

Factors Contributing to Self-Reported Student Pilot Fatigue

by

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ABSTRACT

Student pilots are the future of aviation and one of the biggest problems that they face as new pilots is fatigue. The survey was sent out asking if student pilots were fatigued, if they attribute flight training, school work, work outside of school, and social obligations to their sleep loss, and how they spend their time on those activities. The survey was given to aviation students at Arizona State University (ASU) Polytechnic Campus. ASU student pilots were found to be fatigued through a single sample t-test. Other t-tests were done on each of the questions that asked student pilots how flight training, school work, work outside of school and social obligations affect their sleep loss. Flight training and school were found to be contributing to student pilots sleep loss. Work outside of school and social obligations were found to not be contributing to student pilots sleep loss. It was found that student pilots' tendency to use a planner or calendar was found to not be significant. Along with this planning through the week when they will do assignments or study for exams was also not found to be significant. Students making lists of assignments and when they are due was also found to not be significant. The t-test also found that student pilots are neutral on the topic of whether good time management skills would help increase the amount of sleep that they get.

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CHAPTER 1

INTRODUCTION

Factors Contributing to Self-Reported Student Pilot Fatigue

During severe weather in 1999 the pilots of American flight 1420 attempted a landing in Little Rock, Arkansas. Flight 1420 was experiencing 75mph gusts of wind during its landing (Nullmeyer, 2018). In the report done by the National Transportation Safety Board the first officer who survived the crash reported that the captain signaled him to put away the manual on the crosswind of the runway because the captain was confident in the crosswind limitation was 20 knots (National Transportation Safety Board, 1999). In addition, the pilots failed to deploy the spoilers causing the plane to go off the runway. This all happened at the end of the pilots 13.5-hour shift and 11 people died in this accident (National Transportation Safety Board, 1999). This story demonstrates what can happen when pilots do not get adequate sleep and the dangers that fatigue holds for our airline pilots and our student pilots.

Reis, Mestre, Canhao, Grandwell, and Daiva (2016) found that pilots were not getting enough sleep. They found that 34% of the 435 pilots surveyed were having sleep complaints. Along with this 54% of the pilots were experiencing daytime sleepiness and 90.6% were experiencing fatigue. The high prevalence of sleep complaints, sleepiness and fatigue were also reported by short/medium haul pilots (Reis, Mestre, Canhao, Grandwell and Daiva, 2016). Student pilots face the same problems that professional pilots do when it comes to fatigue and how to manage it. Learning how to know the signs, symptoms, and how to mitigate fatigue is extremely important. Student pilots have

social obligations, flight training, work outside of school, and school work that they need to do in order to become pilots. They also need to understand and mitigate fatigue.

There are other areas such as medical school in which fatigue is problematic, Shaikh, Kahloon, Kazmi, Khalia, Nawaz, Khan, and Khan (2004) performed a study on researching how well medical students deal with exams, academics, relationship problems, family problems, and homesickness (Shaikh et al., 2004). They found that exams and academics were the biggest contributors to medical students' fatigue. This can relate to how school work and flight training can affect student pilots sleep loss.

How do social obligations, flight training, work outside of school, and school work relate to flight student's lack of sleep? Along with do student pilots attribute flight training, school work, social obligations, and work outside of school to their sleep loss? How much time are student pilots spending on flight training, school work, social obligations, and work outside of school? Finally, do student pilots use tools like planners, calendars, lists, and planning through the week their assignments, tests, and exams? Student pilots are the future of the aviation community and how a lack of sleep might be related to other activities is an area that needs to be researched.

Therefore, the purpose of this study is to understand whether or not flight students are fatigued, the reasons that flight students get inadequate sleep and the degree to which time management plays a role. Insight will be gained through this research on, how activities contribute to fatigue, and how time management can mitigate it.

CHAPTER 2

LITERATURE REVIEW

When student pilots are not getting enough sleep because of social obligations, flight training, school work and work outside of school they can experience fatigue. The symptoms of fatigue are often described as drowsiness, sleepiness, and tiredness. Mental fatigue is a syndrome that includes subjective tiredness and a slowing of normal cognitive functions (Simons, 2017). The practical definition of fatigue for pilots that is used by the International Civil Aviation Organization “is a physiological state of a reduction in mental or physical performance that is the result of sleep loss or extended wakefulness, circadian phase, or workload that can impair a crew’s alertness and their ability to perform their duties on the aircraft” (Simons, 2017, p.2). There are studies that have looked into the effects of a good night sleep and how getting a goodnight sleep can allow for people to have better cognitive function. Research for this study was gathered from a variety of fields such as government fatigue research, pilot fatigue, student fatigue, the fatigue experienced by medical school residents, the fatigue experienced by commercial divers, and research on sleep itself.

Physiology of Sleep

There are five stages of sleep and the first one is light sleep, where all muscle activity slows down with only a few muscle twitches very rarely. During stage two, breathing and heart rate slow down with a small decrease in the body’s temperature. When stage three starts this is when deep sleep begins, and the brain starts to slowly generate delta waves. Then in stage four the person begins rhythmic breathing and there is very limited muscle activity and the brain continues to produce delta waves. Finally,

there is stage five in which the rapid eye movement starts, and the brain waves speed up, which allows for dreaming to occur. Along with this, the muscles relax and the heart rate increases. Breathing begins to quicken and becomes shallow (Nullmeyer, 2018). Sleep is an interesting process and one that has been well researched but there are still many mysteries to sleep. Researchers need as much knowledge as possible to better aid pilots in combating fatigue with the results of their research.

