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Effects of smoking on pulmonary functions in aviation personnel

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Abstract

Aviation personnel, who are required to be healthy enough to tolerate the flight conditions in which airline transportation is carried out, and who are subjected to comprehensive examinations for this purpose, should stay away from the habits that will adversely affect their health. One of these habits is smoking. In this study, it was aimed to evaluate the effects of smoking on pulmonary functions of aviation personnel. Demographic data and PFT values of the patients were analyzed retrospectively in the Aero-Medical Center. Of the 69 people included in the study, 28 (40.6%) were female and 41 (59.4%) were male. 26 of the males (63.4%) and 4 (14.3%) of the females applied for pilot medical examinations, while 24 (85.7%) of the females and 15 (36.6%) of the males applied for cabin crew medical examinations. The smoking rate was found to be 24.4% (n=10) for males and 17.9% (n=5) for females. Among females, mean values of FEV1, FEV1/ FVC, PEF and MEF25-75 in smokers were found to be lower than non-smokers. The discrete effects of smoking status and gender on the changes of FEV1 / FVC mean values were found to be statistically significant ($p<0.05$). Although the decrease in PFT values of smokers show an asymptomatic course, it is evaluated that if these people continue to smoke, the clinical implications of decrease in PFT values may occur in the following years and this may negatively affect flight safety. Besides, to prevent some of the negativities that smoking habit will bring, it is considered that it will be beneficial for smoker aircrew to start activities and incentives for smoking cessation, especially at a young age, in a way that does not affect the flight status of the person.

Keywords: Smoking, aviation, hypoxia, pulmonary functions

Introduction

Today, air transportation makes people's lives much easier. Since the early years of aviation, the increase in the technological capabilities of aircrafts and therefore in security measures has made air travels more common and accessible. On the other hand, it should be kept in mind that no matter how much the technology develops in aviation industry, the 'human' will always be one of the most important and critical components in flight operations. That is why it is crucial that the medical conditions of the pilots, cabin crew and other aviation personnel (aircraft maintenance personnel, air traffic controllers, flight dispatchers, etc) who are involved in these operations should meet certain medical standards to maintain the highest level of flight safety.

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At sea level, normally, atmospheric PO2 is measured at approximately 160 mmHg, partial pressure of oxygen in the arterial blood (PaO_2) is measured between 95 - 100 mmHg and arterial blood oxygen saturation (SaO_2) is measured between 95-100 %. As altitude increases, the proportion of oxygen (approximately 21%) in the atmosphere remains constant, but both the atmospheric pressure and the partial pressure of oxygen in the inspired air (PO_2) decrease. High altitudes (between 31,000 and 38,000 ft) where the commercial airplanes routinely cruise have severe weather conditions that are incompatible with life. To provide air-conditioning and adequate oxygenation for the maintenance of vital functions, to minimize the risk of hypoxia, barotrauma, and decompression sickness and therefore, to prevent the passengers and aviation personnel from being medically incapacitated during air travels at these altitudes, airplane cabins are artificially pressurized equivalent to altitudes below 8,000 ft [1,2]. Although the concentration of oxygen in the atmosphere is about 21%, the air that the aircrew and passengers breathe in airplane cabin is equivalent to the air with an oxygen content of 15.1% at sea level and thus, PO_2 is measured as 118 mmHg, PaO_2 between 62-67 mmHg and SaO_2 between 90-93%. While hypoxia created by 8,000 ft cabin altitude can be tolerated by healthy people, those with underlying diseases that increase susceptibility to hypoxia cannot tolerate this cabin atmosphere and may need oxygen support [3]. Therefore,in order to tolerate the physiological alterations mentioned above, aviation personnel periodically undergo medical examinations to keep their health status at a certain level.

