The Relationship Between Nicotine Withdrawal Symptoms and Nicotine Habits in Pilots

by

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ABSTRACT

Nicotine and tobacco use, whether it be through cigarette smoking or other devices, creates negative health conditions in pilots. The literature that was reviewed pertained to nicotine withdrawal symptoms and their negative impact on pilot performance. There have been studies conducted in order to explore how these symptoms impact pilot performance using cigarettes as the only nicotine device and does not specify the nicotine levels or the frequency of use. This thesis extends this work to examine the relationship between the nicotine withdrawal symptoms and the nicotine behaviors of pilots. It was hypothesized that the extent of withdrawal symptoms may differ by device and by nicotine levels and frequency of use, with higher levels and more frequent use being associated with more severe withdrawal symptoms. These behaviors included the device they use to take nicotine whether it be cigarettes, vaporizers, e-cigarettes, or smokeless tobacco. The behaviors also included exploration of how nicotine levels relate to withdrawal symptoms whether the nicotine level is as low as 3mg or high as 36mg. The last relationship that was explored was that between the withdrawal symptoms presented in pilots and how often they used nicotine, whether it be often as every day or less frequent as 1-2 times a year. It was found that there is no statistical relationship between nicotine withdrawal symptoms and the nicotine habits such as device used, nicotine level used, and frequency of use.

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INTRODUCTION

Overview of the Problem

The reasons for nicotine and tobacco use varies. In most cases, the influence of these substances on daily performance will not greatly impact people's lives. The same cannot be said for pilots. Pilots work in environments unlike any other and can be susceptible to different types of health risks and physiological taxes. Literature was reviewed on the negative health effects and withdrawal symptoms of nicotine and tobacco use to show how the effects impact pilots. Studies have been conducted on pilots to understand the withdrawal symptoms associated with smoking cigarettes. These studies did not pertain to the specific involvement of nicotine or differing devices used for the ingestion of the substance. Further, the studies never resulted in new regulations, only the need for nicotine and tobacco cessation programs.

Motivation and Background

For over 2,000 years, tobacco and nicotine have been present in America. The tobacco industry was steadily growing in the 1700s and flourished in the late 1800s when mass-produced cigarettes were made possible with the patenting of a machine (Felman, 2018). There were many signs throughout history pointing to the dangerous properties of tobacco and nicotine. Tobacco was introduced as an insecticide in 1763; in 1828, nicotine was identified as a poison when isolated from the tobacco plant; in 1890, 26 states had banned nicotine sales to minors; in 1964, the Surgeon General created a study linking heart disease and lung cancer with smoking; and, in 1994, the U.S. Food and Drug

Administration (FDA) officially recognized nicotine as a substance that created drug dependency (Felman, 2018). It was not until 2009 when the Supreme Court granted the FDA control over nicotine regulations (Felman, 2018).

The exact number of pilots who smoke is unknown, and, as of now, nicotine users can become pilots. Pilots work in areas of reduced atmospheric pressures, making the resultant compromised lung functions from smoking less than ideal. Although symptoms differ with each person, cigarettes can affect alertness as well as vision and sleep habits. By February 25, 1990, the federal government banned smoking cigarettes on airplanes on almost every domestic flight. Ten years later, smoking was banned on both international and domestic flights (Sharkey, 2015). According to FAR 135.127, passengers and crew members abide by different rules when it comes to smoking aboard commuter aircraft, and there are situations in which a pilot is allowed to smoke on the flight deck (Cornell Law School, n.d.). Pilots smoking on the flight deck pose safety concerns, such as improperly extinguished cigarettes or exposure to secondhand smoke. Unfortunately, the walls of the flight deck are not impenetrable and do not keep smoke from escaping into the cabin of the aircraft where the passengers reside and cause exposure to secondhand smoke. This very issue has been a reality, as illustrated by Olympic Airlines Flight 417, where a passenger who was asthmatic and sensitive to secondhand smoke was seated too close to the escaping smoke in the aircraft despite repeated requests to be moved to a different seat (Justia US Supreme Court, 2004). This passenger ended up dying due to his pre-existing medical condition being aggravated from exposure to the cabin environment.

Nicotine and tobacco use are part of the leading cause of preventable cancer. There are an estimated 12.7 million tobacco users in the world, with about 5.4 million related deaths each year. The central cause of addiction among tobacco users is nicotine (Mishra et al., 2015). In 2010, the Surgeon General concluded nicotine to be just as addictive as cocaine or heroin. Many studies have found nicotine to negatively affect organs as well as systems in the human body, including cardiovascular, respiratory, renal, and reproductive (Mishra et al., 2015). It can also affect insulin resistance and cause predisposition to metabolic syndromes and diabetes, which illustrates the negative effects of nicotine across many body processes. According to Mishra et.al (2015), due to nicotine's negative effects, such as increased risk of cardiovascular, respiratory, and gestational disorders, the sale and distribution of nicotine should be under the supervision of trained medical professionals.

Nicotine has negative withdrawal effects. The FAA officially banned smoking on all aircraft in "scheduled passenger interstate, intrastate and foreign air transportation" in 2000 (Goldner, 2000). Therefore, pilots who are flying long-distance flights often are not able to smoke cigarettes, use electronic cigarettes, or use smokeless tobacco. According to the FAA, tension, irritability, trouble concentrating, decreased heart rate, lower blood pressure, and impaired performance are some of the most significant effects from nicotine withdrawal (n.d.). These withdrawal symptoms could contribute to poor pilot performance and could result in a lapse in safety. When a pilot is tense or irritable, they likely will not be focusing on flying. Trouble concentrating inhibits the pilots' ability to perform their duties in the cockpit. In addition, other disturbances can occur, such as decreased heart rate and lower blood pressure, which can cause a pilot to become dizzy or

lightheaded, causing slower performance and lack of attention to tasks at hand (Mayo Clinic Staff, 2018a).

Even without the direct negative effects of nicotine, there are also the negative withdrawal effects. Pilots who are flying long-distance flights often are not able to smoke or use an electronic cigarette or use smokeless tobacco. These withdrawal symptoms could attribute to poor pilot performance and result in a lapse in safety. Withdrawal symptoms do not only occur for nicotine users who are trying to stop the habit; nicotine withdrawal symptoms can occur between 4 and 24 hours after a person smoked their last cigarette (McLaughlin, Dani, Biasi, 2015). Two hours after the last cigarette, the body has often removed half of the nicotine (Fagerstrom, 2014). Nicotine withdrawal or nicotine dependence is fast-acting and can occur in those who continuously exploit nicotine.

Past studies have created a gap in knowledge. The studies examined took place in 1983 and 2003, both of which only focused on the withdrawal effects of cigarettes rather than nicotine as a whole. The studies have simply created a need for additional information to be unearthed. At that time, in 1983, there was not a lot of research done on the negative effects of smoking cigarettes. Cigarettes were also the main focus for negative health impacts. There were no studies conducted for pilots based solely on nicotine versus cigarette smoking alone. This parameter did not change in 2003, as the primary factor remained to be cigarette smoking. Nicotine withdrawal effects should be investigated using various nicotine and tobacco devices, subjective symptoms, and frequency of use.

There is a wide collection of data that focuses on the negative effects of smoking on the health of the human body. The data that was referred to focused on the health effects of nicotine, withdrawal symptoms of nicotine, the dangers of the physiological effects of smoking withdrawal, and experimental studies of the impact of smoking withdrawal on pilot performance. There was a need to conduct additional research on other methods besides cigarette smoking withdrawal. There needed to be more emphasis on other means of nicotine intake and whether the chosen device and the amount can change the withdrawal effects. There was also a lack of information regarding various levels of nicotine and their relationship with withdrawal symptoms. The data collected should indicate whether nicotine withdrawal symptoms remain constant throughout multiple devices, whether frequency of nicotine use changes withdrawal symptoms, and if nicotine levels effect withdrawal symptoms. It is hypothesized that withdrawal symptoms in pilots are present regardless of the type of nicotine intake, frequency, or nicotine level.

Chapter 2

LITERATURE REVIEW

The Framework

The main topic of the research is exploring the affect of nicotine behaviors on withdrawal symptoms in pilots. The literature that was reviewed provides background for the research question. The effects of nicotine and tobacco on the health of pilots was

explored. The essential framework for the literature investigated how tobacco and nicotine have long-term effects on pilot health and then how withdrawal symptoms can have short-term effects on pilot performance. This literature is reviewed in order to provide additional information on how tobacco and nicotine can disrupt the body processes. Some of these disruptions, although unfavorable in normal circumstances, can have truly injurious consequences for pilots in flight. In addition, studies regarding nicotine use by pilots have focused primarily on cigarette use. Cigarettes are not the only way for nicotine to be consumed, and it is not the only means pilots are using either. It is important that the data cover information about nicotine devices being used to understand individual effects and how nicotine's destructive presence remains. The data reviewed discusses the specific impact that cigarette smoking can have on pilot health and performance. This leads to information about other tobacco and nicotine intake that occurs and the individual concerns and effects other devices cause. Next, withdrawal symptoms are viewed in order to set a framework for the research conducted. This information is used in order to understand the reasons for the reviewed studies and programs that were conducted. The studies in the literature provide an example of how the negative impact of nicotine and tobacco has initiated other reviews. The studies also show that there is a need for additional research in terms of use, withdrawal symptom identification, and pilot performance.

Cigarette Smoking

The negative effects of nicotine and tobacco have been documented countless times throughout history. The FAA has a list of disqualifying medical conditions that declare a pilot unfit. Some of the conditions include: bipolar disease, coronary heart

disease, diabetes mellitus requiring hypoglycemic medications, heart replacement, heart attack, substance abuse, and drug abuse (FAA, 2016, p. 17-2). Listed in the disqualifying medical conditions are substance and drug abuse, which begs the question: why nicotine, tobacco, and cigarette use are not included in this "condition". These substances are not only hazardous to human health, but they are extremely addictive. Addictive substances will become habit-forming and will result in dependency. Substance dependence can lead to substance abuse.

Some noticeable FAA disqualifying medical conditions include coronary heart disease, diabetes mellitus, heart replacement, and heart attack. These medical conditions stand out because those who smoke cigarettes or abuse tobacco and nicotine are at a great risk for these listed health conditions. As far back as 1973, it was documented that cigarette smoking is linked to myocardial infarctions or heart attack and can lead to death from coronary heart disease (Aronow, 1973). Additionally, smoking nicotine cigarettes, regardless of the level, causes increased systolic blood pressure and increases the blood oxygen demand. Smoking nicotine decreases the amount of oxygen available for the tissues in the heart (Aronow, 1973).

Smoking cigarettes further increases the negative health risks of nicotine and tobacco. Cigarette smoking harms nearly every organ in the human body, increasing the risk of cancer, almost anywhere in the body, from the throat, to the bladder. Smoking causes about 90% of all lung cancer deaths and 80% of deaths from chronic obstructive pulmonary disease (COPD) (CDC, 2018b). A pilot who smokes cigarettes is decreasing the amount of oxygen that not only is available for their heart, but for their entire body. A pilot requires additional oxygen in order to perform at higher altitudes. In addition, as

altitude increases, night vision degrades due to the reduced pressures of oxygen (FAA, 2016, 17-24). Therefore, a smoker's night vision will degrade even faster due to having a lower starting oxygen saturation level. Pilots often fly at night. If a pilot has degraded night vision, it will be more difficult for them to conduct required tasks, recognize traffic, and land the aircraft safely.