Sleep and Memory

Sleep for student pilots is hard to come by; having to balance their classes, flight hours, tests, impact their ability to get enough sleep. There was a study done by Schnabel (2012) that examined how the amount of sleep allows for better memories. In the 1950's it was discovered that there was a significant relationship between sleep and memory (Schnabel, 2012). The researchers found that during REM (rapid eye movement) the brain is able to strengthen memories during this stage of sleep by semi-consciously re-experiencing the new memories that the person has. In the 50's it was originally thought that when people dreamt it was a rehearsal of that day's events.

Testing this idea is still very difficult and has become an issue for researchers. The researchers were unable determine how a good night's sleeps effects how memories are stored. There are two types of memories, namely they are procedural memory and declarative memory. Procedural memory is the memory of cognitive skills. Declarative memory is specific events, dates, and places. These two types of memory are stored in different parts of the brain and they are not consolidated in the same manner during sleep (Whitman, 2012). This means that sleep is not a uniform process.

There is another stage of sleep called non-REM sleep which is also referred to as slow wave sleep. When researchers first started researching REM sleep the findings, they were getting were inconsistent and was causing a lot of controversy. The theory of slow wave sleep (SWS) started in the 90's and refers to memory consolidation. The original studies on SWS started with animal studies and then eventually were conducted on humans. In a more recent study done in Born's lab (2012), participants had been practicing a discrimination task and a visual task. During the visual task they found that procedural memory improved after the participant had slow wave sleep (Schnabel, 2012). This experiment was ground breaking in terms of controlling for the confounding effects of sleep loss.

Stickgold (2012) found in his research that when his participants were given a similar discrimination challenge as the one used by Born's lab, the participants did not improve with repeated testing unless the participants were sleeping the first day of the study. Stickgold was able to control for the amount of lost alertness. He did this by testing subjects who had slept for three nights after the first night of the study but did not sleep the next two nights. Memory benefits of sleep can depend on age because SWS decreases as you age, and a substantial decrease after people reach 30. By 50 it is significantly worse than when participants were 30 (Schnabel, 2012). Memory is a large part of why we sleep, and it is a very important part of it.

There is evidence to suggest that the when people sleep, they are better able to access memories and they are able to better recall these memories as well. In a study done at the University of Exter and Basque Center for Cognition Brain and Language the findings were suggesting that when their participants slept, they were better able to

remember facts than they were able to remember while still awake. The participants were given a list of words to recall. Immediately after being exposed to them they would sleep and go over the words again. In another scenario, the same thing was done only this time they were not allowed to sleep. A specific difference between the two scenarios was that the words that the participants were reading at the immediate test that were forgotten were then remembered at the 12-hour retest (University of Exter, 2015). They also found that when compared to the daytime wakefulness, sleep was allowing them to recover memories more than it was preventing memory loss. Sleep almost doubles the chance of remembering the new information. After sleeping it has also shown that memories are becoming more easily accessible and they are sharpened.

This study gives support to the idea that while asleep, the participants were rehearsing information that was flagged as important (University of Exter, 2015). How well students sleep when they are doing their flight training is important. Students who learn good sleep habits early will not be fighting fatigue for the rest of their careers as pilots. Learning these skills will also help them as students. They will be getting better scores on their flight training which will allow them to be better pilots. This is going to allow the incoming generation of pilots to better prepared and give them the ability to be able to understand how important sleep is and the dangers of fatigue.

Government Research on Fatigue

Hursh, Redmond, Johnson, Thorne, Belenky, Batkin, Eddy at the Department of Defense (DOD) in 2004 conducted a study that looked at fatigue that was occurring in military operations. They made a model that looked at sleep, activity, fatigue, through The Task Effectiveness SAFTE Model. The core of this model is the sleep reservoir that

represents processes that are governing the performance of cognitive activity. Under fully rested conditions, otherwise known as optimal conditions a person has a specific maximum capacity for performance. While awake the contents of the reservoir are depleted and while sleeping it is filled back up (Hursh et al., 2004). How much the reservoir gets refilled is based on the intensity of sleep and sleep quality. Sleep intensity is determined by time of day (circadian process) and current level of your sleep reservoir. Sleep fragmentation is determined by the external forces that each person experiences day to day. Performance effectiveness is the output of the model and the level of effectiveness is modeled by the time of day and the levels of that persons sleep reservoir (Hursh et al., 2004). Other industries such as the medical and trucking industries have workers who experience high fatigue levels and research from these areas can also be used and applied to the fatigue that is experienced by pilots.

Transportation and Sleep

By improving and changing policies that are in place, the aviation community can make flight even safer not just for the passengers, but also the pilots. Along with this we can look at how fatigue affects the trucking community, so this would be Commercial Driver's License (CDL) drivers and tour bus drivers. For example, in 1998 and 1999 tour bus crashes were affected by the number of hours the drivers were doing and the accidents were due to insufficient rest (Nullmeyer, 2018). They felt that insufficient rest was responsible for the errors that were being made by the drivers. In addition, fatigue was ranked among the top 10 transportation safety issues because of the accidents that truckers were having. Of these accidents 31% were fatal and were fatigue related. Along with this people driving cars also have fatigue problems. Driver fatigue causes 100,000

deaths a year. The cost of this many deaths to society has been estimated to be more than 12 billion dollars a year (Nullmeyer, 2018). Sleep is an important process and is needed to make sure that people can operate correctly and make rational decisions.

There have been other accidents in history that have shown people what happens when people do not get enough sleep. An example of this was the grounding of the Exxon Valdez. This also another example of how fatigue can cause extreme damage in that 11 million barrels of oil were spilled that day (Nullmeyer, 2018). The 3rd mate after an 18-hour shift without sleep, missed a light and a buoy that marked the shoreline, and crashed into a reef. Sleep is a very important process and is still a bit of a mystery even today. Having a better understanding of how it works and why we have to sleep will allow researchers help people make sure they are getting the rest that they need.