Aeromedical examinations should be carried out comprehensively and carefully to minimize medical pathologies that may adversely affect flight safety. Initial and periodical (renewal and revalidation) medical examinations of pilots, cabin crew and other aviation personnel working in the civil aviation sector in our country are carried out according to the medical requirements in the legislations issued by The Directorate General of Civil Aviation Turkey, ICAO - International Civil Aviation Organization and EASA - European Aviation Safety Agency [4,5]. As a result of these examinations carried out in accordance with certain requirements and standards, it may be said that aviation personnel are healthier than the normal population, since they are determined as fit to fly before starting a new career in aviation and periodically undergo aeromedical examinations in the following years [6]. In a study conducted in New Zealand, it was found that pilots had significantly less asthma, ischemic heart disease, depression, Type 2 DM, anxiety, stroke, prostate disease, and migraine than the general population [7].

Besides these periodical examinations, the aviation personnel should also take some precautions and stay away from habits that will adversely affect their health. One of these habits is smoking. Smoking causes tissue damage in the lungs by creating oxidative stress at the cellular level, and consequently long-term chronic inflammation in the respiratory tract. This chronic inflammation causes narrowing of the lumen in small airways, destruction of the alveolar attachments and lung parenchyma and thus, a decrease in lung elasticity. Lung parenchymal damage and the impaired immune response become chronic, and this creates a predisposition to respiratory tract infections [8]. In addition to respiratory system diseases, smoking has also been associated with many detrimental effects, such as atherosclerosis and coronary artery disease [9].

Objective

In this study, we aimed to evaluate the effects of smoking on pulmonary functions among smokers and non-smokers

Materials and Methods

Examination of Civil Aviation Personnel

In our country, aeromedical examinations of civil aviation personnel are carried out by a medical council, including Otorhinolaryngology, Ophtalmology (visual field testing and color assessment), Neurology, Psychiatry and Internal Medicine branches, and additional medical examinations and consultations may be requested in some cases. Types of the aeromedical examinations are initial and periodical (renewal and revalidation) examinations. In these examinations, the demographic characteristics of the individuals are routinely recorded, physical examinations are performed, and vital signs are measured. In addition, blood tests, urinalysis, Electrocardiogram (ECG), Epworth Sleepiness Scale, PFT, Audiogram, Tympanometry and Lung X-ray are performed during the examinations. Frequency of these tests depend on the age of the personnel and type of the examination they undergo.

PFT Device: PFT parameters were measured by using NSPIRE Flowhandy Zan 100 spirometer.

Study Group

Demographic data, smoking status and PFT values of aviation personnel who had been examined at our Aeromedical Center between 05th May 2017 and 15th July 2019 were retrospectively analyzed.

Exclusion Criteria

Aviation personnel, whose smoking status was missing and PFT test was not performed due to the medical requirements in the legislations, were excluded from the study. The first aeromedical examination results of the personnel who had undergone more than one examination between 05th May 2017 and 15th July 2019 were included in the study.

Data Collection and Statistical Analysis

The statistical analysis of the data obtained from the records of aeromedical examinations executed in SPSS. A p-value of ≤ 0.05 was considered statistically significant. Descriptive statistics were presented as frequency, percentage, mean ± standard deviation. The distribution of the groups was analyzed with the Kolmogorov Smirnov test. “Chi-square Test”, “Independent Sample t Test” and “Mann Whitney U Test” were used for comparison between groups. The effects of independent variables were evaluated with 2-way ANOVA analysis.

Ethical Principles and Permissions

Each stage of the research was carried out by following the principles outlined in the Declaration of Helsinki. Approval was obtained for the study with the 2019 decision of the Ethics Committee of Eskisehir Osmangazi University.

Results

10 subjects whose smoking status was missing and 1 subject whose PFT test was not performed, were not included in the study. Of the 69 subjects included in the study, 28 (40.6%) were female and 41 (59.4%) were male. 26 (63.4%) male subjects and 4 (14.3%) female subjects applied for pilot medical examinations, while 15 (36.6%) male subjects and 24 (85.7%) female subjects applied for cabin crew medical examinations. Among the 41 male subjects, 32 (78%) of them applied for initial, 8 (19.5%) of them applied for renewal and 1 (2.4%) of them applied for revalidation medical examinations. Among the 28 female subjects, 27 (96.4%) of them applied for initial and 1 (3.6%) of them applied for renewal medical examinations. Mean values of age, height, body weight and BMI of males were higher than females, and these differences were found to be statistically significant ($p<0,05$) (Table1).