Pilots are often in areas of lower pressure where it becomes more difficult for oxygen to be supplied throughout the body. If a pilot who smokes is subject to an area of low pressure, they are more likely to get carbon monoxide poisoning. Humans need their blood to transport oxygen in order to maintain consciousness and proper metabolic activity (DeHart, p.93, 1994). Smoking and carbon monoxide (CO) are of interest in aviation due to carbon monoxide's ability to bind 200 times more easily to hemoglobin than oxygen (DeHart, p.93, 1994). A smoker could have 7% carboxyhemoglobin on the ground, which is equal to a 93% oxygen saturation level (DeHart, p.93, 1994). Thus, a smoker at ground level would have the same oxygen saturation level on the ground as a non-smoker at 8,000 ft, causing a smoker to decrease their blood oxygen level before conducting flight operations (DeHart, p.93, 1994). The more cigarettes a pilot has during the day, the more likely they are to get carbon monoxide poisoning. As the duration of smoking increases, CO levels in smokers increase (Deveci, Deveci, Açik, Ozan, 2004). The longer a pilot smokes, the more likely they are to get carbon monoxide poisoning. Carbon monoxide can cause a person to become weak, dizzy, nauseated, confused, and lose consciousness (Mayo Clinic Staff, n.d.). In addition, as altitude increases, night vision degrades due to the reduced pressures (FAA, 2016, p. 17-24). Therefore, a smoker's night vision will degrade even faster due to having a lower starting oxygen

saturation level. A study in 2004 was conducted in order to prove an effective way to confirm a patient's smoking status and/or habits. It was found that the amount of carbon monoxide exhaled in smokers versus non-smokers was significantly higher (Deveci, Deveci, Açik, Ozan). The study found there was a positive correlation between daily cigarette consumption and CO levels as well as between the duration of smoking and CO levels (Deveci, Deveci, Açik, Ozan, 2004).

Pancreatic cancer is a major concern for smokers. The most common type of pancreatic cancer is pancreatic ductal adenocarcinoma (PDAC). Less than 5% of those diagnosed with PDAC live past 5 years from the date of diagnosis (Pandol, Apte, Wilson, Gukovskaya, Edderkaoui, 2012). Tobacco smoking is one of the major risks in contracting PDAC, with nearly one-fourth of pancreatic cancer deaths linked to tobacco and adults, on average, lose 13-15 years from their life expectancy (Pandol, Apte, Wilson, Gukovskaya, Edderkaoui, 2012). There are more than 7,000 chemicals in tobacco smoke, 250 of which are harmful, and 60 of those are carcinogens which are cancer-causing agents (Pandol, Apte, Wilson, Gukovskaya, Edderkaoui, 2012). Nicotine is a harmful and major component found in tobacco, and although it is not carcinogenic on its own, when it metabolizes, it has been found to produce other cancer-causing agents. When nicotine reaches the lungs during smoking, it absorbs into the bloodstream, metabolizes, and can make its way into the pancreas along with the carcinogenic agents (Pandol, Apte, Wilson, Gukovskaya, Edderkaoui, 2012).

Smoking tobacco is very dangerous to cardiovascular health and is a major cause of cardiovascular disease. Smoking accounts for about one in four deaths from cardiovascular disease (CDC, 2014a). Cardiovascular disease is the leading cause of

death in the U.S., amounting to over 800,000 deaths per year. The chance of cardiovascular disease increases with the number of cigarettes smoked each day, as well as long-term smoking (CDC, 2014a). The chemicals found in cigarette smoke alters the blood vessels in the body, causing them to become inflamed or narrowed (CDC, 2014a). The negative change in the blood vessels can lead to other cardiovascular conditions. The first condition that can occur is atherosclerosis, which can cause arteries to narrow, causing plaque to build up, in turn, reducing blood from flowing to different regions in the body (CDC, 2014a). Coronary heart disease can also occur due to plaque buildup in the arteries, and the chemicals in cigarette smoke can lead to blood thickening and clots forming in veins and arteries. These clots can create a blockage, leading to cardiac arrest and death (CDC, 2014a). When the blood flow is interrupted in the body, a stroke can occur, resulting in a loss of brain function and can cause permanent brain damage. The lack of blood flow can also lead to peripheral arterial disease (PAD), where different limbs and parts of the body aren't able to receive the oxygen in the blood to function (CDC, 2014a). In some cases, when the limb becomes too deprived, it has to be removed. Smoking can cause early damage to the abdominal aorta, which is the main artery that brings blood throughout the body. The damages inflicted by cigarette smoke can create a weak area in the aorta and lead to an aneurysm (CDC, 2014a). This is a life-threatening condition. The majority of deaths caused from aortic aneurysms are smoking related (CDC, 2014a).

Other Types of Tobacco and Nicotine Intake

The most common way to consume tobacco and nicotine is through smoking, though other methods exist and are gaining popularity. It is often perceived that

smokeless tobacco products, such as chewing tobacco, or “dip”, is a safer alternative to smoking cigarettes. The risks still remain with the smokeless alternatives and introduce new risks independent of smoking tobacco (Mayo Clinic Staff, 2017). The Chewing tobacco is the most common smokeless tobacco product and can be chewed, sucked on, or sniffed. Nicotine is still present in this product and is absorbed into the body through the soft tissue in the mouth (Mayo Clinic Staff, 2017). Therefore, smokeless products still harbor tobacco, and although lung cancer isn’t likely, it can lead to an increased chance of oral cancer in the mouth, throat, cheek, gums, or lips. Tobacco is still being introduced to the body and can cause other issues such as dental disease due to the increased contact of tobacco on a person’s teeth and gums (Mayo Clinic Staff, 2017). A less obvious risk would be an increased chance of heart disease due to the rise in heart rate and blood pressure from smokeless tobacco products. In addition, nicotine is still present as an addictive agent in the product and can be just as addictive as cigarettes (Mayo Clinic Staff, 2017). The nicotine is still present in the bloodstream, and those who use smokeless tobacco products are often exposing themselves to more nicotine throughout a day than cigarette users. It has been found that there is more nicotine in dip than in cigarettes, and the nicotine can often stay in the bloodstream longer, making it harder to quit (“The dangers of dip”, n.d.). The “high levels of dependence” will create negative withdrawal symptoms similar to cigarette users (Mayo Clinic Staff, 2017).

Electronic cigarettes (E-cigarettes) and vaporizers are still new to the medical world, and there has yet to be any official research or knowledge on the health effects of these devices. E-cigarettes have become the “most commonly used tobacco product among youth” (CDC, 2018a). Evidently, e-cigarettes do not use tobacco combustion, but,

rather, nicotine and other components are converted from liquid, found in cartridges, into small particles as an aerosol. The aerosol is inhaled by the user. (Callahan-Lyon, 2014). These devices appear to be less harmful due to the lack of burned toxins, however, there may be links to negative exposures through the aerosol substance (Callahan-Lyon, 2014). According to the Centers for Disease Control and Prevention (CDC), the substances in an e-cigarette aerosol include nicotine, ultrafine particles inhaled deep into the lungs, diacetyl, which is a chemical flavoring known to lead to lung disease, volatile organic compounds, cancer-causing chemicals, and even heavy metals such as nickel, tin, and lead (2018a).

The CDC reported that some e-cigarette products that claim to have no nicotine have been found to contain nicotine (2018a). Nicotine is "absorbed through the airway, skin, mucous membranes, and gastrointestinal tract" (Callahan-Lyon, 2014). Cigarette users rarely face cases of nicotine poisoning, but e-cigarette users' chances increase due to the "high-nicotine concentrations" found in the device cartridges (Callahan-Lyon, 2014). This problem increases with inconsistent product labelling. Studies were conducted to test the reliability of the labels, and liquid was purchased from online and in-person retail stores. The liquid ranged from 14.8-87.2mg/mL of nicotine, and the measure concentration differed by 50% from the labeled concentration (Callahan-Lyon, 2014). Despite various studies on the nicotine content inside e-cigarettes, there is still inconclusive data about the overall effects.

Withdrawal Symptoms and Effects

Nicotine can cause temporary euphoric physiological and psychological sensations. The feelings encourage the user to continue ingesting tobacco and/or nicotine.

When the substance is continuously used, it results in dependency (Mayo Clinic Staff, 2018b). The most common withdrawal symptoms are nicotine cravings, anger or irritability, anxiety, depression, and weight gain. Other symptoms that have been reported include nausea, headaches, coughing, sore throat, trouble sleeping, difficulty concentrating, and depressed mood (Burke & Gotter, 2018). About half of smokers experience at least four withdrawal symptoms when they try to quit (National Cancer Institute, 2010).

According to the National Institute on Drug Abuse, nicotine withdrawal symptoms are evoked due to the addictive nature of nicotine (2018). When nicotine is used a brief surge of endorphins is emitted in the brain and increases levels of dopamine which reinforces the nicotine behavior. When nicotine is repeatedly used, the user's dopamine sensitivity is altered, which effects learning, stress, and self-control (NIDA, 2018). Dependence is when the body becomes used to nicotine being in the system, causing withdrawal when nicotine is taken away. According to NIDA, symptoms can occur such as "irritability, craving, depression, anxiety, cognitive and attention deficits, sleep disturbances, and increased appetite" (2018). These symptoms can occur within a few hours, which leads to continued use of the tobacco or nicotine. Withdrawal symptoms can continue for a few weeks or even months (NIDA, 2018). Nicotine levels peak within 10 seconds and can temporarily boost cognitive functions. However, the long-term effects are "associated with cognitive decline" and those in withdrawal have diminished attention spans or memory (NIDA, 2018). Therefore, the pleasurable effects of nicotine can only be sustained with continued use and can have negative short-term as well as long-term effects.

Nicotine and Tobacco Induced Illnesses

In 2018, a study was conducted on the association between smoking and hypoxic conditions with inflammatory and autoimmune diseases. The study showed significant evidence that hypoxic conditions can result in altered immune system activity (Hussain, Tripathi, 2018). The altered immune system activity occurred in the form of increased cellular components of the immune response. This response can result in auto-inflammatory and auto-antibody generation. It was found that hypoxia and smoking, when combined, pose a strong environmental risk factor for inflammatory and autoimmune diseases (Hussain, Tripathi, 2018).

In 2014, the Surgeon General found that smoking can be a direct cause of type 2 diabetes. Smokers have a 30-40% greater chance of developing diabetes than non-smokers (CDC, 2014b**)**. The risk of developing type 2 diabetes increases with the total number of cigarettes smoked per day. Smoking has been found to increase inflammation, oxidative stress, and is associated with a higher risk of abdominal fat (CDC, 2014b). Both inflammation and oxidative stress interferes or causes damage to the body's cells, and belly fat encourages the production of the hormone cortisol, which increases blood sugar. It has also been found that the exposure to nicotine reduces the effectiveness of the hormone insulin, which helps lower blood sugar levels (CDC, 2014b). The inability to use insulin in the body can lead to diabetes.

In 2015, a study was conducted by researchers from Harvard T.H. Chan School of Public Health, Huazhong University of Science and Technology in China, and National University of Singapore regarding the exposure to smoking and secondhand smoke, which can lead to increased risk for type 2 diabetes (Fischer, 2015). The researchers

conducted an analysis of 88 previous studies with data from over 6 million participants. They found that more than 27 million cases of type 2 diabetes may be credited to active smoking (Fischer, 2015). Those who were former smokers had an increased chance of contracting type 2 diabetes by 14 percent, while those exposed to secondhand smoke had an increased chance of 22 percent (Fischer, 2015). Not only are smokers more at risk of contracting diabetes than non-smokers, but the risk of diabetes increases with the number of cigarettes smoked per day. Former smokers would be those who used to smoke and no longer smoke, light smokers would suggest an estimated 0-19 cigarettes per day, while heavy smokers were considered 20 or more cigarettes per day (National Center for Chronic Disease Prevention, 2014). The relative risk of contracting diabetes increases with the number of cigarettes smoked.

Increased insulin resistance can occur in those who smoke, whether they have diabetes or not (Gunton, Davies, Wilmshurst, Fulcher, & McElduff, 2002). Smoking also has negative effects on those who already have diabetes, leading to increased chances of diabetic incidence, aggravation of glucose homeostasis, and chronic diabetic complications (Chang, 2012). Smoking leads to conditions that make a person more prone to diabetes as well as further aggravate symptoms in those with a diabetic condition. Considering diabetes can be a disqualifying medical condition, the FAA should want to reduce the chances of a pilot contracting the disease.