Pilots and Sleep

Bougrine, Gounelle, Mollard, and Coblenz in (2003) examined what fatigue means to pilots that perform short and long-haul flights (SHF-LHF). They used a questionnaire that was given to pilots of four airliners which looked into the perceived causes of fatigue, the signs and symptoms of fatigue, the observed signs of fatigue in pilots, as well as the strategies that are used by pilots to help aid them in getting through the symptoms of fatigue (Bourgeois, Carbon, Gounelle, Mollard, & Coblenz, 2003). They sent out 3,436 surveys and they received 739 back. Of the pilots surveyed 59% of the long-haul pilots were reporting that fatigue was being experienced mostly at night and they were also reporting 45% of their fatigue was due to jet lag.

The short haul pilots were experiencing long periods of multiple flight segments. They were reporting to be experiencing fatigue 53% of the time and they were

experiencing fatigue with early wake ups 41% of the time. In this study, manifestations of fatigue were reported 60% by short haul pilots and 49% of the short haul pilots also were experiencing a lack of attention and concentration. Pilots were also reporting that they saw an increase in response time and small mistakes in calculations and interpretations among their fellow crewmembers (Bourgeois et al. 2003). These pilots also reported that when pilots were feeling tired during flight their tasks were becoming more difficult to perform than usual.

Reis, et al. (2003) examined to how fatigue affects short, medium, and long-haul pilots. This study was conducted through a survey in which a scale was used to measure and test the severity of the fatigue they were experiencing. They used the self-response fatigue severity scale to measure the level of subjective fatigue that was being experienced by the pilots. It was found that long and medium/short haul pilots were reporting high mental fatigue of 89.3% and 94.1% (Reis, Mestre, & Canhao, 2013). A study was done that examined whether or not pilots were at more risk of an accident if they were fatigued.

The problem that they examined was the concern that pilot schedules could lead to fatigue and an increased chance of aviation accidents. There has been little research to indicate a connection between the pilots' schedules and commercial aviation accidents. In this study they conducted a chi-square test to determine whether or not the proportions of accidents and length of duty time were related. The analysis suggested that making limits on duty time for commercial pilots would reduce the risk of accidents (Goode, 2003). Although, such a rule would be expensive and would have a big impact on the

commercial airlines, if it were to be implemented there would be a reduction in the risk of commercial accidents due to pilot fatigue.

Petrie, et al. (2006) looked at subjective fatigue but instead of low-cost pilots and short haul pilots they looked at international pilots. International pilots have different responsibilities to deal with that are going to affect their level of fatigue such as irregular sleep, long duty days, night flying, and multiple time zones. Current flight and duty time regulations are based on the amount of time they are working and the amount of time they have to rest, not the amount of time they sleep and the amount of time they are awake (Petrie, Roach, Dawson & Lamond 2006). Along with this, the researchers were looking into whether prior sleep and duty history were predictors of the pilots sustained attention and subjective fatigue during international flights.

Petrie, et al. in (2006) had 19 pilots, ten of whom were captains and nine of whom were officers. They collected data through wrist monitors and sleep diaries. The flight that the pilots flew was a return flight from Australia to Europe via Asia and Asia-Australia. Before and after each of these flights the pilots would do a five-minute palm pilot based psychomotor vigilance task (PVT) and they would self-rate their levels of fatigue using the Samn-Perelli fatigue checklist. The Samn-Perelli fatigue checklist is a seven-point Likert scale with the following labels 1= fully alert, wide awake; 2= very lively, responsible, but not at peak; 3= okay, somewhat fresh; 4= a little tired, less than fresh; 5= moderately tired, let down, 6=extremely tired, very difficult to concentrate; 7= completely exhausted unable to function effectively (Petrie, et al. 2006). Using these data points, they used the rating that the pilots gave on the Samn-Perelli fatigue test and the PVT mean response speed to do a linear mixed model regression analysis that was

examined the impact of sleep in the 24 hours before, the prior wake and duty time, fatigue and sustained attention before and after flight on self-rated fatigue and PVT response speed.

Their findings showed that the 24 hours before the flight was a significant predictor of self-rated fatigue and mean response speed after the international flight. Along with this they found that flight sector was a significant predictor of the self-rated fatigue score. Having a good understanding of how pilots experience fatigue can lead researchers to get a better understanding of how student pilots experience fatigue. By getting this understanding of how student pilots experience fatigue researchers are able to better learn ways to help student pilots prevent fatigue by making sure they are not losing sleep. Students have a lot of stress, work, and other factors that contribute to their sleep loss.

School Work contributes to Students' Lack of Sleep

Flight training and school work contribute to lack of sleep in student pilots. Shaikh, Kahloon, Kazmi, Khalia, Nawaz, Khan and Khan (2004) on the ability of medical students to cope with stress from exams, academics, relationship problems, family problems, and homesickness between men and women. This study relates to flight training and school work effects on sleep loss because it shows how students feel that the biggest stressors in school are exams and academics. This suggests that there could be an interaction between how students perform in their flight training and the amount of time they are spending studying for course work, flight training, and balancing a social life (Shaikh et.al., 2004). In this study they didn't look at flight training, but they did look at exams and academics and how those affect students stress levels.