The smoking rate was found to be 21.74% among the 69 subjects. The rate of smoking was %24.4 (n=10) among males and %17.9 (n=5) among the females. Smoking cessation rates was found to be %14.6 (n=6) among males and %14.3 (n=4) among females. The incidence of smoking among males was found to be greater than that of the females, but the difference was statistically insignificant (Chi-square Test; p=0.57). Respiratory functions were found to be within normal limits in both genders. Comparisons of mean values of FEV1 (FEV1: Force Expiratory Volume in 1 second), FEV1/FVC (Force Expiratory Volume in 1 second/ Force Vital Capacity), PEF (Peak Expiratory Flow) ve MEF25-75 (Mean Expiratory Flow 25–75%) for smoking status between males and females was shown in Table 2.

No interaction was found between gender and smoking status in terms of their effects on pulmonary function test values (p>0,05). The discrete effects of smoking status and gender factors on the changes of FEV1/ FVC mean values were found to be statistically significant (p<0.05) (Table 3).

Since female subjects are young adults and do not show distributions for age decades, the effect of the age factor was investigated only for male subjects. Male subjects were divided into 3 groups according to age decades (≤19 years old, 20-29 years old, ≥30 years old). Among male subjects, comparisons of mean values of FEV1, FEV1/FVC, PEF and MEF25-75 according to age groups and smoking status were shown in Table 4.

Table 1. Gender comparison of demographic variables (BMI: Body Mass Index, SD: Standard Deviation)

	FEMALE		MALE		p value
	N	Mean±SD	N	Mean±SD	
Age	28	21.21±4.76	41	28.12±10.29	0.01**
BMI	28	20.92±2.12	41	24.46±3.03	0.001*
Height	28	166.46±4.32	41	177.95±6.37	0.001*
Weight	28	58.11±7.53	41	77.41±9.83	0.001*

* Independent Sample T Test ** Mann Whitney U Test

Table 2. Comparisons of mean values of FEV1, FEV1/FVC, PEF ve MEF25-75 for smoking status between males and females (FEV1: Force Expiratory Volume in 1 second, FEV1/FVC: Force Expiratory Volume in 1 second/ Force Vital Capacity, MEF25-75: Mean Expiratory Flow 25–75%, PEF: Peak Expiratory Flow, SD: Standard Deviation)

	FEMALE		MALE	
	Yes(N=5)	No (N=23)	Yes (N=10)	No (N=31)
	Mean±SD	Mean ± SD	Mean ± SD	Mean±SD
FEV1	93.20±5.26	97.00±14.80	101.70±19.02	98.32±8.95
FEV1/FVC	109.40±10.41	110.91±6.39	112.10±13.40	113.74±5.92
PEF	84.40±18.39	86.74±16.82	90.80±30.70	88.23±12.40
MEF25-75	92.2±23.87	99.39±23.98	121.90±41.23	110.26±26.58

Table 3. The effects of smoking status and gender factors on mean values of FEV1, FEV1/FVC, PEF and MEF25-75 (FEV1: Force Expiratory Volume in 1 second, FEV1/FVC: Force Expiratory Volume in 1 second/ Force Vital Capacity, MEF25-75: Mean Expiratory Flow 25–75%, PEF: Peak Expiratory Flow)

	Smoking Status		Gender		Smoking Status X Gender	
	F	P*	F	p*	F	p*
FEV1	0.003	0.963	1.873	0.402	0.842	0.362
FEV1/ FVC	599.157	0.026	1840.027	0.015	0.001	0.979
PEF	0.002	0.970	2.577	0.355	0.202	0.655
MEF25-75	0.056	0.852	4.640	0.277	1.193	0.279