Previous Studies and Cessation Programs

The U.S. Military strives to discontinue the use of tobacco and nicotine through the use of cessation programs. In 2002, the United States Air Force (USAF) sent out a medical command for tobacco use in the Air Force. This was a health promotion to

establish procedures for tobacco use in Air Force buildings, facilities, vehicles, and aircraft (Carlton, 2002). The policies were established. There were new commanders to enforce policies, medical care providers to ask about tobacco use during each encounter, and medical treatment facility commanders to provide "tobacco product cessation classes" to active-duty members, family members, and retirees. This was all done for the goal to create a tobacco-free environment within the Air Force (Carlton, 2002). Despite the USAF's procedures and new installments, the use of smokeless tobacco in the USAF exceeded that of civilian use. In 2016, it was found that 16% of USAF Airmen had used smokeless tobacco products and 10% regularly used smokeless tobacco (Linde et al., 2016).

In 1983, the FAA authorized research on the effects of smoking withdrawal on complex performance and physiological responses. This stemmed from the 1976 petition introduced to the FAA to prohibit all smoking on the flight deck during all commercial operations and to ban smoking by the commercial flight crew within an 8-hour time period before flight operations (Mertens, McKenzie, & Higgins, 1983). At the time, scientific evaluations found that the adverse effects of smokers' health, carbon monoxide levels, and nicotine levels of smokers did not have a significant effect on flight performance for healthy pilots. Other studies that focused on withdrawal symptoms concluded that these symptoms, which included depression, irritability, difficulty concentrating, decreased heart rate, falls in blood pressure, and changes in brain activity, presented the need for additional research on its effects at cabin altitude (Mertens, McKenzie, & Higgins, 1983). The experimentation was conducted at a cabin altitude of 6,500 feet, and it was found that complex performance was adversely affected by

smoking withdrawal. It was also found that when subjects were able to smoke, they were able to maintain their level of performance over a 4-hour testing period (Mertens, McKenzie, & Higgins, 1983). When the subjects were barred from smoking, their performance worsened over the testing period. It was found that the pilots had trouble tracking and noticing red lights in the cockpit. These factors were considered insignificant until other studies were conducted on tracking performance. The participants also had reduced alertness. A significant degradation of performance was found, creating concerns that cigarette withdrawal can create safety risks. (Mertens, McKenzie, & Higgins, 1983).

The study stated, "the present findings add to the body of evidence demonstrating important adverse effects of short-term smoking withdrawal on performance at a simulated operational air carrier altitude" (Mertens, McKenzie, & Higgins, 1983). Despite this study, the FAA still believed that smoking should not be banned from the flight deck, nor did it provide any recommendations to prevent performance degradation due to withdrawal effects. The FAA, rather, recommended that smoking-cessation programs were the better choice (Mertens, McKenzie, & Higgins, 1983). Despite findings that smoking withdrawal adversely affected performance in the aircraft, there were no further recommendations. Thus, it was concluded by this study that smoking caused adverse withdrawal symptoms, but it was never directly associated to nicotine or any device other than cigarettes (Mertens, McKenzie, & Higgins, 1983).

In 2003, another study was conducted to research the effects of nicotine withdrawal on pilots during flight. This study was conducted using only male aviators, who were regular smokers, and who were pilots of military fixed-wing and rotary-wing

aircraft (Giannakoulas, Katramados, Melas, Diamantopoulos, & Chimonas, 2003). This was another study that was based solely on the exclusivity of cigarette smoking. These pilots were given a 12-hour abstention from smoking while performing flight duties (Giannakoulas, Katramados, Melas, Diamantopoulos, & Chimonas, 2003). The study concluded that short-term withdrawal of nicotine "may be detrimental to flight safety" and "may influence flying parameters" (Giannakoulas, Katramados, Melas, Diamantopoulos, & Chimonas, 2003). This study provides applicable information to the research question, but it does not provide information on additional nicotine uses, devices, or frequency.

Summary and Hypotheses

The data that has been collected over time regarding tobacco and nicotine use have created a necessity for pilot-involved studies. Pilots have a unique environment in which they work, therefore, the effects that have been identified can jeopardize flight operations. It is shown through the literature that the negative health effects of nicotine and tobacco have been thoroughly studied, including the implications on pilots. The studies conducted have not proven to be enough to achieve an agreement or regulation for nicotine use in pilots and have not explored the effects of nicotine habits on withdrawal symptoms. The literature explores the negative effects of nicotine on pilots and its effect on pilot performance. Central to these effects are nicotine withdrawal symptoms which can pose challenges specific to pilots who are often at work for extended periods without nicotine. There is a lack of research on the behaviors of pilots using nicotine and how these behaviors are associated with their withdrawal symptoms whether it be the way they intake nicotine, how often they use nicotine, or the level of nicotine.

This investigation was accomplished through a survey, designed and conducted to measure withdrawal symptoms of nicotine users and the relation between these symptoms and various nicotine use behaviors. Specifically, the survey that was created examined the type of nicotine intake, the frequency of nicotine use, and the respondent's normal nicotine level. The information produced findings applicable to the impact of nicotine habits in pilots and withdrawal symptoms. The research was conducted to expand on the general knowledge of nicotine effects on pilots.

The survey was intended for any pilot who uses nicotine regardless of the vehicle in which they intake nicotine or how often. Nicotine devices and frequency of use were an important component to the research because they provided an additional layer of information in how nicotine can affect an individual's withdrawal symptoms. Studies that have been conducted in the past used the same nicotine device, and the same testing period or nicotine abstention time. This study allows another dimension to view nicotine effects from different uses and applications. This information could be used to understand how, and if, withdrawal symptoms increase under certain circumstances. It can also inform whether future nicotine regulations should have specific parameters set, as opposed to an overall ban. It is hypothesized that nicotine withdrawal symptoms reported will depend on the nicotine implement used, nicotine levels, and frequency of nicotine use.

Chapter 3

METHODOLOGY

Participants

Forty pilots who self-reported nicotine use and who were 18 years of age or older responded to this survey. The survey was distributed anonymously using various contacts who were able to send out the survey to an unknown number of pilot respondents. The age of the participants varied from 18 years old, to over 75 years old, with half of the participants between the ranges of 18-24 years old.

Survey

Appendix A includes a copy of the survey questions as presented to the participants. The survey was designed to collect information about the participants' general nicotine habits and the effects they feel when those habits cannot be maintained. The participants were able to answer as many or as few questions as they deemed necessary, as none were required for them to submit the survey. The first two questions regarding whether the participant was a pilot and whether they used nicotine were included to restrict the sample to pilots who used nicotine.

The participants were asked to provide information on their specific nicotine devices. This was included to provide insight on whether the device used had some impact on withdrawal symptoms. Another question that served to find the relation between withdrawal symptoms and behavior, asked for the participant's level of nicotine in their device. Another question was designed to find the relationship between withdrawal symptoms and the frequency of use by asking the participants how often they

used their nicotine device. The participants were also asked to provide the nicotine levels they used in their devices. There were several questions given on the 5-point Likert scale regarding common withdrawal symptoms and if the participants were often afflicted with the presented symptoms and to what degree. The symptoms include difficulty concentrating, nicotine cravings, trouble sleeping, hunger, sluggish/tired, irritable/angry, headache, nausea, and anxiety/restlessness. The scale was included for these symptoms in order to assess how much a pilot is affected by their symptoms.

Participants were also asked the degree to which their symptoms affected them as a whole. The question presented the statement that the participant had no discernible symptoms. This question allows the participants to ascertain whether the symptoms are detrimental to their daily activities. The participants were asked whether they believed their withdrawal symptoms inhibited their daily performance to further evaluate the participants' individual effects and opinions. These questions were designed to provide insight into whether the symptoms are benign or if they can cause a more concerning lapse in safety. A viewpoint question was included in the survey which was the opinion of whether nicotine should be regulated, giving insight to pilots' views of nicotine regulation.

Chapter 4

RESULTS

The common nicotine withdrawal symptoms were explored alongside the frequency of nicotine use, devices used, and nicotine levels presented. It was important to understand if the device used to intake nicotine, the level of their nicotine, or how often they use nicotine was related to the substance's negative withdrawal effects. Pilots have different views about what affects their own performance and whether a risk is acceptable. The entire survey is based on pilots who use nicotine and can identify their own symptoms. The main focus for the survey was understanding if pilots' withdrawal symptoms differed with nicotine intake behavior.

The devices that were being used by the participants ranged from cigarettes (n=11), vaporizers (n=13), e-cigarettes (n=13), smokeless tobacco (n=13), Juul, which is another type of e-cigarette, (n=2), and cigar, with seldom use, (n=1), as shown in Figure 1. Several of the respondents used multiple nicotine devices. This was an interesting piece of data to see how some participants will use multiple devices habitually, and a large portion of respondents used some type of e-cigarette or vaporizer. According to Figure 2, the participants were relatively younger in age and there was an even distribution of nicotine devices between e-cigarettes, smokeless tobacco, and cigarettes. The participants who smoked cigarettes ranged from less than 1 per day, to 15-20 cigarettes smoked each day, illustrated in Figure 3. The number of cigarettes smoked per day can also point to the amount of nicotine intake by the participants. Figure 4 illustrates the level of nicotine that e-cigarette, vaporizer, and Juul users consumed. The majority of

the participants used 36mg/mL or 6mg/mL. Most vaporizer and e-cigarette users used 1mL-5mL of their nicotine liquid per day on average, as shown in in Figure 5.

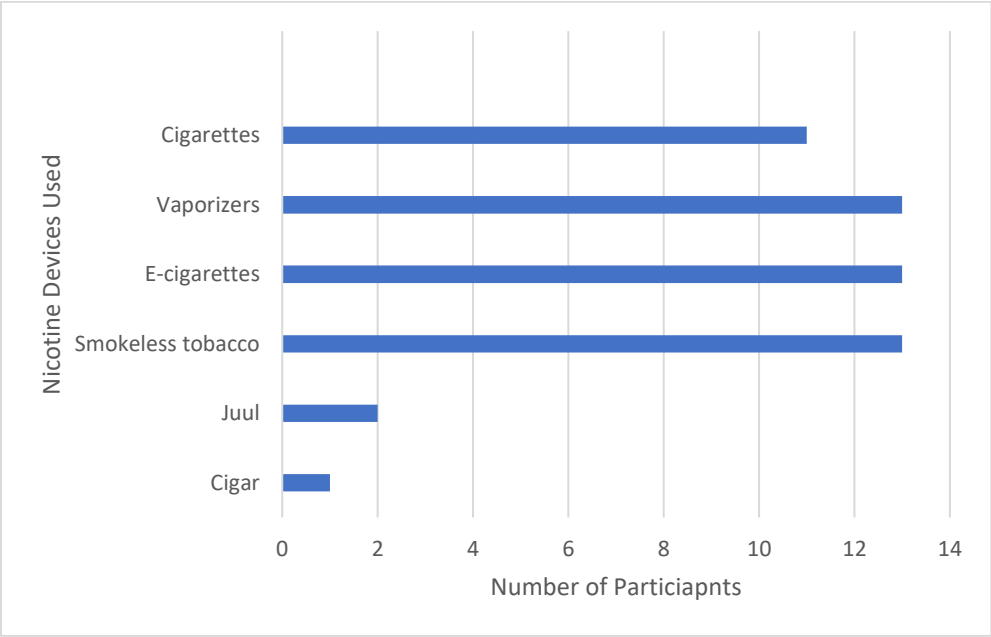

Figure 1. Number of participants by nicotine devices used (N=40)

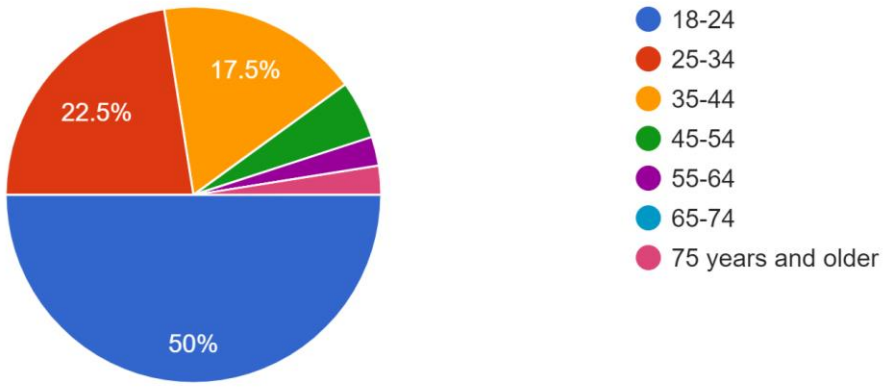

Figure 2. Percent of respondents by age (N=40)

