	6	9	16	10	11	10
Physical exercise	2	2	3	10	11	9	11	21	16	15
Healthy eating habits	0	3	4	9	10	14	9	10	25	16
Better management of non-work issues	3	3	6	10	10	4	8	10	10	38

Note. All numbers are percentages and rounded figures for ease of reading.

Forty-eight percent of the respondents indicated more sleep as the most important strategy to mitigate fatigue. Interestingly, "more sleep" was selected among the top-three personal solutions to prevent fatigue by 81% of the respondents. Reduced workload followed and was placed among the top-three solutions to mitigate fatigue by 47% of respondents. On the other hand, approximately 50% of respondents placed a healthy lifestyle in terms of nutrition and exercise among the bottom-three personal solutions to fatigue. Only seven percent of respondents placed a healthy lifestyle among the top-three solutions to mitigate fatigue while about half of the participants placed these items near the middle of the importance ranking. Furthermore, management of non-work issues was not considered important by but a few participants. This ranking of personal solutions is similar to the pattern identified by McDale and Ma (2008).

Respondents were once again given an open-ended question and asked to provide information about additional potential personal solutions to manage fatigue. Thirty-two participants answered this question. A commonly mentioned topic was better management of work-related tasks. However, high workload was considered less strenuous if breaks were allowed. Several respondents felt that fatigue could be conciously avoided by scheduling high priority tasks at times of peak performance (Avers & Johnson, 2011; Civil Aviation Safety Authority, 2012; Goode, 2003; Marcus & Rosekind, 2015). Another respondent argued that "grounding" oneself to take care of other personal or work related issues could be helpful. Additionally, participants desired the establishment of goals and learning outcomes to spur motivation. Other comments stressed the value of adequate hydration and nutrition (Akerstedt, 2000; ICAO, 2012a; Sieberichs & Kluge, 2016).

Discussion and Conclusions

Collegiate aviation pilots have multiple responsibilities imposed by attending college full-time in addition to dense flight training curriculums (Keller et al., 2019). Those unique causes of fatigue that other pilots generally do not experience could result in stress and sleep difficulty leading into habit patterns that are hard to interrupt (Adjekum, 2016; Ashley, 2013; Gao & Rajendran, 2017; McDale & Ma, 2008). Nevertheless, contrary to commercial and military aviation flight training has received little attention in previous fatigue research.

This study evaluated pilots in an accredited Part 141 flight school and provided insight into their perceptions of lifestyle and mitigation strategies in regards to fatigue in general aviation operations. The majority of participants (68%) had logged less than 250 flight hours and was under 25 years of age (93%). The sample therefore consisted primarily of flight students with little aviation experience. Three percent of participants in this study were females. According to the FAA (2017b), seven percent of pilots are females. Hence, females could be underrepresented in this study or in Part 141 schools.

An adequate daily quantity and quality of sleep and rest opportunities are inevitable to physical and physiological restoration when suffering from fatigue (Caldwell et al., 2009, 2016; Dawson et al., 2012; FAA, n.d.; ICAO, 2012a; Jean-Louis et. al., 1998). Many respondents (66%) indicated in their quantitative responses that they were missing an adequate quantity or quality of sleep each night. When asked about desired solutions, 81% of the respondents indicated more sleep among the top-three personal solution to prevent fatigue. Furthermore, reduced workload was desired by 47% of the respondents.

Management of fatigue and the establishment of adequate sleep habits has long been an area of concern in fatigue research (Dawson & McCulloch, 2005; Fletcher et. al., 2015; Hicks, & Pellegrini, 1991). Many students claimed to be distracted from their sleep routines by socializing with friends or roommates and by using electronic devices. This indicates a lack of awareness concerning workload management and task prioritization by participants. Thus, training and education to assist collegiate aviation pilots manage their work-free time may be a possible area of improvement that could help decrease the feeling of assignment overload. In this regard, about 40% of respondents indicated dissatisfaction with their workload management habits. Somewhat paradoxically, participants considered workload management the least important item in fatigue mitigation.

Buboltz et al. (2001) suggested that the environmental demands during college interfere with the creation of sleep habits, leading to sleep difficulties and general tiredness. Several respondents pointed out the detrimental effects that the dorm atmosphere had on their sleep habits, such as noise or lack of air conditioning systems. Few respondents placed importance on preparation for sleep (38% among the top-three solutions), which may contribute to the decreased quantity or quality of sleep identified in the first part of the survey. Approximately 38% of participants indicated that they did not intentionally prepare for a good night's sleep. About the same percentage did not agree with getting adequate sleep. Therefore, more education on preparation for sleep may be required (Caldwell et al., 2009; Caldwell & Caldwell, 2016).

A leading concern is that half of the sample did not consider themselves to engage in fully adequate bodily exercise, nutritional habits, and workload and stress management. These areas, however, are prime considerations when working towards healthy sleep patterns (Caldwell et. al., 2009; Dawson & McCulloch, 2005; ICAO, 2012a). The most effective solutions to mitigate fatigue as identified by the participants are more sleep, reduced workload, and an effectice daily or weekly schedule of flight and class activities. Better organization of course activities through an efficient schedule specific to each flight student's situation may be applicable. To ideally target positive habit formation, these activities should be incorporated as long-term habits, or else mitigation actions will only be temporary (Caldwell, 2001; Dawson & McCulloch, 2005; n.d.; Fletcher et al., 2015; Goode, 2003; Wesensten et al., 2004).