Table 4. Comparisons of mean values of FEV1, FEV1/FVC, PEF and MEF25-75 according to age and smoking status among male subjects (FEV1: Force Expiratory Volume in 1 second, FEV1/FVC: Force Expiratory Volume in 1 second/ Force Vital Capacity, MEF25-75: Mean Expiratory Flow 25–75%, PEF: Peak Expiratory Flow, SD: Standard Deviation)

	≤19 years old		20-29 years old		≥30 years old	
	Smoking Status		Smoking Status		Smoking Status	
	Yes (N=1)	No (N=5)	Yes (N=5)	No (N=16)	Yes (N=4)	No (N=10)
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
FEV1	89.00±0	97.40±8.59	100.80±23.86	97.56±8.29	106.00±15.71	100.00±10.71
FEV1/FVC	117.00±0	115.60±2.19	108.40±18.80	112.25±7.24	115.50±4.66	115.20±4.37
PEF	88.00±0	84.00±13.06	75.00±27.25	85.63 ±8.29	111.25±29.33	94.50±16.00
MEF25-75	117.00±0	111.40±24.76	112.40±40.74	104.44±25.82	135.00±49.99	119.00±28.74

No interaction was found between age and smoking status among male subjects in terms of their effects on FEV1, FEV1/FVC, PEF and MEF25-75 values. The discrete effects of smoking status and age factors on mean values of FEV1, FEV1/FVC, PEF and MEF25-75 were found to be statistically insignificant (p>0.05) (Table 5).

Table 5. The effects of smoking status and age factors on mean values of FEV1, FEV1/FVC, PEF and MEF25-75 among male subjects (FEV1: Force Expiratory Volume in 1 second, FEV1/FVC: Force Expiratory Volume in 1 second/ Force Vital Capacity, MEF25-75: Mean Expiratory Flow 25–75%, PEF: Peak Expiratory Flow)

	Smoking Status		**Age**		**Smoking Status X Age**	
	F	**P***	**F**	**p***	**F**	**p***
FEV1	0.004	0.949	1.990	0.334	0.437	0.649
FEV1/FVC	0.082	0.781	5.619	0.151	0.264	0.770
PEF	0.106	0.769	2.742	0.267	2.249	0.121
MEF25-75	1.678	0.205	17.393	0.054	0.067	0.935

* 2-way ANOVA analysis FEV1: Force Expiratory Volume in 1 second FEV1/FVC: Force Expiratory Volume in 1 second/ Force Vital Capacity
MEF25-75: Mean Expiratory Flow 25–75% PEF: Peak Expiratory Flow

Discussion

In a study conducted with 1810 pilots and cabin crew candidates, the smoking rate was found to be 15.4% [10]. In another study by Jimenez-Restrepo et al., the smoking rate of 84 male civilian pilots with an average age of 32 was found to be 35.7% [11]. Although the smoking rates of the aviation personnel vary, there are some studies in the literature reporting that the incidence of tobacco use in this population is like that of the general population [12,13]. Of the 69 people included in our study, the smoking rate was found to be 21.74%. These people need to reduce their smoking rates to be protected from the harmful effects of smoking and thus, to maintain their health.

In our study, we found that smoking rate of males (%24.4) is higher than that of females (%17.9) and this result is consistent with the general population [14,15]. Mean age was found to be 30.6±9.68 among smoker males and 22.40±3.05 among smoker females in our study and it may be said that the mean ages of both smoker males and females are between the ages of 18-39, which is generally accepted within the young adulthood period [16]. According to the Global Adult Tobacco Survey, conducted by Turkey in 2016, it was found that 31.6% of our country's population uses tobacco products and the rate of tobacco use is 44.1% for males and 19.2% for females. Besides, it was observed that 57.5% of tobacco users who were between the ages of 15-34 (62% of males, 46.5% of females) started smoking under the age of 18. In the same study, it was also stated that the age at starting smoking and using other addictive substances in our country is within the young adulthood period [14]. Young adulthood is a sensitive and critical period in which individuals face many challenges of life, their sense of identity and personal development are shaped, and it may be more difficult to abandon some bad habits gained during adolescence and this period in the following years [17]. It is important for young adults who want to start a career in aviation to give up harmful habits like smoking and get even medical support, if necessary, to prevent the potential harmful effects of smoking in the future. However, if pharmacological treatment is required, there is a possibility that some medications used in the treatment may not be acceptable for flying. This may cause those young adults to abstain from smoking cessation. As per article d-12 of MED.A.020- Acceptable Means of Compliance (AMC) and Guidance Material (GM) published by EASA, nicotine replacement therapy may be acceptable, but other drugs affecting the central nervous system, such as bupropion and varenicline, requires unfitness for pilots [4]. For this reason, in order to prevent smoking related health problems that create unfitness for flight, it will be beneficial to support smokers by applying a range of effective smoking cessation methods.