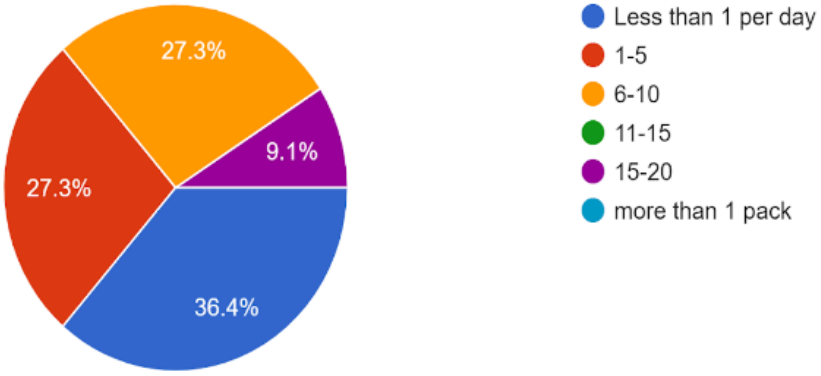

Figure 3. Percent of respondents by number of cigarettes smoked per day on average (N=11)

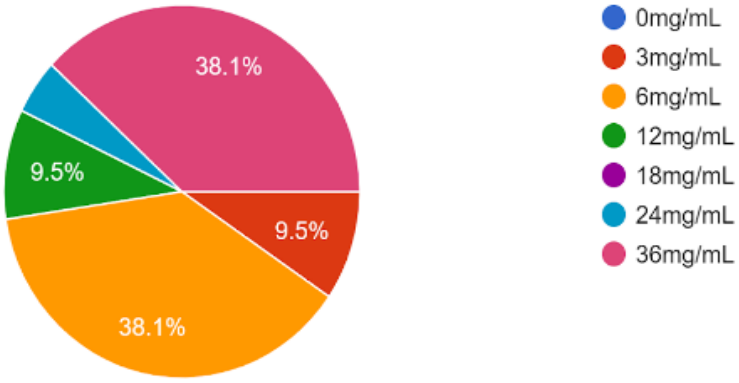

Figure 4. Percent of respondents by amount of nicotine in e-cigarette liquid or cartridge (N=21)

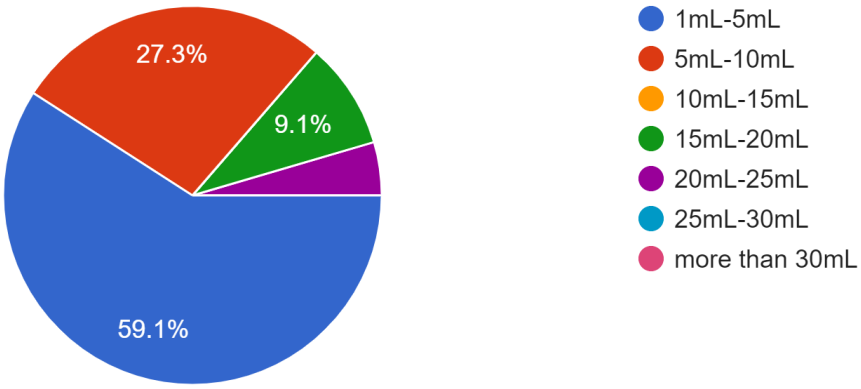

Figure 5. Percent of respondents by amount of nicotine liquid used by vaporizer and e-cigarette users (N=22)

The participants were then asked how often they use their devices. Out of 40 participants, 37 responded to this question. About 70% of the participants said they used their nicotine device every day, as illustrated in Figure 6. From these responses, it is inferred that most of the subjects had habits formed with the use of nicotine. Other responses ranged from 1-2 times a week, once a week, every month, every few months, to 1-2 times a year. Therefore, not all the participants were daily users of nicotine.

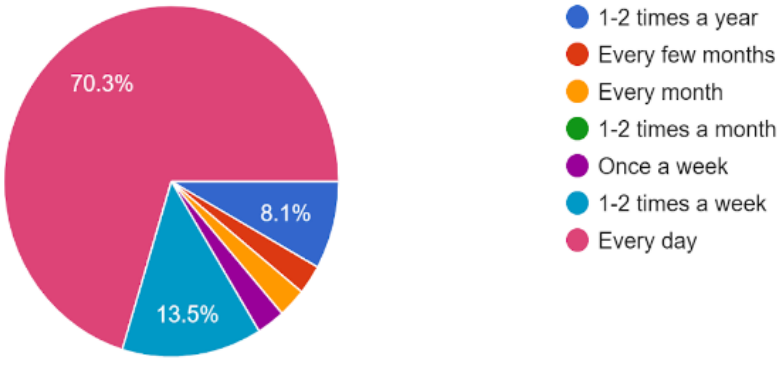

Figure 6. Percent of respondents by frequency of use (N=37)

Another question that was asked of the participants was how long they waited on average between using their nicotine device. The responses to this question were widespread, as illustrated in Figure 7. The most common responses were 30-60 minutes and every 2 hours. The other responses ranged from less than 30 minutes, to less than every day, which would indicate, once again, that not all participants regularly intake nicotine.

Figure 7. Percent of respondents by wait time between usage (N=40)

The next section of the survey provided various statements to the participants about common withdrawal symptoms. The participants were provided the 5-point Likert scale where they were able to strongly disagree, disagree, remain neutral, agree, or strongly agree with the statements being made about their own symptoms. There were several withdrawal symptoms that were more common than others, whereas some rarely affected any of the participants. The first statement referred to trouble concentrating when not able to have nicotine at the subject's preferred time. Figure 8 shows only 5 of the participants agreed with this statement, while the other 35 participants either

disagreed to some degree or were neutral on the symptom. Therefore, it appears most participants are able to remain focused despite temporary abstinence from nicotine.

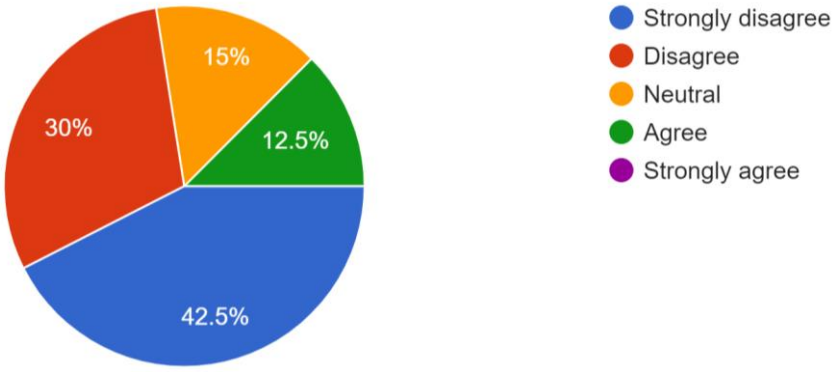

Figure 8. Percent of respondents and difficulty concentrating as a withdrawal symptom (N=40)

The next withdrawal symptom that was introduced was nicotine cravings when not able to intake nicotine at the preferred time. Approximately half of the participants experience nicotine cravings, whereas the other half experience none or were neutral to the statement, as shown in Figure 9. These cravings would distract from daily activities. The next statement pertained to trouble sleeping when nicotine was not used. Figure 10 shows that only 2 participants believed that they had trouble sleeping, whereas most of the subjects disagreed, with a small portion being neutral. Trouble sleeping does not appear to be a common issue amongst the survey participants, overall removing the risk of lack of sleep from the argument. The next statement referred to hunger felt without nicotine. Over half of the participants did not feel hunger due to nicotine withdrawal,

illustrated in Figure 11. About a quarter of the participants agreed with the statement that hunger was a factor from nicotine absence.

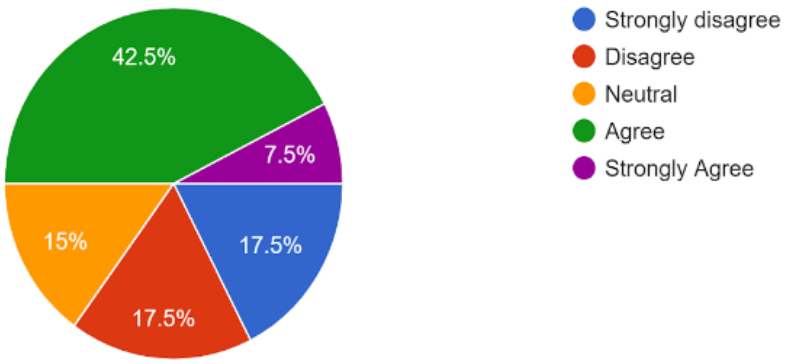

Figure 9. Percent of respondents and nicotine cravings as a withdrawal symptom (N=40)

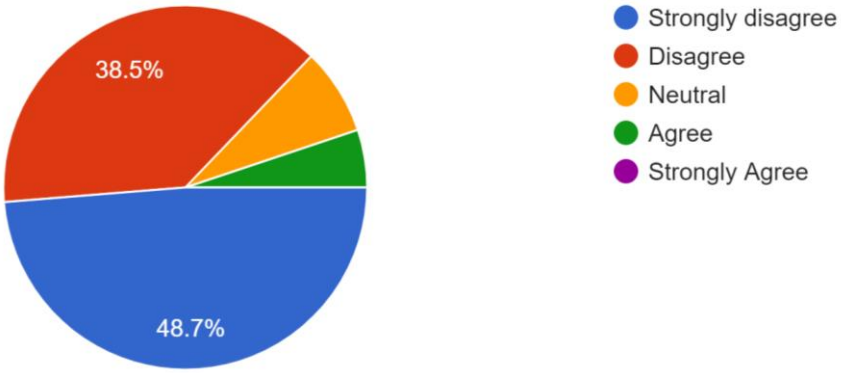

Figure 10. Percent of respondents and trouble sleeping as a withdrawal symptom (N=39)

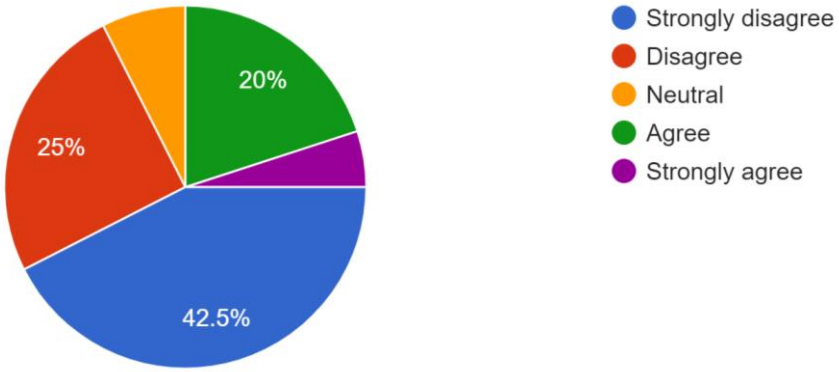

Figure 11. Percent of respondents and hunger as a withdrawal symptom (N=40)

The next withdrawal symptom that was identified was feeling sluggish or tired when unable to have nicotine. Almost 70% of the respondents disagreed with this statement, around 20% agreed with the statement, and the remaining were neutral, as shown in Figure 12. This type of symptom could result in slower reaction time and less concentration.

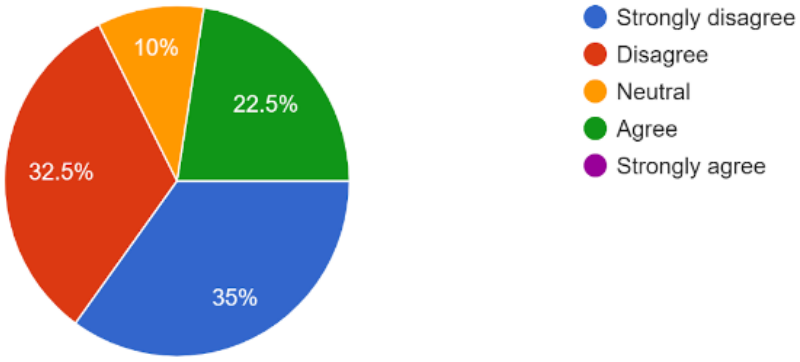

Figure 12. Percent of respondents feeling sluggish and tired as a withdrawal symptom (N=40)

Irritability and anger were the next symptoms introduced to the participants. Figure 13 shows the responses to this question and how they were overall evenly spaced between agreeing, disagreeing, and being neutral on the matter. About 35% of the participants believed that they became irritable or angry at time of nicotine deprivation. This type of a response may make it harder for crew members to work together and may result in resentment in the cockpit.