Reasons for Stress	Men n=138	Women n=126	Mean
Exams	71	84	77.5
Academics	59	67	63
Relationship problems	22	31	26.5
Family Problems	21	31	26
Homesickness	22	26	24

Table 1 Reasons for Stress with Scores for Men and Women and Mean. (Shaikh et al., 2004)

Table 1 shows the number of participants that felt that that a particular area was causing them stress. It was found that exams and academics were the highest contributors to stress among men and women in medical school. This shows how hard school work can be for students and how it can contribute to the stress of students. Stress and fatigue can relate in that they work together a lot of times (Shaikh et al., 2004). Stress can deprive people of sleep and cause them to get fatigued. School work is likely to be a large factor in students' loss of sleep because most of their time spent in school is doing school work. Along with school work most students have some sort of job whether it is a research position in a lab or other work. It will contribute to their sleep loss because they need to manage their school work, work for the research lab and the other parts of their lives.

Work Outside School of and Lack of Sleep

Laberge, Ledoux, Auclair, Thuilier, Gaudreault, Gaudrealilt, Veillette, and Perron (2011) researched the risk factors for work related sleep loss in students with year-round school employment. In this study the average work week for the students was 14.7 hours. It was shown that higher psychological distress, poorer health perception, greater sleep debt, higher exposure to physical work factors associated with sleep loss were being

reported. All of these factors along with multiple jobs were associated with higher levels of chronic fatigue. However, the number of hours that students work was not associated with neither acute nor chronic work fatigue. It was also found that getting good sleep can prevent high levels of acute work-related fatigue (Laberge et al., 2011). This study relates to the current study in that it shows how work outside of school is contributing to sleep loss in students. This study showed it had a great effect on fatigue and the students in the study only worked 14.7 hours a week. When students are not working at their jobs or working on school work they are with friends and family. This time that is spent with friends and family can also lead to students lose sleep.

Social Obligation and Lack of Sleep

Referring back to the study previously mentioned by Shaikh et al. (2004) the researchers showed how relationship problems, family problems, and homesickness can relate back to stress that is felt by medical students. It was found that these areas were not causing as much stress to students as exams and academics, but they were still contributing to fatigue (see table 1). This relates back to the study being done in that it shows researchers that family, and relationship problems can cause an increase in stress which can also cause loss of sleep. By students learning how to manage their time with school work, work outside of school, flight training, and social obligations, they will be better prepared for when they are in work force because they will know to manage their time correctly.

Time Management and Lack of Sleep

Past research has shown that both time management and conscientiousness can be used to predict students' achievements in school. Past research has demonstrated that

time management shares a strong empirical relationship with conscientiousness for middle and high school students with a correlation reported at .57 for the middle school students and .65 for the high school students. Students who have high conscientiousness tend to have more time management strategies including meeting deadlines, organization, and planning. Time management was defined as “a set of habits or learnable behaviors that may be acquired through increased knowledge training, or deliberate practice” (MacCann, 2011, p.619). Conscientiousness was defined as “a broad and over-arching trait, whereas time management is a set of acquired habits” (MacCann, 2011, p.619). Time management and conscientiousness “are strongly linked through factor analysis evidence shows that they are psychometrically direct construct” (MacCann, 2011, p.619). This relates back to the study being done in that it shows how time management can help people be more successful. Which goes to show how time management can be used to help student pilots manage and even prevent fatigue.

Learning how sleep loss due to social obligations, flight training, work outside of school and school work may help student pilots be better able to manage their time and allow them to get more sleep. Along with learning about fatigue, researchers are able to understand why students are losing sleep because sleep loss is a contributing factor to pilot fatigue. School work and flight training take up a large amount of time in student’s lives. In flight training, the student has to spend time working on the book work associated with learning how to fly. Students also learn how to schedule flight time and make with their schedules match the flight instructors schedule. Finally, school work can also cause problems in student’s lives because they will have projects, papers to write and class work.

Making time for social obligations is also difficult to do as a student. Students need to make friends and spend time with their families. When students spend too much time with friends or family it can lead them to be distracted and students can get behind in class work. Along with this, most students work while they are in school. Some have research positions where their work on projects takes up most of their day. These positions are important to students because they give them experience for future jobs. Students have to make time, so they do not fall behind on school work or flight training.

Having good time management skills could help alleviate the problems that student pilots have with getting enough sleep. If student pilots are able to plan out their day, organize their projects, work outside of school, and manage social obligations they are going to be more effective at prioritizing their time. Through this research researchers will have a better understanding of how aspects of student life activities are related to sleep loss. This thesis examines fatigue and contributions to fatigue in a sample of student pilots. Bases on this review of the literature the first hypothesis is that student pilots are fatigued. The second hypothesis is that factors such as social obligations, flight training, school work, and work outside of school contribute to flight students' sleep loss. The third hypothesis is that student pilots at ASU use tools such as planners, calendars, lists, and planning through the week when they are going to do their assignments, exams, and tests.

CHAPTER 3

METHODS

Overview

The survey presented in Appendix A was sent to flight students at Arizona State University through a third party. When the students received the survey, they were given the qualifications, consent form, survey link and a document containing the definitions of terms used in the survey. They were given one week to complete the survey. After one week the researcher closed the survey and did a t-test to determine if the students at ASU were fatigued. Along other t-tests to look at how flight training, school work, work outside of school and social obligations attribute to student pilot sleep loss. Then an ANOVA was done looking how much time student pilots are spending on flight training, school work, work outside of school and social obligations. Then other t-tests were done to look at if the student pilots are using planners and calendars, planning through the week, and if they make lists of their assignments and exams. Finally, it was also looked at if student pilots felt that good time management skills would increase the sleep that they get.