In our study, it was found that smoking decreased PFT values in women and the discrete effects of smoking status and gender factors on the changes of FEV1/ FVC mean values were found to be statistically significant (p<0.05). There are several studies reporting that PFT parameters of males are higher than women [18,19], and FEV1/FVC values are higher in males [20], and our results were found to be consistent with these studies. In a study conducted among male undergraduate students between the ages of 18 and 30, FVC and FEV1 values of smokers were found to be significantly lower than non-smokers and it was shown that smoking decreased pulmonary functions [21]. In a study by Hariri and Van Mansor [22], in which smokers and non-smokers were compared, pulmonary functions were found to be lower in smokers than non-smokers and it was observed that FEV1 and FVC values decreased as the number of cigarettes smoked per day and the smoking duration increased. Smoking induces airway inflammation and fibrosis, destroys alveolar attachments and this process plays an important role in susceptibility to hypoxia by causing chronic obstructive pulmonary diseases such as bronchitis and emphysema [23]. In a study in which 10 healthy pilots under the age of 25 were exposed to hypobaric hypoxia at 5500 meters, oxygen saturation levels of smokers were found to be significantly lower than non-smokers [24]. Pulmonary function testing may be useful to predict many pulmonary disorders among aviation personnel. As per MED.B.015- Acceptable Means of Compliance (AMC) and Guidance Material (GM), a FEV1/FVC ratio of less than 70 % requires further evaluation in aviation personnel by a specialist in respiratory disease. Flight restriction is only required in the presence of chronic obstructive pulmonary disease, asthma with decreased pulmonary functions and requiring systemic steroids, inflammatory disease of the respiratory system requiring medication and resolved with sequelae, active sarcoidosis, recurrent spontaneous pneumothorax, and unsatisfactorily treated sleep apnea syndrome [4]. These conditions have also negative effects on pulmonary functions and many of them can be detected at the first stage of the examination. In our study, PFT results were not found abnormal, and the subjects (both smokers and non-smokers) were asymptomatic. Nevertheless, if the smokers keep smoking in the following years, it is considered that their PFT results may decrease, cardiovascular pathologies linked to smoking may occur, they may become symptomatic, mild hypoxia inside the aircraft cabin may not be tolerated, their performance will most likely worsen and thus, this process may eventually jeopardize flight safety in the future. Moreover, it may have negative impact on their career in aviation.

For aviation personnel, measures taken to prevent smoking except flight duties are mostly deterrent measures. But smoking is prohibited for all flight crew (pilots, cabin crew) and passengers aboard aircraft [25]. If there is no harmful or disruptive behavior, the penalty of smoking on board both for passengers and aircrew is generally sentenced to a fine, the amount of which varies from country to country. Smoking bans is appropriate and necessary to maintain flight safety, on the other hand, smoker pilots and cabin crew who are obliged not to smoke on board may exhibit nicotine withdrawal symptoms (performance decrement, impairment of cognitive functions etc.) especially during long-haul (7 to 12 hours and more) flights and this may also negatively affect flight safety [26]. The effects of nicotine withdrawal on cognitive performance begin to emerge within 4-12 hours after the last cigarette was smoked [27,28]. In a study by Giannakoulas et al., the effects of nicotine withdrawal symptoms on regular smoker pilots were investigated using psychomotor test batteries, computer aided programs and questionnaire. In this study, prolongation of reaction times, increase in anxiety and irritability, impairment in cognitive functions and reasoning ability were observed within a 12-hour period of smoking abstinence during flight and it has been stated that these effects may adversely affect flight performance and thus, endanger the flight safety [29]. On the other hand, some smoking cessation methods require a long treatment process and the pharmacological agents used may also cause some adverse side effects [30]. Therefore, to make this cessation process be properly managed without compromising flight safety, aviation personnel who decide to quit smoking and need medical support for this purpose, should be evaluated comprehensively and declared temporarily unfit if medication is necessary.