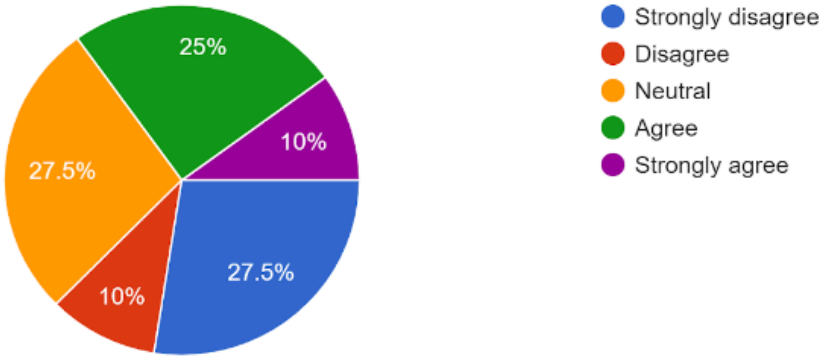

*Figure 13.*Percent of respondents feeling irritability and anger as a withdrawal symptom (N=40)

When participants were given the statement that headaches occur when they did not use nicotine at their preferred time, the majority of participants disagreed. Over 20% of the participants agreed with the statement that headaches were a common withdrawal symptom, illustrated in Figure 14. When participants were presented with the symptoms of nausea, over 90% of the participants did not feel nausea as a common withdrawal symptom, shown in Figure 15. From this question, nausea is not a major withdrawal factor for the participants.

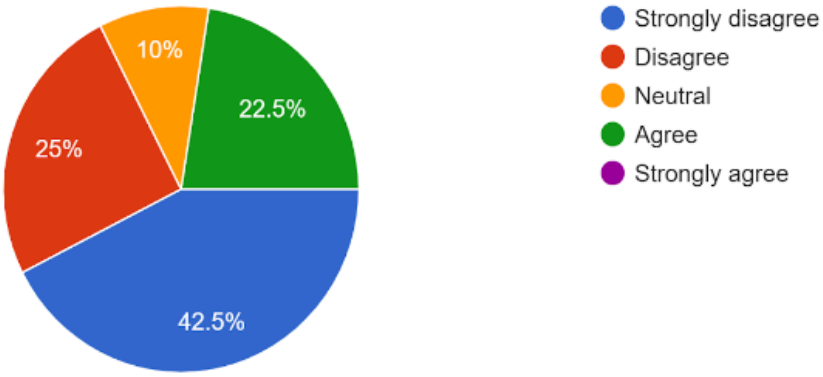

Figure 14. Percent of respondents and headaches as a withdrawal symptom (N=40)

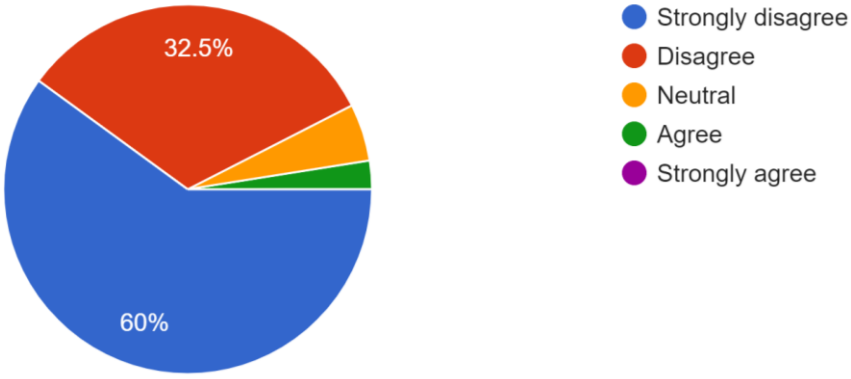

Figure 15. Percent of respondents and nausea as a withdrawal symptom (N=40)

Next, participants were presented with anxiety and restlessness as a withdrawal symptom. The number of participants who disagreed and agreed with the statement were about split in half. There was a small number of participants who were neutral in regard to the symptom, illustrated in Figure 16. It would make sense that those who crave nicotine would feel a sense of restlessness when unable to use it when desired. This type

of a reaction, again, leads to a lack of focus or paying attention to details and can even cause fatigue.

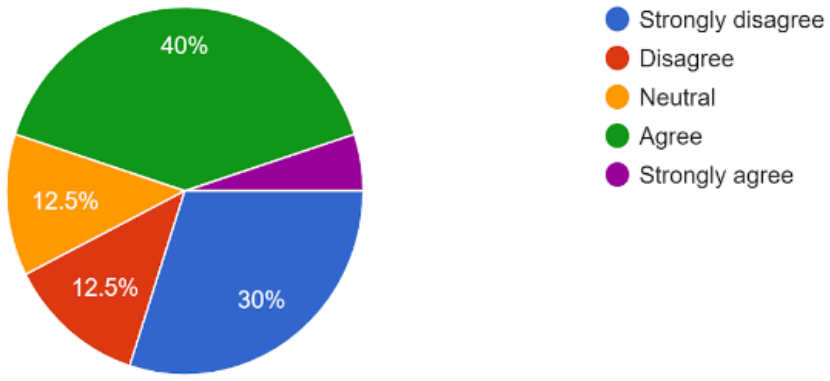

Figure 16. Percent of respondents with anxiety and restlessness as a withdrawal symptom (N=40)

To round out the withdrawal-symptoms statements, the participants were asked if they had any discernible withdrawal symptoms. A small portion of participants were neutral on this statement, whereas about half of the participants believed there were noticeable symptoms. Figure 17 shows that less than 40% believed their symptoms were not noticeable. Despite the presence of symptoms, many participants believed that their daily performance was not inhibited due to nicotine abstention. This belief may be related to the general opinion that nicotine use should not be regulated for pilots illustrated in Figure 18. Responses to this question may be biased because many people who partake in an activity or habit are not going to want to be policed, nor are they going to want to admit to having adverse performance.

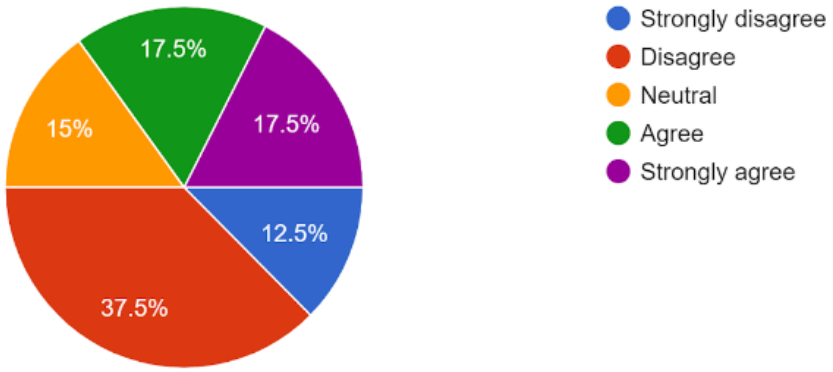

Figure 17. Percent of respondents reporting no discernible symptoms from nicotine withdrawal (N=40)

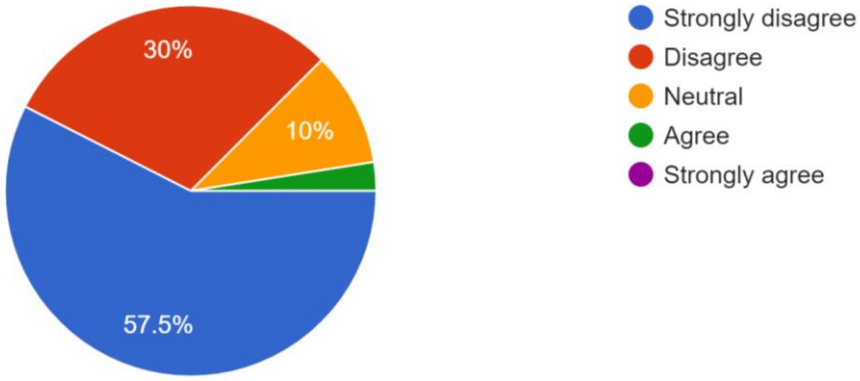

Figure 18. Percent of respondents and the opinion that nicotine intake should be regulated for pilots (N=40)

When participants were asked if nicotine withdrawal symptoms inhibited their daily performance, only about 8% of participants agreed, as shown in Figure 19. The majority of participants believe that their withdrawal symptoms do not impede normal daily activities. Despite symptoms being present and noticeable, almost every participant

disagrees with the fact that pilots' nicotine use should be regulated. This statement makes sense because, subjectively, the participants believe they can overcome any withdrawal symptoms that might add risk to flight operations.

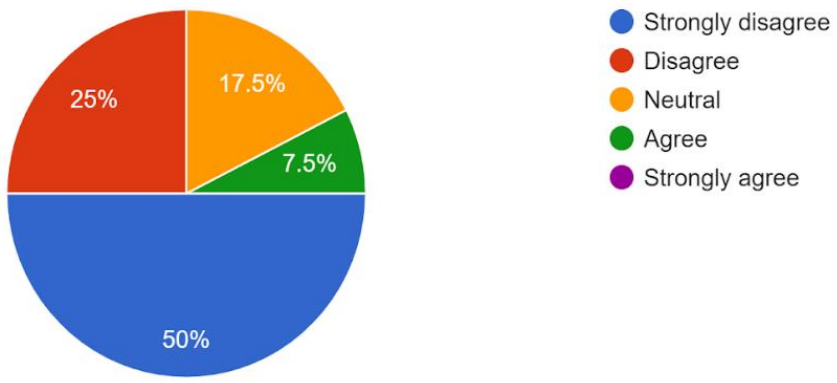

Figure 19. Percent of respondents and reports of symptoms from nicotine inhibiting daily performance (N=40)

Withdrawal Symptoms and Nicotine Use

It is hypothesized that nicotine withdrawal symptoms are related to a pilot's nicotine intake behaviors, whether it is the device, the frequency, or the level of nicotine. The data used in the statistical analysis are based on the numerical value of each answer for nicotine withdrawal symptoms in relation to the total number of indicated devices using 40 participants' answers. Each withdrawal symptom answer was given a numeric value and the total for all symptoms were summed. The values were as follows: strongly disagree=1, disagree=2, neutral=3, agree=4, and strongly agree=5. Using the 9 withdrawal questions and symptoms values, the participants' total withdrawal values had a potential high score of 45 and low score of 9. Multiple unequal variance t-tests were

performed in Excel. Using a 95% significance rate, *p* values less than 0.05 indicate statistical significance.

The first tests were performed for each device, comparing withdrawal symptoms for users and non-users of that device. For example, withdrawal symptoms of cigarette users (N=11) and those who did not use cigarettes (N=28) were compared resulting in $t(37)= -0.13$, $SE=1.87$, $p=0.89$ indicating no difference in withdrawal symptoms for cigarette users and non-users. The means and standard deviations are shown in Figure 20.