The qualitative data helped the researchers understand the quantitative findings, as suggested by Patton (2015). Three major themes emerged from the participants' responses to the open-ended questions in the survey questionnaire. The first theme that became apparent to the researchers was that participants' bedtime was delayed through socializing with friends and the use of electronic devices until late at night. The adverse impacts of these factors have previously been indicated by Asaoka, Komada, Fukuda, Sugiura, Inoue, and Yamazaki (2010) as well as Short, Kuula, Gradisar, and Pesonen (2019).

The second theme that became apparent to researchers was that uncomfortable dorm environments led to sleep disturbances due to factors such as excessive noise and light at bedtime. Previous studies pointed out that an adequate sleep environment is important to obtain an appropriate quality and quantity of sleep (Caddick, Gregory, Arsintescu, & Flynn-Evans, 2018; Sexton-Radek, & Hartley 2013).

The third theme that became apparent was that a large amount of school assignments and time spent on the job frequently left participants sleepless. Sleep deprivation through work and school schedules has previously been studied by Carskadon (2002) and Park and Sprung (2015).

It would be interesting to further conduct studies on how honestly students respond to the IMSAFE checklist, if they deem this to be a valuable tool, and if it has a beneficial impact on their aeronautical decision-making process. Educating flight instructors on the basic concept of fatigue and strategies for managing fatigue is another valued option. To maintain adequate safety standards concerning fatigue mitigation, flight students usually require external control from their instructor or flight school (McDale & Ma, 2008). Future studies could use inferential statistics. Additionally, scenario-based training and case studies could be integrated into course curriculums to further enhance student perception of fatigue-related risks.

Limitations to this study include possible errors in sampling, coverage, and the measurement (Gunn, 2002). Furthermore, errors in validity and reliability of the measurement instrument as well as limitations to generalizability cannot be excluded. Notwithstanding the attempt to increase the response rate through an informative invitation letter and two reminder emails, non-response error remains a factor that skews research data (Punch, 2003).

As previously noted, this study is the fourth of a series whose general goals are to evaluate Part 141 collegiate aviation students' self-awareness of their fatigue issues, impact of fatigue on flight training quality and safety, and potential solutions. Based on the current and previous findings, the next study will investigate the collegiate aviation pilots' subjective level of fatigue and sleepiness at particular times during the day using the the Samn-Perelli Scale (Samn & Perelli, 1982) and the Karolinska Sleepiness Scale (Kaida et al., 2006), respectively. It is recommended that future similar studies target a larger population of different Part 141 collegiate aviation programs. In addition, future studies could utilize a qualitative approach so as to have a better understanding of the quantitative findings, as suggested by Patton (2015).

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Appendix: CAFI - Bank of questions

Participants' demographics assessment

1. Age:
    a. 18-25
    b. 26-35
    c. 36-45
    d. 46-55
    e. over 55
    f. Prefer not to say

2. Gender:
    a. Male
    b. Female
    c. Prefer not to say

3. Enrollment status:
    a. Freshman
    b. Sophomore
    c. Junior
    d. Senior
    e. Graduate Student
    f. 3+2 Student
    g. Other

4. Certificates/ratings held (check all that apply):
    a. Student
    b. Private
    c. Commercial
    d. Instrument
    e. Multi-Engine
    f. CFI
    g. CFI-Instrument
    h. MEI
    i. ATP
    j. Remote Pilot

5. Approximate total logged flight time:
    a. Less than 250 hours
    b. 250 - 500 hours
    c. 501 - 1000 hours
    d. 1001 - 1500 hours

e. 1501 - 2000 hours
f. More than 2000 hours

Bank of questions

1. Given each item, please select the accuracy of the statement describing your current lifestyle. 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree, 6=not applicable.

    a. I have a healthy work/academic life balance
    b. I exercise regularly
    c. I maintain a proper and healthy diet
    d. I am good at workload management
    e. I am good at stress management
    f. I get adequate sleep every night (quantity and quality).
    g. I prepare well to get adequate sleep (limiting electronic device use, have a dark room, limit interruptions, reduce noise, limit caffeine, etc.).

2. In your experience what are the most significant factors that inhibit you quality and quantity of sleep?

3. Please read through the entire list then rank (click and drag) in order the following personal solutions to mitigate fatigue. 1 being the most important and 10 being the least important. You can provide factors that are not listed in the comment box below.

    a. Reduced workload
    b. Scheduled breaks
    c. More sleep
    d. Efficiency in scheduling of classes and flight activities
    e. Management of sleep preparation
    f. Self-awareness of fitness to fly
    g. Guaranteed rest for a given amount of flying
    h. Physical exercise
    i. Healthy eating habits
    j. Better management of non-work issues

4. What other personal solution(s) do you find important?