Mean values of age, height, body weight and BMI of males were found to be significantly higher than females in our study and these results were consistent with the reports published. In a study by Vijayalakshmi et al, men were found to have significantly higher BMI than women [31]. In another study, men were found to be 8% taller than women [32]. According to World Health Organization (WHO), for adults, a BMI of 18.5-24.99 is considered normal, 25-29.9 overweight, greater than or equal 30 obesity (33). In, our study, the mean BMI in men and the mean BMI in women were calculated as 24.46±3.03, and 20.92±2.12 respectively and these values are considered normal. In a study conducted in Colombia, the average BMI of 84 male civilian pilots with an average age of 32 was found to be 25.8, and 63% of them had a BMI of 25 and above [11]. In another study conducted with 1810 pilots and cabin crew candidates, the mean BMI was found to be 24.10 ± 3.07 [10]. The subjects in our study are young adults. Besides, aviation personnel are selected among healthy people and they periodically undergo medical examinations. These may be said to cause the BMI averages to be determined as normal.

Smoking is also known to cause cardiovascular diseases [34,35]. In a study conducted with commercial airline pilots, it was reported that smoking is among the risk factors for cardiovascular diseases [36]. The annual incapacitation rate among United Kingdom (UK) commercial pilots was found to be 0.25% [37] and most in-flight medical incapacitations were found to be cardiac pathologies [38,39]. In a study performed on 55 pilots and 35 cabin crew members who were asymptomatic, electrocardiographic recordings were obtained throughout the entire flight (takeoff, cruise, approach, and landing phases) and it was detected more electrocardiographic changes (sinus tachycardia /bradycardia, ventricular /supraventricular extrasystole) during the take-off and landing phases than the other phases [40]. It may hence be said that in the presence of underlying cardiac or pulmonary pathologies, probably a medical emergency that will not occur yet may be precipitated by flight- related workload and stress during the flight. A sudden in-flight medical incapacitation related to the respiratory and cardiac problems in a pilot may seriously endanger the flight safety, and if it develops in a cabin crew, maybe he or she will not be able to fulfil a critical task (administering first aid, dealing with emergencies, etc.) during the flight. Therefore, aviation personnel should have a good health condition that can tolerate flight conditions to be able to respond in a timely and effective manner in case of any situation that endanger flight safety (sudden cabin pressure loss, technical malfunction, etc.), or in the event of a possible medical emergency for passengers.

Conclusion

In our study, the smoking status of aviation personnel and the detrimental effects of smoking were demonstrated by examining the respiratory functions of the aviation personnel. It will be appropriate to design new strategies to promote smoking cessation by taking deterrent measures (such as developing peer support programs to increase social support, awareness, and confidence among the personnel, rewarding successful cessation attempts, etc.) incorporated in their daily lives and work times. Sanctions may be considered by airlines and authorities if there are unacceptable behaviours related to smoking addiction which adversely affect workplace environment, flight, and passenger safety. It is also very important to conduct a multicenter anti-smoking campaign across the country against using tobacco products that pose great risks for cardiovascular and respiratory diseases and protecting the health of aviation personnel to ensure flight safety.

Conflict of interests
The authors declare that they have no competing interests.

Financial Disclosure
All authors declare no financial support.

Ethical approval
Each stage of the research was carried out by following the principles outlined in the Declaration of Helsinki. Approval was obtained for the study with the 2019/41 decision of the Ethics Committee of Eskisehir Osman Gazi University.