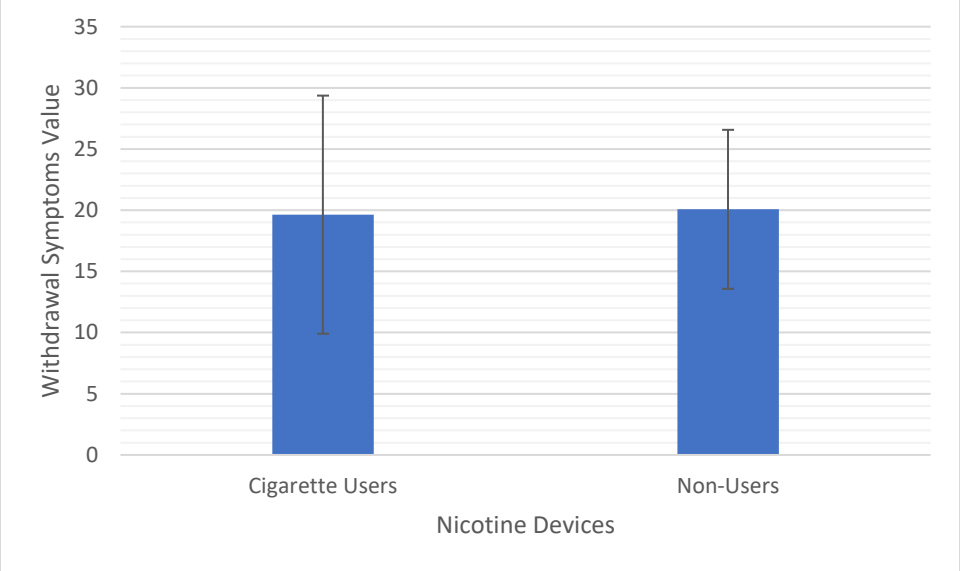

Figure 20. Means and standard deviations of withdrawal symptoms for cigarette users and non-cigarette users. Cigarette users' mean: 19.64, Cigarette users' standard deviation: 9.73, Non-cigarette users' mean: 20.07, Non-cigarette users' standard deviation: 6.49

The next *t*-test compared vaporizer users (N=13) to non-vaporizer users (N=26). This test resulted in $t(37)=0.32$, $SE=1.66$, $p=0.75$ indicating no difference in withdrawal symptoms for vaporizer users and non-users. The means and standard deviations were calculated with Figure 21 showing the intersection of the standard deviations.

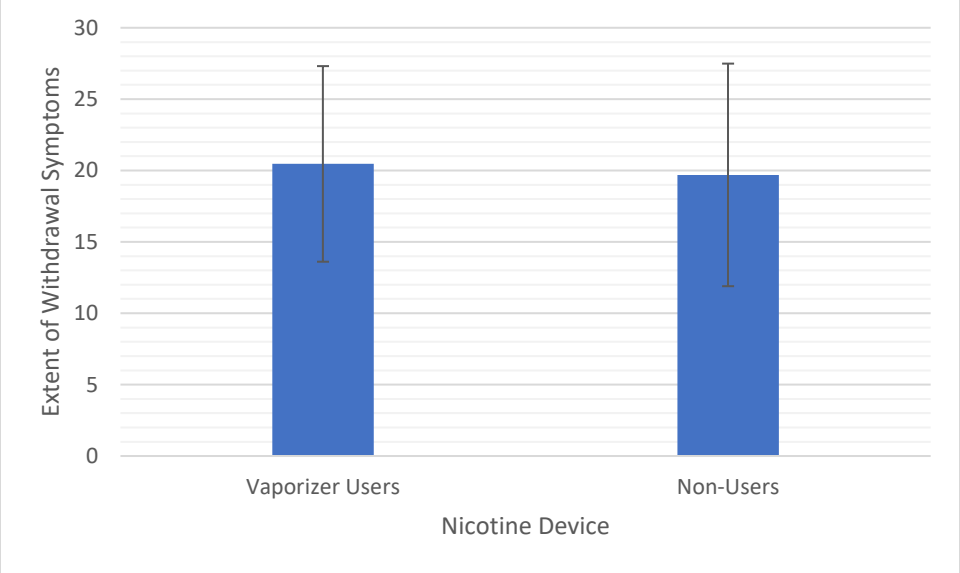

Figure 21. Means and standard deviations of withdrawal symptoms for vaporizer users and non-vaporizer users. Vaporizer users' mean: 20.46, Vaporizer users' standard deviation: 6.85 Non-vaporizer users' mean: 19.69, Non-vaporizer users' standard deviation: 7.79

The next t-test compared e-cigarette users (N=15) with non-users (N=24). This test resulted in $t(37)= -0.80$, $SE=1.64$, $p=0.43$ indicating no difference in withdrawal symptoms for e-cigarette users and non-users. The means and standard deviations were calculated with Figure 22 showing the intersection of the standard deviations.

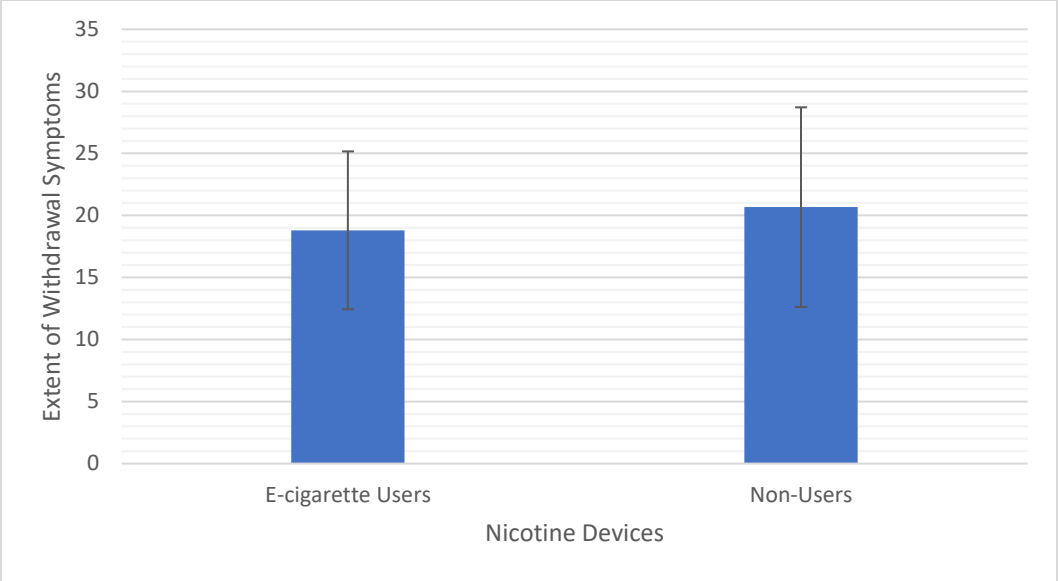

Figure 22. Means and standard deviations of withdrawal symptoms for e-cigarette users and non-e-cigarette users. E-cigarette users' mean: 18.80, E-cigarette users' standard deviation: 6.36, Non-e-cigarette users' mean: 20.67, Non-e-cigarette users' standard deviation: 8.05

Then smokeless tobacco users (N=12) were tested again non-users (N=27). The test resulted in, in $t(37)=1.71$, $SE=1.79$, $p=0.10$ indicating no difference in withdrawal symptoms for smokeless tobacco users and non-users. The means and standard deviations were calculated with Figure 23 showing the intersection of the standard deviations.

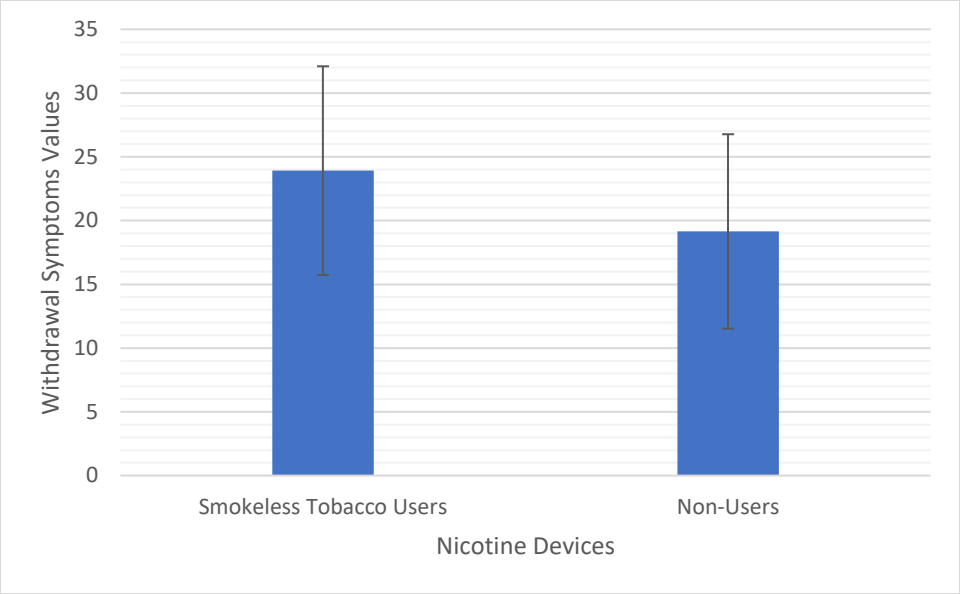

Figure 23. Means and standard deviations of withdrawal symptoms for smokeless tobacco users and non-users. Smokeless tobacco users' mean: 23.92, Smokeless tobacco users' standard deviation: 8.18, Non-smokeless tobacco users' mean: 19.15, Non-smokeless tobacco users' standard deviation: 7.62

It was also important to examine if different intakes and frequency of nicotine use would affect the overall symptoms. This would indicate whether there is a specific rate of nicotine use that creates adverse effects or if symptoms are dependent simply on the presence of any nicotine. When considering if frequency of intake changes the withdrawal symptoms, we look at what the participants signified as their use. The frequency of use was split into two categories with more frequent users being every day, 1-2 times a week, or once a week. The less frequent users were 1-2 times a year, every few months, and every month. These individuals were in the minority. More frequent users (N=31) were tested against non-frequent users (N=5). The test resulted in, in $t(34)$= -0.62, SE=2.16, p=0.56 indicating no difference in withdrawal symptoms for frequent

users and non-frequent users. The means and standard deviations were calculated with Figure 24 showing the intersection of the standard deviations.

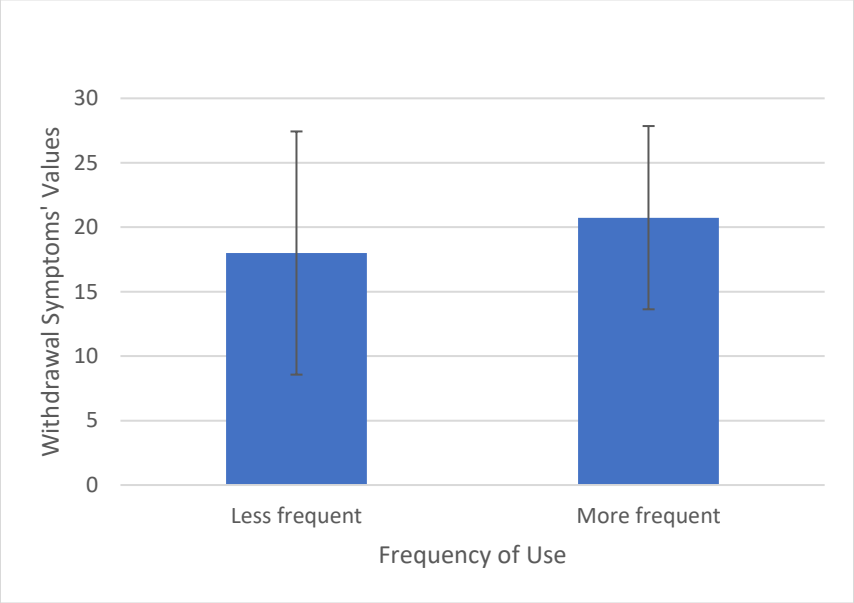

Figure 24. Means and standard deviations of withdrawal symptoms for more frequent and less frequent nicotine users. More frequent users' mean: 18.00, More frequent users' standard deviation: 9.43, Less frequent users' mean: 20.74, Less frequent users' standard deviation: 7.11

A majority of the participants were everyday users (N=25) and those who use nicotine 1-2 times a week (N=5). These participants were also tested against each other to see if these frequencies affected withdrawal symptoms. The test resulted in, $t(28)= -0.62$, $SE=2.16$, $p=0.56$ indicating no difference in withdrawal symptoms for frequent users and non-frequent users. The means and standard deviations were calculated with Figure 25 showing the intersection of the standard deviations.