Participants

The student pilots surveyed were from Arizona State University and were 18 years or older. Out of 109 professional flight students who were sent the survey and there were 44 respondents. Nine of the 44 participants were removed because they did not meet the prerequisite for being a student pilot. Three participants did not answer any of the questions. Two participants that were removed because reported hours of flight training and school work were outliers compared to other participants. This meant 32 participants

were used for data analysis. Not all of the participants had a job outside of school so only 17 were used to analyze the impact of work outside of school. One participant did not response to the question on the level of fatigued they experience. Demographics were collected for all responding participants. Their age range was between 18-40 years old. The survey is in Appendix A.

Materials

The survey was implemented in Qualtrics. The survey started by asking the participants their age and if they were student pilots. This determined if they met the prerequisites for the study. A five-point Likert scale was used to ask participants about how the flight training, school work, work outside of school and social obligations were affecting sleep loss and about if they are using time management skills. In addition, how good time management skills could mitigate their sleep loss. Along with the amount of time they are spending on flight training, school work, work outside of school, and social obligations. Lastly, a seven- point scale was used to measure fatigue levels.

Procedure

The survey presented in Appendix A was emailed to flight students at Arizona State University through a third party. When the students received the survey, they were given the survey prerequisites, consent form, survey link and a document of terms and definitions used. Students were given one week to complete the survey. Upon receiving the email students read over the attached materials, then clicked the survey link. This action indicated their consent to participate. They were presented with the survey questions. The survey took 10-15 minutes to complete. Data collection occurred in one week with not follow up.

CHAPTER 4

RESULTS

Figure 1 displays how the student pilots responded to the question about if they were getting 6-8 hour of sleep during the school year. There were 17 student pilots who agreed with the statement that they are getting 6-8 hours of sleep during the school year. There were four participants who responded strongly agree. There were three participants that responded with neither agree nor disagree. There were six participants who responded disagree and two that responded strongly disagree. So, this means that 21 of the 32 participants (66%) are getting 6-8 hours of sleep which is around what people should be getting every night. Alternatively, 34 percent of the students are getting less than 6-8 hours of sleep per night.

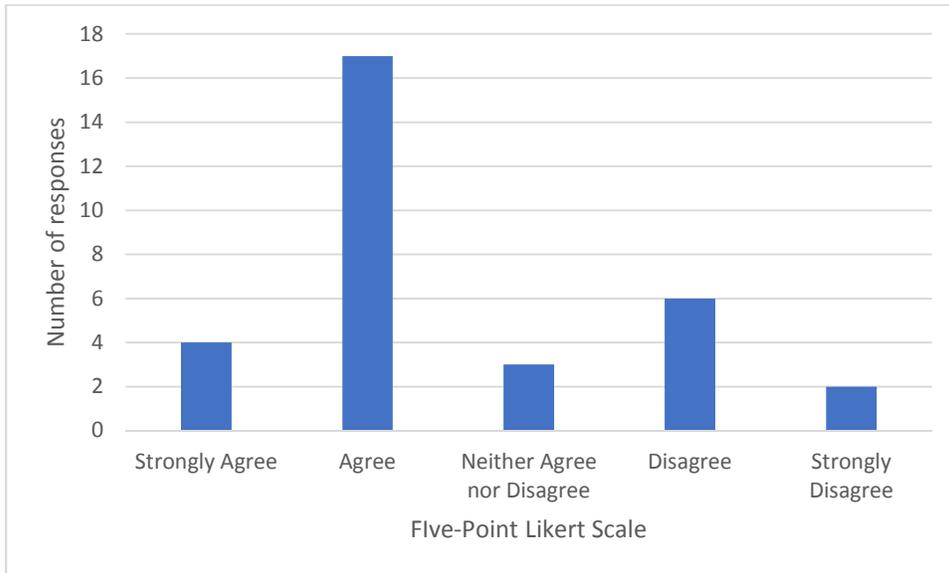


Figure 1 Number of responses for if student pilots are getting 6-8 hours of sleep

A single sample one tailed t-test was done to see if ASU student pilots were fatigued. Fatigue was measured using a seven-point scale that was taken from a study Petrie, et al. (2006) that had looked at fatigue. Students were questioned on how they would

rank their level of fatigue during the school year. The scale is as follows 1= fully alert, wide awake, 2= very likely, responsible, not peak, 3= ok, somewhat fresh, 4= A little tired, less than fresh, 5= Moderately tired, let down, 6= Extremely tired very difficult to concentrate, and 7= Completely exhausted unable to function effectively. Fatigue was defined as responses of four or more and no fatigue was defined as three or less (Petrie, et al. 2006).

The data were tested against three if the responses were one to three this was considered to be not fatigued and then responses that were four to seven had fatigue (table 2). The results of this test were that student pilots are fatigued with mean ratings (M=3.96, SD=1.25) significantly greater than 3, $t(30)=4.31$, SE=0.22 $p= 0.00$ (Table 3). Therefore, hypothesis that student pilots at ASU are fatigued is supported.

Fatigued	Not Fatigued
19 Participants	12 Participants
Mean=4.79	Mean=2.67

Table 2 Number of participants fatigued (<3) and not fatigued (<4) along with mean of each group

Contributors to Sleep Loss

Student pilots were asked about various contributors to loss of sleep. They rated on a five-point Likert scale whether they agree (1) or disagree (5) that time spent in flight training (M=2.19), doing school work (M=2.31), social obligations (M=3.19) or work outside of school (M=3.29) were causing sleep loss. A single sample t-test was done to test the means against a neutral response of 3. Flight training was found to significantly contribute sleep loss, in student pilots ($t(31)=-4.00$, SE=0.20 $p=0.00$) (Table 3). School work was also perceived by students to significantly contribute to sleep loss, ($t(31)=-3.47$, SE=0.20, $p=0.00$) (Table 3). On the other hand, students perceived neither social

obligations ($t(31)=0.86$, $SE=.22$, $p=0.40$) nor work outside of school to be significant contributors to sleep loss ($t(16)=-0.77$, $SE=0.38$, $p=0.45$; Table 3). This means flight training and school work are perceived to contribute to student pilots' sleep loss more so than work outside of school and social obligations.