References

1. MUHM JM. Predicted arterial oxygenation at commercial aircraft cabin altitudes. Aviat Space Environ Med. 2004 75:905–12.
2. Mortazavi A, Eisenberg MJ, Langleben D, et al. Altitude-related hypoxia: risk assessment and management for passengers on commercial aircraft. Aviat Space Environ Med. 2003;74:922–7.
3. Ahmedzai S, Balfour-Lynn IM, Bewick T, et al. British thoracic society standards of care committee. managing passengers with stable respiratory disease planning air travel: british thoracic Society recommendations. Thorax. 2011;661:1-30.
4. Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Part-MED, Medical requirements for aircrew. European Union Aviation Safety Agency. 2019;1:8-95.
5. Manual of Civil Aviation Medicine Doc 8984 AN/ 895. Third Edition. International Civil Aviation Organization. 2012.
6. Bhat KG, Verma N, Pant P, et al. Hypertension and Obesity Among Civil Aviation Pilots. Aerosp Med Hum Perform. 2019;1;90:703-8.
7. Sykes AJ, Aldington S, Powell DM, et al. Are Pilots Healthier Than The General Population? A study of Morbidity in New Zealand Pilots. 83rd Annual Scientific Meeting of Aerospace Medical Association, May 13-17, 2012, Atlanta;336.
8. Centers for Disease Control and Prevention (US); National Center for Chronic Disease Prevention and Health Promotion (US); Office on Smoking and Health (US). How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report of the Surgeon General. Atlanta (GA): Centers for Disease Control and Prevention (US);2010;435-519.
9. Rigotti NA, Pasternak RC. Cigarette smoking and coronary heart disease: risks and management. Cardiol Clin. 1996;14:51-68.
10. Monin J, Dussault C, Hornez A, et al. Sports and Physical Activities Among French Aircrew Members: A Prospective Epidemiological Survey. 86th Annual Scientific Meeting of Aerospace Medical Association, May 10–14, 2015, Lake Buena Vista, FL;185.
11. Jimenez-Restrepo S, Rodriguez A, FajardoH. Alteration of liver function in the pilot population of the national army of colombia. 84th Annual Scientific Meeting of Aerospace Medical Association, May 12-16,2013, Chicago, Illinois; 385.
12. Omar MM, Al-Mulla KF, Al-Seleem TA, et al. Middle East aircrew use of alcohol, tobacco, coffee, and medicaments. Aviat Space Environ Med. 2005;76:395-8.
13. Grossman A, Landau DA, Barenboim E, Goldstein L. Smoking cessation therapy and the return of aviators to flying duty. Aviat Space Environ Med. 2005;76:1064-7.
14. Global Adult Tobacco Survey- Fact Sheet- Turkey 2016 Aailable from: https://nccd.cdc.gov/GTSSDataSurveyResources/Ancillary/DownloadAttachment.aspx?ID=3452. access date: November 25, 2021
15. Hiscock R, Bauld L, Amos A, et al. Socioeconomic status and smoking: a review. Ann N Y Acad Sci. 2012;1248:107-23.
16. Greenhalgh EM, Bayly M, Scollo M. 1.4 Prevalence of smoking—young adults. In Greenhalgh, EM, Scollo, MM and Winstanley, MH [editors]. Tobacco in Australia: Facts and issues. Melbourne: Cancer Council Victoria; 2021.
17. Aktu Y. Life Structure of Early Adulthood Period in Levinson's Theory. Current Approaches in Psychiatry. 2016; 8:162-77.
18. Ostrowski S, Barud W. Factors influencing lung function: are the predicted values for spirometry reliable enough? J Physiol Pharmacol. 2006;57 Suppl 4:263-71.
19. Shimray AJ, Kanan W, Jamatia SN, et al. Gender difference in spirometric lung functions in chronic obstructive pulmonary disease patients attending rims hospital out-patient department. IOSR-JDMS. 2014;13:49-51.