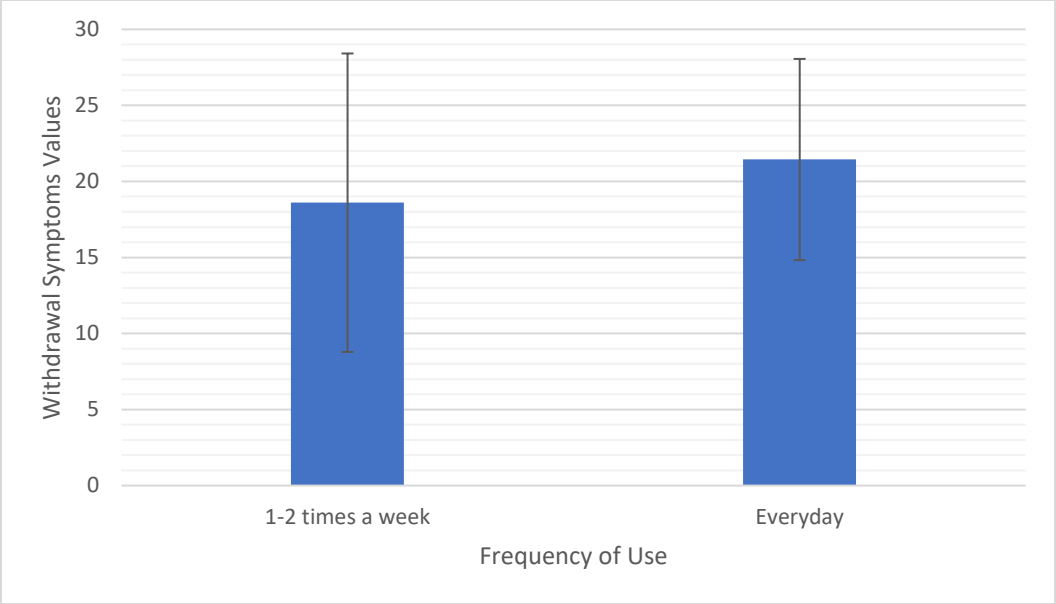

Figure 25. Means and standard deviations of withdrawal symptoms for everyday users and 1-2 times a week users. Everyday users' mean: 21.44, Everyday users' standard deviation: 6.61, 1-2 times a week users' mean: 18.60, 1-2 times a week users' standard deviation: 9.81

The additional information that was included was how much nicotine was in a participant's vaporizer or e-cigarette. The nicotine levels that were tested were 3-12mg (N=12) and 24-36mg (N=9). Figure 26 shows results of $t(19)=0.11$, $SE=2.14$, $p=0.92$ indicating no difference in withdrawal symptoms for frequent users and non-frequent users. The means and standard deviations were calculated with Figure 18 showing the intersection of the standard deviations.

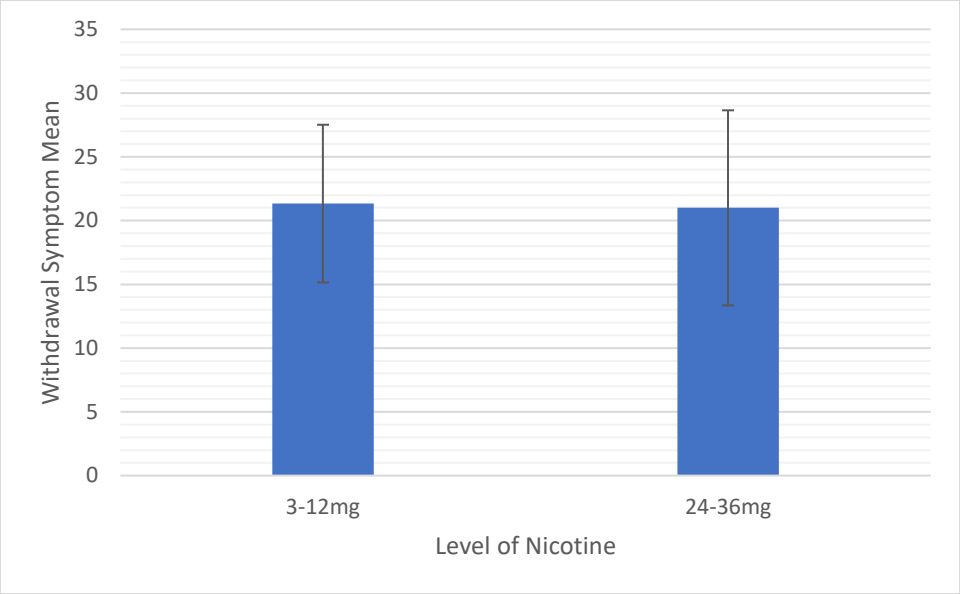

Figure 26. Means and standard deviations of withdrawal symptoms for nicotine levels between 3-12mg and 24-36mg. 3-12mg mean: 21.33, 3-12mg standard deviation: 6.18, 24-36mg mean: 21.00, 24-36mg standard deviation: 7.65

Chapter 5

DISCUSSION

Significance of Findings

The participants' responses indicated that there is no significant relationship between nicotine withdrawal symptoms and nicotine devices, frequency of nicotine use, and level of nicotine used. The results failed to support the hypothesis that the withdrawal symptoms change under different nicotine behaviors. There was no evident difference between devices and withdrawal symptoms, therefore, it cannot be concluded from this study that a specific nicotine device poses additional risks for pilot performance in relation to withdrawal. In addition, based on the findings for the frequency of use, there is

no apparent difference in nicotine withdrawal symptoms based on how often nicotine is used. The results also showed that the level of nicotine used made little difference in the withdrawal symptoms. The findings show that nicotine withdrawal symptoms remain relatively similar despite the habits of the nicotine user.

The withdrawal symptoms that were viewed are subjective, and it is difficult for them to be identified by anyone other than the subject experiencing the symptoms. These symptoms can affect each person differently, whether they are a pilot or not. It is the belief that pilots will be affected by withdrawal differently based on their nicotine habits. Thus, a survey was created in order to gather information from pilots who intake nicotine and for them to document their honest accounts of nicotine withdrawal and habits. Having pilots answer questions about their own symptoms, performance changes, and nicotine behaviors is most advantageous because their knowledge is firsthand experience.

It was found that approximately 75% (N=40) of the participants believe that their nicotine withdrawal symptoms are not detrimental to their daily performance. Although the presence of nicotine withdrawal symptoms was not overwhelming, there were nonetheless symptoms presented by the respondents. The symptoms, although not severely hazardous by themselves, can create distractions during flight that may create safety risks. It is difficult to understand the exact impact and risk of withdrawal when each person is affected differently, both physiologically and psychologically.

The need for the study was supported by the participants' answers. As aforementioned, past studies have had a main focus on the use of cigarettes, however it was seen that cigarette users amounted to only about 28% (N=40) of the participants surveyed. The other studies were conducted in 2003 and 1983. In 2019, vaporizers and e-

cigarettes appear to be more prevalent with 70% (N=40) of the participants using one or both devices. There are various, popular means of using nicotine today, demonstrating the importance of testing the relationship of the behaviors and pilot withdrawal.

The survey answers brought to light another matter, where the level of nicotine that a person can intake can be drastically different. According to the results the most popular nicotine levels in a participant's vaporizer or e-cigarette were 6mg/mL and 36mg/mL, counting for approximately 76% (N=21) of respondents that answered. This reveals another gap in the literature because nicotine levels have a vast range that are available to consumers and had the possibility of effecting withdrawal in pilots.

Limitations

The participants themselves potentially differed in many ways. There is the matter of information recall, personal experiences, personal biases, and personal minimums. All of these are factors that can play a role in the way the participants responded to the survey questions. The withdrawal symptoms presented may affect each person differently, changing the degree to which they are affected. It appears from the findings that many participants who had withdrawal symptoms believed that they could overcome the symptoms and their daily performance would not be inhibited. "Daily performance" implies normal activities, however, activities that provide additional stress on cognitive functions may be affected by nicotine withdrawal symptoms. Additionally, when taking part in an activity that a participant believes does not adversely affect them, they will be against regulating it. Therefore, the question of whether the participant believed

regulation is a good idea relies on their own judgement and view of their own symptoms rather than possible real effects.

Another limitation was that there was a small portion of participants who used nicotine rarely or not often. This created outliers in the data, creating a deficiency in evidence regarding the difference between those who use nicotine often versus on occasion. Another limiting factor for this study is that the participants were not put under any situations or conditions in which their actual performance could be tested. There is also the matter of what a participant considers nicotine deprivation. One participant may be considering the nicotine withdrawal time differently from other participants. This can create various views and effects of an individual, depending on the span of time they wait and how much nicotine has left their body. Therefore, it is hard to decipher what span of time the participant normally must wait before truly feeling nicotine cravings.

Implications for Future Research

This study introduces new ideas regarding different nicotine devices and how they can have similar effects on the withdrawal symptoms of an individual. Studies that have been conducted in the past have focused on the effects of cigarettes on nicotine withdrawal, without considering other devices' effects. The past studies have also given a specific time interval involving nicotine abstention and testing durations. Future studies could be improved by testing different nicotine consumptions against each other and using varying amounts of time in order to test another component of nicotine withdrawal in pilots. It would also be an interesting addition to use participants who have been using nicotine for different durations of their life. This may change the way individual's react to withdrawal symptoms. In addition, studies could be done by exposing the participants

to varying levels of stress to identify whether withdrawal symptoms are worsened with more stressful mental pressures as opposed to normal activities under nicotine withdrawal. Simulators could also be used to test pilot performance while under withdrawal and when not. These would be best done by comparing both situations in which the pilot was not under withdrawal. Therefore, any future research that is conducted on this topic should consider all types of nicotine absorption as well as various measurements of nicotine. Studies should also include participants whose frequency of nicotine use differs. Future studies will be most valuable if they are able to perceive how nicotine differences affect pilot performance. Without differing situations, only assumptions can be made about what circumstances cause unacceptable nicotine withdrawal.

Chapter 6

CONCLUSION AND RECOMMENDATIONS

According to the U.S. Drug Enforcement Administration, drugs like heroin are illegal due to there being “no recognized medical use and a high potential for abuse” (Walker, n.d.). The very same could be said for nicotine, however, it remains legal and abused by countless people, including pilots. Tobacco and nicotine use are outdated habits, and with today’s medical knowledge, it has been shown that pilots are more susceptible to its risks. However, from the results, there was no significant evidence that nicotine behavior is related to the extent of withdrawal effects that can potentially impact

pilot performance. Nicotine withdrawal effects are common throughout various nicotine users despite their habits.

Nicotine and tobacco are the direct cause of many health conditions that can occur in the human body. These conditions lead to a low quality of life, cause other disqualifying medical conditions, and can lead to death. One of the FAA's main duties is ensuring the safety of civil aviation through regulation; however, it is improbable for the FAA to ban something that is not federally banned. In order for a pilot to earn medical certifications, they must be tested by an Aviation Medical Examiner (AME) and be approved for a medical certificate (FAA, 2016). These medical certificates include First Class, Second Class, and Third Class. First-class certification is normally reserved for Airline Transport Pilots who will be flying numerous passengers (FAA, 2016). The thought is that if the FAA were to create regulations for nicotine and tobacco, they would have to place a contingency, both for the AME, as well as the medical certificate. A pilot would need to be tested continuously for tobacco and nicotine in order to prove that they remained free of the substances while acting as a pilot. The regulation of nicotine, tobacco, and cigarette use in pilots is neglected, but it is not only in the hands of the FAA. In order to further ensure the safety of pilots, passengers, crew members, and civilians, there needs to be creation and enforcement of policies prohibiting the use of nicotine and tobacco by airline pilots in individual companies.

The research has illustrated that the degree of risk involved with nicotine withdrawal is overall constant with various habits. Each person is affected differently by physiological conditions as well as different stressful environments. Each pilot is unique and will endure different effects from nicotine, as shown in the study. There is no

definitive approach to accurately discover which pilots would be able to withstand any physiological effects or abnormal flight operations.