Category	T-Value	P-Value	Standard Deviation	Number of Participants	Degrees of Freedom	Mean
Flight Training	-4	0	1.15	32	31	2.19
School Work	-3.47	0	1.19	32	31	2.31
Social Obligations	0.86	0.4	1.23	32	31	3.19
Work Outside of School	0.77	0.45	1.57	17	16	3.29

Table 3 Single Sample t-test Results

Figure 4 shows how much time student pilots are spending on average doing flight training, school work, work outside of school and social obligation. Student pilots are spending on average 31 hours on flight training a week. They are also spending 13 hours on average doing school work a week. Student pilots are also spending on average 16 hours a week working outside of school. Finally, student pilots are spending on average 8 hours week on social obligations so spending time with friends and family. However, these means are not significantly different from one another, $F(1,30)=3.18$, $p=0.08$.

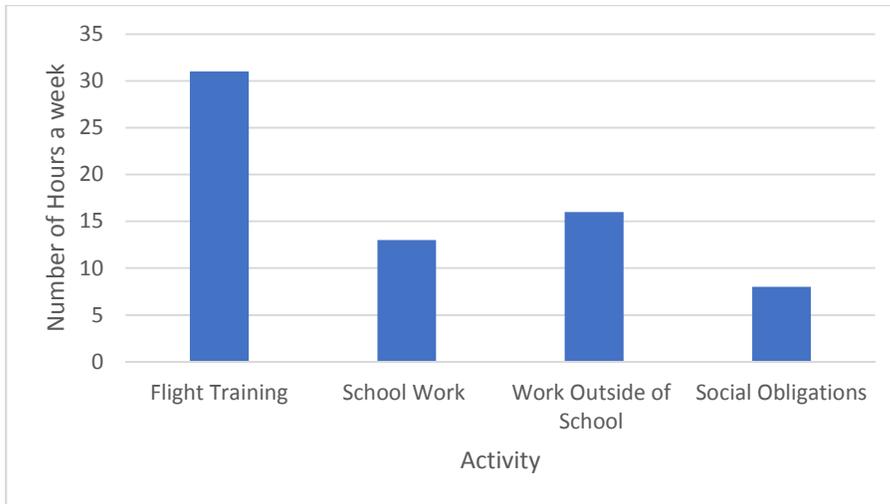


Figure 4 Mean values of the amount of time spent on flight training, school work, work outside of school and social obligations.

Time Management Skills

How do student pilots at ASU use tools such as planners, calendars, lists, and planning through the week their assignments, tests, and exams? A t-test was done on each of the responses to each of these questions (rated on a 5-point Likert scale) compared to the mean value of 3. The questions that were used had students rate their agreement with the following statement: the use of a planner or calendar to organize my schedule would help me with my time management skills, and I plan through the week when I will do assignments or study for exams, I make lists of assignments and when they are due, I feel that having good time management skills would increase the amount of sleep I get.

Student's tendency to use a planner or calendar was found to not be significant ($M=2.03$, $SD=.97$) $t(31)= 0.00$, $SE=.17$ $p=0.50$, as was students' planning plan through the week when they will do assignments or study for exams was found to not be significant ($M=2.34$, $SD=1.00$) $t(31)= 0.02$, $SE=0.18$ $p=0.50$. Students' responses to making lists of the assignments and when they are due was also not found to not be

significantly different from the neutral response of 3 ($M=2.56$, $SD=1.19$) $t(31)= 0.01$, $SE=.21$ $p=.50$.

Along with this these students were also asked about if they felt that having good time management skills would increase the amount of sleep they are getting. A t-test again was done on this to see how student pilots feel about the how having good time management skills would help them get more sleep. The results of the t-test found that student pilots are neutral on the topic of whether good time management skills this will increase the amount of sleep they get ($M=1.75$, $SD=0.83$) $t(31)= 0.00$, $SE=.14$ $p=0.50$. But this does not mean that good time management skills will not increase the amount of sleep that the student pilots are getting. The number of responses to the question on a five-point Likert scale is in figure 5 below.

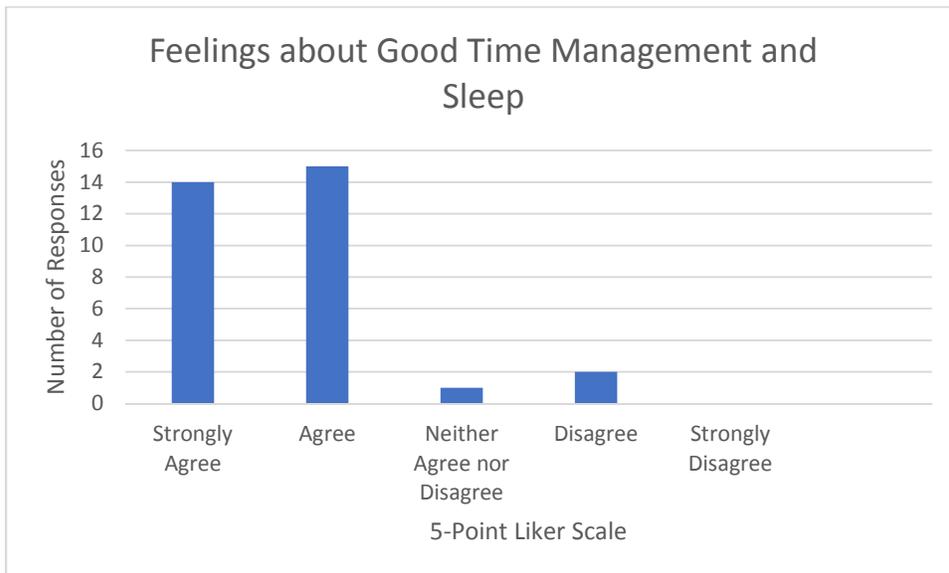


Figure 5 Student Pilot Responses to their Feelings about Whether Good Time Management will Increase their Sleep