20. Behera AA, Behera BK, Dash S, Mishra S; Variation of pulmonary function tests with relation to increasing age in healthy adults. International Journal of Health Sciences and Research (IJHSR). 2014;4:136-41.
21. Adegoke BOA, Akinremi AA, Akintobi AE. Effects of tobacco smoking on pulmonary function indices among undergraduate students. Niger J Med. 2015;18:1-14.
22. Hariri A, Wan Mansor WFA. Effects of Cigarettes Smoking on Pulmonary Function among University Students. MATEC Web Conf. 2017;87:02002:1-5.
23. Pickard JS, Gray GW. Respiratory Diseases: Aeromedical Implications. Davis JR, Johnson R, Stepanek J, Fogarty JA, editors. Fundamentals of Aerospace Medicine, 4th Edition, Philadelphia, Lippincott Williams&Wilkins, 2008, p. 306-17.
24. Macovei A, Vlad D, Macri M. Noninvasive Monitoring of Cardiac Output During Hypoxia by Bioimpedance. 81st Annual Scientific Meeting. May 9-13, 2010, Phoenix, AZ;325.
25. Federal Aviation Administration, Prohibition of Smoking on Scheduled Passenger Flights, Final Rules, Federal Register / Rules and Regulations. 2000;65:36771-5.
26. Mumenthaler MS, Benowitz NL, Taylor JL, et al. Nicotine deprivation and pilot performance during simulated flight. Aviat Space Environ Med. 2010 Jul;81:660-4.
27. Snyder FR, Davis FC, Henningfield JE. The tobacco withdrawal syndrome: performance decrements assessed on a computerized test battery. Drug Alcohol Depend. 1989;23:259-66.
28. Snyder FR, Henningfield JE. Effects of nicotine administration following 12 h of tobacco deprivation: assessment on computerized performance tasks. Psychopharmacology 1989;97:17-22.
29. Giannakoulas G, Katramados A, Melas N, et al. Acute effects of nicotine withdrawal syndrome in pilots during flight. Aviat Space Environ Med. 2003;74:247-51.
30. Wilkes S. The use of bupropion SR in cigarette smoking cessation. Int J Chron Obstruct Pulmon Dis. 2008;3:45-53.
31. Vijayalakshmi P, Thimmaiah R, Reddy SSN, et al. Gender differences in body mass index, body weight perception, weight satisfaction, disordered eating and weight control strategies among Indian Medical and Nursing Undergraduates. Invest Educ Enferm. 2017;35:276-84.
32. Samaras T, Marson S, Lillis J. The close inverse relationship between male and female height and life expectancy, Innov Aging. 2018;1:888-9.
33. World Health Organization. Obesity and overweight. Facts Sheets, 9 June 2021. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight Last Accessed 29 of July 2021.
34. Lakier JB. Smoking and cardiovascular disease. Am J Med. 1992;93:8-12.
35. Roy A, Rawal I, Jabbour S, et al. Tobacco and Cardiovascular Disease: A Summary of Evidence. In: Prabhakaran D, Anand S, Gaziano TA, et al., editors. Cardiovascular, Respiratory, and Related Disorders. 3rd edition. Washington (DC): The International Bank for Reconstruction and Development / The World Bank; 2017 Nov 17. Chapter 4.

36. Houston S, Mitchell S, Evans S. Application of a Cardiovascular Disease Risk Prediction Model Among Commercial Pilots. Aviat Space Environ Med. 2010;81:768-73.

37. Evans S, Radcliffe SA. The annual incapacitation rate of commercial pilots. Aviat Space Environ Med. 2012;83:42-9.

38. Buley LE. Incidence causes and results of airline pilot incapacitation while on duty. Aero Med 1969;40:64-70.

39. Raboutet J, Raboutet P. Sudden incapacitation encountered in flight by Professional pilots in French civil aviation, 1948-1972. Aviat Space Environ Med. 1975;46:80-1.

40. Duenes J, Presence of Rhythm Disorders During The Take-Off, Cruise, And Landing Phases In Class 1 Airlines Pilots And Class 3 Cabin Crews. 90th Annual Scientific Meeting of Aerospace Medical Association, May 5– 9, 2019, Las Vegas, NV;174.