The risk of nicotine may change policy for airline companies and allow them to conduct their own research. Although the safety factor for public companies would increase if their pilots were free from tobacco and nicotine, there is also a need to test employees. Employees would need to undergo random drug testing to prove the pilot was abstaining from the substances. According to OHS Health and Safety Services, individual drug screenings can cost between $28-$42 per person. The price often differs depending on the number of employees that are tested annually (2004). With this information in mind, many airlines already employ a drug testing policy, where the nicotine testing would just be an additional substance that is tested for.

According to Alaska Airlines spokesperson, Marianne Lindsey, Alaska Airlines bases their hiring process on whether the candidate smokes or has used tobacco products in the last six months (Dubner, 2013). There is also a drug test administered that detects nicotine use, meaning that Alaska Airlines would not hire a smoker. The main reason for this policy is that smokers are more expensive than non-smokers, estimating to be $4,000 more expensive for healthcare and productivity loss (Dubner, 2013). However, Alaska is one of 21 states that has passed laws allowing for companies to turn down smokers as employees, while the other 29 states cannot reject employee candidates based on their smoking habits (Dubner, 2013). Alaska Airlines can serve as an example for other airlines in their drug policies.

The research conducted has provided evidence that differing nicotine habits have little difference on the presentation of withdrawal symptoms in pilots. These symptoms

are more avoidable with the cessation of tobacco and nicotine, nevertheless, as of now, it is still each individual's choice whether they continue with the habit. Due to the fact nicotine withdrawal symptoms were not overwhelmingly present in the participants in the study, there is no support for nicotine regulation. However, the literature has shown that nicotine has innate risks, but it remains in the hands of companies rather than the federal government to police their pilots' nicotine use. The research has shown that individual nicotine behaviors are not related to the extent of nicotine withdrawal on pilots and provide no support for regulating the specific nicotine habits of pilots to prevent negative effects.

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APPENDIX A

INSTITUTIONAL REVIEW BOARD FORMS

Instructions and Notes:

- Depending on the nature of what you are doing, some sections may not be applicable to your research. If so, mark as "NA".
- When you write a protocol, keep an electronic copy. You will need a copy if it is necessary to make changes.

1 Protocol Title

Include the full protocol title: **The Implications of Nicotine Withdrawal Symptoms on Pilot Performance**

2 Background and Objectives

Provide the scientific or scholarly background for, rationale for, and significance of the research based on the existing literature and how will it add to existing knowledge.

- Describe the purpose of the study.
- Describe any relevant preliminary data or case studies.
- Describe any past studies that are in conjunction to this study.

The purpose of this study to gain knowledge on general nicotine intake habits, the frequency of nicotine use, and withdrawal symptoms for pilots. With this information, it is the hope that the effects of nicotine on pilot performance can be better understood. There have been past studies done on pilot withdrawal symptoms for only cigarette users over a specified time frame. This study accumulated knowledge on the different nicotine devices being used, how often the device is used, and in some cases how much nicotine is being taken in. The study differs because it is accumulating more general knowledge rather than based off of specific parameters.

3 Data Use

Describe how the data will be used. Examples include:

- Dissertation, Thesis, Undergraduate honors project
- Publication/journal article, conferences/presentations
- Results released to agency or organization
- Results released to participants/parents
- Results released to employer or school
- Other (describe)

The data will be used in a Master's Thesis.

4 Inclusion and Exclusion Criteria

Describe the criteria that define who will be included or excluded in your final study sample. If you are conducting data analysis only describe what is included in the dataset you propose to use.

Indicate specifically whether you will target or exclude each of the following special populations:

- Minors (individuals who are under the age of 18)
- Adults who are unable to consent
- Pregnant women
- Prisoners
- Native Americans
- Undocumented individuals

The participants will be adults over the age of 18, capable of giving consent. Those in the study that will be used are pilots who intake nicotine.

5 Number of Participants

Indicate the total number of participants to be recruited and enrolled*:* **The goal for the number of people to fill out the survey is 30.**

6 Recruitment Methods

- Describe who will be doing the recruitment of participants.
- Describe when, where, and how potential participants will be identified and recruited.
- Describe and attach materials that will be used to recruit participants (attach documents or recruitment script with the application).

The recruitment of participants will be done through known pools of pilots. An email will be sent out explaining the survey asking for participants.

7 Procedures Involved

Describe all research procedures being performed, who will facilitate the procedures, and when they will be performed. Describe procedures including:

- The duration of time participants will spend in each research activity.
- The period or span of time for the collection of data, and any long term follow up.
- Surveys or questionnaires that will be administered (Attach all surveys, interview questions, scripts, data collection forms, and instructions for participants to the online application).
- Interventions and sessions (Attach supplemental materials to the online application).
- Lab procedures and tests and related instructions to participants.
- Video or audio recordings of participants.
- Previously collected data sets that that will be analyzed and identify the data source (Attach data use agreement(s) to the online application).

The research activity is an online survey that will take no more than 5 minutes.
The period of time for collection has no specific parameters.
The survey is the primary means of the research.
There are no interventions or sessions.
There are no lab procedures.
There are no audio or video recordings.
There are no previously collected data sets.

8 Compensation or Credit

- **Describe the amount and timing of any compensation or credit to participants.**
- **Identify the source of the funds to compensate participants**
- **Justify that the amount given to participants is reasonable.**
- **If participants are receiving course credit for participating in research, alternative assignments need to be put in place to avoid coercion.**

There will be no compensation for participating in the survey.

9 Risk to Participants

List the reasonably foreseeable risks, discomforts, or inconveniences related to participation in the research. Consider physical, psychological, social, legal, and economic risks.

There are no foreseeable risks to the participants.

10 Potential Benefits to Participants

Realistically describe the potential benefits that individual participants may experience from taking part in the research. Indicate if there is no direct benefit. Do **not** include benefits to society or others.

There is no direct benefit to the participants by taking part in the survey.

11 Privacy and Confidentiality

Describe the steps that will be taken to protect subjects' privacy interests. "Privacy interest" refers to a person's desire to place limits on with whom they interact or to whom they provide personal information. Click here for additional guidance on ASU Data Storage Guidelines.

Describe the following measures to ensure the confidentiality of data:

- Who will have access to the data?
- Where and how data will be stored (e.g. ASU secure server, ASU cloud storage, filing cabinets, etc.)?
- How long the data will be stored?
- Describe the steps that will be taken to secure the data during storage, use, and transmission. (e.g., training, authorization of access, password protection, encryption, physical controls, certificates of confidentiality, and separation of identifiers and data, etc.).
- If applicable, how will audio or video recordings will be managed and secured. Add the duration of time these recordings will be kept.
- If applicable, how will the consent, assent, and/or parental permission forms be secured. These forms should separate from the rest of the study data. Add the duration of time these forms will be kept.
- If applicable, describe how data will be linked or tracked (e.g. masterlist, contact list, reproducible participant ID, randomized ID, etc.).

If your study has previously collected data sets, describe who will be responsible for data security and monitoring.

The entire survey results will be anonymous and the only ones who have access to the data will be the principal investigator and the co-investigator. The results will be stored using the on-line survey tool Google Forms.

12 Consent Process

Describe the process and procedures process you will use to obtain consent. Include a description of:

- Who will be responsible for consenting participants?
- Where will the consent process take place?
- How will consent be obtained?
- If participants who do not speak English will be enrolled, describe the process to ensure that the oral and/or written information provided to those participants will be in that language. Indicate the language that will be used by those obtaining consent. Translated consent forms should be submitted after the English is approved.

The consent for this anonymous, on-line survey will be in the form of a cover letter. The consent form was modified by removing the signature line and it is stated that filling out the survey will be considered consent.

13 Training

Provide the date(s) the members of the research team have completed the CITI training for human participants. This training must be taken within the last 4 years. Additional information can be found at: Training.

Principal Investigator: Nancy Cooke
Co-investigator: Halie Bartlowe

Survey Consent

The Implications of Nicotine Withdrawal Symptoms on Pilot Performance

I am a graduate student under the direction of Dr. Cooke in the Department of Human Systems Engineering at Arizona State University. I am conducting a research study to gain knowledge on general nicotine intake habits, the frequency of nicotine use, and withdrawal symptoms for pilots. With this information, it is the hope that the effects of nicotine on pilot performance can be better understood.

I am inviting your participation, which will involve about 5 minutes of your time, to give honest descriptions of your own withdrawal symptoms, nicotine use, and opinion on the regulation of nicotine in pilots. 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 must be 18 or older to participate in the survey.

Although there is no benefit to you, the possible benefits of your participation are to better understand pilot performance under nicotine withdrawal and possible creation of new policy. There are no foreseeable risks or discomforts to your participation.

Your responses will be anonymous. The results of this study may be used in reports, presentations, or publications, but your name will not be used.

If you have any questions concerning the research study, please contact the research team: Halie Bartlowe: hbartlow@asu.edu or 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.

By filling out this survey, you are agreeing to be part of this study.

Recruitment Email

Hello,

I am a master's student at Arizona State University's Polytechnic Campus seeking a degree in Aeronautical Management and Human Factors. I am conducting research for my thesis to gain knowledge on general nicotine intake habits, the frequency of nicotine use, and withdrawal symptoms for pilots. With this information, it is the hope that the effects of nicotine on pilot performance can be better understood.

I am looking for pilots who use nicotine to take part in an anonymous survey that will take no longer than 5 minutes. Thank you for your time.

Halie Bartlowe

APPENDIX B

SURVEY QUESTIONS

The Implications of Withdrawal Symptoms on Pilot Performance

I am a graduate student under the direction of Dr. Cooke in the Department of Human Systems Engineering at Arizona State University. I am conducting a research study to gain knowledge on general nicotine intake habits, the frequency of nicotine use, and withdrawal symptoms for pilots. With this information, it is the hope that the effects of nicotine on pilot performance can be better understood.

I am inviting your participation, which will involve about 5 minutes of your time, to give honest descriptions of your own withdrawal symptoms, nicotine use, and opinion on the regulation of nicotine in pilots. 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 must be 18 or older to participate in the survey.

Although there is no benefit to you, the possible benefits of your participation are to better understand pilot performance under nicotine withdrawal and possible creation of new policy. There are no foreseeable risks or discomforts to your participation.

Your responses will be anonymous. The results of this study may be used in reports, presentations, or publications, but your name will not be used.

If you have any questions concerning the research study, please contact the research team: Halie Bartlowe: hbartlow@asu.edu or 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.

By filling out this survey, you are agreeing to be part of this study.

NEXT

Never submit passwords through Google Forms.

60

Do you use any nicotine products? (If answer is no, do not fill out survey)

- ○ Yes
- ○ No

Are you a pilot?

- ○ Yes
- ○ No

What is your age?

- ○ 18-24
- ○ 25-34
- ○ 35-44
- ○ 45-54
- ○ 55-64
- ○ 65-74
- ○ 75 years and older

How long do you wait between using your nicotine device on average?

Choose

What device(s) do you use? (Specific questions below)

- [ ] Cigarettes
- [ ] Vaporizers
- [ ] E-Cigarettes
- [ ] Smokeless tobacco
- [ ] Other: _____

When I am not able to have nicotine at my preferred time I have difficulty concentrating.

Choose

When I am not able to have nicotine at my preferred time I feel nicotine cravings.

Choose

When I am not able to have nicotine at my preferred time I have trouble sleeping.

Choose

When I am not able to have nicotine at my preferred time I feel hungry.

Choose

When I am not able to have nicotine at my preferred time I feel sluggish/tired.

Choose

When I am not able to have nicotine at my preferred time I feel irritable/angry.

Choose

When I am not able to have nicotine at my preferred time I get headaches.

Choose

When I am not able to have nicotine at my preferred time I feel nauseous.

When I am not able to have nicotine at my preferred time I feel anxiety/restlessness.

Choose

When I am not able to have nicotine at my preferred time I have no discernible symptoms.

Choose

Symptoms from nicotine withdrawal inhibit my daily performance.

Choose

Smoking and/or nicotine intake should be regulated for pilots.

Choose

Cigarettes

How many cigarettes do you smoke per day on average?

Choose

Vape and E-Cig

What level of nicotine is in your vape liquid or e-cigarette cartridge?

Choose

How much liquid do you use per day on average?

Choose

Other

How often do you use the device on average?

Choose

BACK SUBMIT

Never submit passwords through Google Forms.