CHAPTER 5

DISCUSSION

The findings of the single sample t-test one tailed told the researcher that student pilots at ASU are experiencing fatigue and this is something that will follow them for the rest of their careers. Through other single sample t-tests the researcher found out how student pilots attribute flight training, school work, social obligations, and work outside of school to their sleep loss. Flight training and school work were both found to be significant. Social obligations and work outside of school were found to not be significant in attributing to student pilot's sleep loss.

The researcher found that student pilots are not using tools such as planners and calendars, planning through the week and making lists of their assignments, tests, and exams. Along with this student pilots were asked if they felt that good time management skills would increase the amount of sleep that they would get that they felt that it wouldn't.

With these findings the researcher is able to say that the first hypothesis that student pilots are fatigued is correct that student pilots are fatigue. The researcher supports the hypothesis. The second hypothesis is how student pilots attribute flight training, school work, social obligations, and work outside of school to their sleep loss. It was found that they attributed flight training and school work to their sleep loss but not social obligations and work outside of school. The researcher based on these findings partially accepts the hypothesis since parts of this hypothesis were found to be significant.

For the third hypothesis student pilots spent on average the most time on flight training 31 hours a week, 13 hours a week on school work, 16 hours a week on work outside of school, and finally, 8 hours a week on social obligations. The means were found to not be significantly different from one another.

There were problems with the understanding of the definition of student pilot. Student pilot was something that was never truly defined. The survey was sent to only student pilots, but because they answered no to whether they were student pilots, some respondents had to be removed. It is believed that this is because the students in the flight program receive a certificate calling them a student pilot. So, the people that said they were not a student pilot probably did not have this certificate and so they did not feel that they were a student pilot because of this, impacting the results. Along with this, there were three students that did not answer any of the questions, so they were removed.

Sources of potential bias and threats to the validity of this study would be that the only participants of this study are at Arizona State University Polytechnic campus in the professional flight program. This will affect how well the data of this study can be generalized to other programs around the United States. This is a very specific set of data points of a select population.

The impressions of the measures of this study were good but there were problems for example, the researcher used two different measures number of hours a day and number of hours a week. When the participant was asked the number of hours, they were spending on flight training a day, but then for the questions about school work, social obligations, and job outside of school it was how many hours a week.

The implications for the results of this survey are that researchers have a little bit of a better understanding of how flight training, school work, work outside of school, and social obligations are affecting the sleep loss of student pilots and how time management can play a role in how it can help students with their sleep. This information can also help aid students in getting a better understanding of how important good time management skills can be in helping them, not just now but in the future when they are working in the future. Also, how important getting good sleep can be to them.

Future research that can be done with this topic would be accounting for the stress that student pilots experience. So, the study itself would be similar to the current study, but it would also have questions about the student's stress levels. It could also have a question asking the participants about things that they feel are affecting the amount of sleep that they are getting. Also, something else that could be done would be to see how training the student pilots on good time management along with better management of stress could change the results. Another idea would be is to compare student pilots to non-student pilots to see who would be better at mitigating sleep loss.

The importance of these findings is that there is more research on how flight training, school work, work outside of school and social obligations are affecting sleep loss in student pilots and this can lead to changes within programs to help these student pilots learn skills to help mitigate sleep loss. Along with this this research can be used to help establish the idea that if there was a training or some sort of intervention that can be put in place to help these student pilots learn important skills about how to mitigate sleep loss. By learning these skills early in their career, they would be able to apply these skills

when they get jobs working for airliners so they can be better pilots and help make aviation safer.

This problem is important because fatigue and sleep loss are some of the biggest problems in aviation and one that researchers have been trying to solve since commercial and military aviation has been around. By continuing this research there is a lot that can be learned about what is causing the fatigue in these students along with what can be done to help these students. Through the research that has been done along with the continuation of this research it will help the aviation community as a whole by having educated pilots who know how to make sure they are getting proper sleep.

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APPENDIX A

DATA COLLECTED FEBRUARY 2019

SURVEY INSTRUCTIONS

Qualifications to Participate

*Must be 18 years old

* Must be a student pilot

Definition of Fatigue

Fatigue is a state of physiological state of mind where there is a decrease in mental or physical performance that is the result of a loss sleep, circadian phase, or workload that is causing a reduction in a person's alertness and is disrupting the ability of that person to perform their job (Simons, 2017, p.2).

Definition of Social Obligations

Social Obligations are when students are going out with friends and family. This could be for a meal, movies, parties, and school clubs. This is time spent with friends that is for social interaction and where students are having fun.

Definition of Time Management Skills

Time management skills is the use of planners, schedules, lists, and calendars to organize assignments, exams, and due dates. Along with other techniques that allow for someone to keep on top of assignments, exams and due dates for school work.

Definition of Work outside of school or apart of the university

Work outside of school is jobs that students hold that are a part of the university or work outside of school. These can be jobs that are for labs, graduate researcher or researcher assistant, or work study jobs. These can also be jobs that are for restaurants, shops, or other retail places.

Definition of Flight Training and Classwork

Flight training is defined as work that is spend studying for flight tests, or practice runs for flight test, flight test themselves or other work that is related to getting some sort of pilot's license. Classwork is defined as homework, studying class work for exams or going over information learned in class that day, taking notes, reading chapters in textbooks, or other time that is spent learning information for classes that you are a part of.

Instructions

1. Make sure you meet qualifications to participate in the study these are listed above.
2. Read over definition of fatigue and use this definition provided as a guide when answering questions.
3. Please answer all the questions that you feel comfortable with.
4. This survey should take about 10-15 minutes to complete.
5. By completing this survey, you are giving consent to participate.

Thank you for your participation!

SURVEY

1. Are you a student pilot?
-Yes
-No

2. How old are you
-type in section

3. How many hours a day do you spend doing work (studying or practicing for flight training)? (Type in space the number of hours).
-type in section

4. Rate on the scale below based on the following statement.

I feel that the amount of time that I spend studying for flight training causes me to lose sleep.

Strongly Agree
Agree
Neither Disagree nor Agree
Disagree
Strongly Disagree

5. Rate on the following scale below based on the following statement.

I am getting 6-8 hours of sleep during the school year.

Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
Strongly Disagree

6. How many hours a week do you spend doing school work (this includes homework, studying, doing anything related to school work)?

Type in section

7. Rate on the following scale below based on the following statement.

I feel that the amount of time that I spend doing school work (this includes homework, studying, doing anything related to school work) causes me to lose sleep.

Strongly Agree
Agree
Neither Disagree nor Agree
Disagree
Strongly Disagree

8. How many hours a week do you spend with friends, family, or going to social events

Type in Section

9. Rate on the scale below based on the following statement.

The amount of time that I spend with social obligations friends and family causes a decrease in the amount of sleep I get.

Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
Strongly Disagree

10. Rate on the scale below about the following statement.

The use of a planner or calendar to organize my schedule would help me with my time management skills.

Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
Strongly Disagree

11. Rate on the scale below about the following statement.

I plan through the week when I will do assignments or study for exams.

Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
Strongly Disagree

12. Rate on the scale below about the following statement.

I make lists of assignments and when they are due.

Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
Strongly Disagree

13. Rate on the scale below about the following statement.

I feel that having good time management skills would increase the amount of sleep I get.

Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
Strongly Disagree

14. Do you have a job outside of the university or for the university? If you answer no to this question answer not applicable for question 13 and 14.

-Yes
-No

15. How many hours a week do you work? (If you answered no to question 12 type not applicable in space provided.)

-Type in Section

16. Rate on the following scale about the following statement.

I feel that the number of hours I work a week causes me to lose sleep.

Strongly Agree

Agree

Neither Agree nor Disagree

Disagree

Strongly Disagree

17. How would you rank your level of fatigue during the school year?

Fully alert, wide awake

Very lively, responsible, not peak

Ok, somewhat fresh

A little tired, less than fresh

Moderately tired, let down

Extremely tired very difficult to concentrate

Completely exhausted unable to function effectively

EMAIL FORMAT

Hello [Insert Name]

My name is Mariah Harris and I am working on my master's thesis. The survey attached to this email is looking into how flight training, school work, work outside of school, and social obligations affect student pilots fatigue levels. The survey will take you 10-15 minutes to complete and I would really appreciate your participation in the survey.

Qualifications for participation include

- *Must be 18 years old
- * Must be a student pilot

Instructions

1. Make sure you meet qualifications to participate in the study these are listed above.
2. Read over definition of fatigue and use this definition provided as a guide when answering questions.
3. Please answer all the questions that you feel comfortable with.
4. This survey should take about 10-15 minutes to complete.
5. By completing this survey, you are giving consent to participate.

Thank you for your participation!

Attached to this email are a few documents that you will need to look over before participation. One is the consent form and a document of definitions that will be used for this survey.

You will have 1 week to complete this survey from the day it is sent out.

Survey

https://asu.co1.qualtrics.com/jfe/form/SV_ehMXsLqcAwHiSYR

Thank you
Mariah Harris

CONSENT FORM

Factors Contributing to Self-Reported Student Pilot Fatigue

I am Mariah Harris a graduate student under the direction of Professor Nancy Cooke in the Department/Division/ College of Fulton Engineering at Arizona State University. I am conducting a research study to better understand the affects flight training, school work, work outside of school and social obligations have on the fatigue levels of student pilots.

I am inviting your participation, which will involve taking a short survey that will take you 10-15 minutes to finish. You have the right not to answer any question, and to stop participation at any time.

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty, you do need to be 18 years or older for you to participate in the study. There will be no credit or compensation for participation.

There are no benefits for your participation this is for a master's thesis project, so you will be aiding me in getting my degree with your participation. There are no foreseeable risks or discomforts to your participation.

The survey is being sent out via a third-party Greg Files. I will not be given any information about participants names or any other information. I will only see the results of the survey. Confidentiality will be maintained, and your responses will be anonymous. The results of the survey may be used in reports, presentation or publication but your name will not be a part of the information given.

If you have any questions concerning the research study, please contact the research team at: Mariah Harris mjharr11@asu.edu and Nancy Cooke Nancy.Cooke@asu.edu. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788. Please let me know if you wish to be part of the study

Through the completion of the survey your giving consent to participate in the survey.

DEFINITIONS SHEET

Definition of Fatigue

Fatigue is a state of physiological state of mind where there is a decrease in mental or physical performance that is the result of a loss sleep, circadian phase, or workload that is causing a reduction in a person's alertness and is disrupting the ability of that person to perform their job (Simons, 2017, p.2).

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