**FACTORS RELATED TO HEARING LOSS ON MILITARY HELICOPTER CREWS OF PUSPENERBAD SEMARANG**

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**ABSTRACT**

**Background:** *Hearing loss that occurs in pilots due to the high intensity of exposure to noise by aircraft / helicopters. The helicopter noise level ranges from 104-110 dB. Flying hours, acoustic trauma, diabetes mellitus, hypertension and smoking can affect the incidence of hearing loss*

**Objective:** *Knowing the factors that are related to hearing loss in the Military Helicopter Crew of Puspenerbad Semarang.*

**Methods:** *Observational research with cross-sectional design on the pilot crew of the Puspenerbad helicopter Semarang, aged 20-58 years, the sample was determined as many as 96. Hearing loss consists of hearing loss and tinnitus, was assessed by otoscopy and audiometry. Tinnitus was obtained from the history. Previous ear surgery history, infection of the outer ear and middle ear, as well as a history of or having taken ototoxic drugs (kanamycin, cisplatin and carboplatin) were excluded. Data analysis used the chi-square test and fisher's exact and yates correction.*

**Results:** *One hundred and fourteen samples with a mean age of 26.54 + 4.72 were all male. Several factors such as flying hours (p = 0.698), acoustic trauma (p = 0.151), diabetes mellitus (p = 0.596), smoking (p = 0.222), hypertension (p = 0.356) were not associated with sensorineural hearing loss. Several factors such as flight hours (p = 0.706), acoustic trauma (p = 0.5160), diabetes mellitus (p = 0.789), smoking (p = 0.495), hypertension (p = 0.112) were not associated with tinnitus.*

**Conclusion:** *There is no association between flight hours, acoustic trauma, diabetes mellitus, hypertension, and smoking with hearing loss.*

**Key words:** *Hearing loss, tinnitus, helicopter crew.*

**ABSTRAK**

**Latar belakang:** Gangguan pendengaran yang terjadi pada penerbang karena tingginya intensitas terpapar bising oleh pesawat/helikopter. Tingkat kebisingan helicopter berkisar 104-110 dB. Jam terbang, trauma akustik, DM, hipertensi dan merokok dapat mempengaruhi kejadian gangguan dengar

**Tujuan:** Mengetahui faktor – faktor yang berhubungan dengan gangguan pendengaran pada Kru Helikopter Militer Puspenerbad Semarang

**Metode:** Penelitian observasional dengan *design* belah lintang pada kru penerbang helicopter Puspenerbad Semarang, usia 20-58 tahun, sampel ditentukan sebanyak 96. Gangguan pendengaran terdiri dari kurang dengar dan tinitus. Kurang pendengaran dinilai dengan pemeriksaan otoskopi dan audiometri. Tinitis didapatkan dari anamnesis.Riwayat operasi telinga sebelumnya, infeksi pada telinga luar dan telinga tengah, serta riwayat atau pernah mengkonsumsi obat- obatan yang bersifat ototoksik (kanamisin, cisplatin dan carboplatin) dieksklusikan. Analisis data menggunakan uji *chi-square* dan *fisher’s exact* serta *yates correction*

**Hasil:** Seratus empat belas sampel dengan rerata umur 26,54+4,72 semua berjenis kelamin laki laki. Beberapa factor seperti jam terbang (p=0,698), trauma akustik (p=0,151), diabetes melitus (p=0,596), merokok (p=0,222), hipertensi (p=0,356) tidak berhubungan dengan kurang dengar sensorineural. Beberapa factor seperti jam terbang (p=0,706), trauma akustik (p=0,5160), diabetes melitus (p=0,789), merokok (p=0,495), hipertensi (p=0,112) tidak berhubungan dengan tinitus.

**Simpulan:**.Tidak terdapat hubungan antara jam terbang, trauma akustik, diabetes melitus, hipertensi, dan merokok dengan gangguan pendengaran

**Kata kunci:** Kurang dengar, tinitus, kru helikopter

**INTRODUCTION**

Hearing loss is the partial or complete inability to hear sounds in one or both ears. Hearing loss can occur in pilots due to the high intensity of exposure to noise generated by the aircraft (Eryani, Wibowo, & Saftarina, 2017). The hearing loss referred to sensorineural hearing loss (SNHL) and tinnitus.

Tinnitus is generally associated with hearing loss, acoustic trauma, age and stress, as well as metabolic diseases such as diabetes mellitus and hypertension. Sudden mechanical interference on cochlear and auditory structures caused loud noise for a moment on the ear because of the eruption or explosion occurs in the majority of military personnel.

Jam Flying hours> 2000 can cause hearing loss in both ears (Dewi, 2012). Another study states that helicopter noise levels are higher than the noise levels for propeller aircraft (Hercules), Hercules aircraft have a noise level of 94 dB while helicopters reach 104-110 dB. Helicopter pilots have 2.67 times the risk of hercules pilots (Dewi, 2012). In other studies, it was found that aircraft noise had an effect on hearing impairment of technicians (Choirunisa, 2017). The purpose of this study was to determine the factors that are associated with hearing loss in the Military Helicopter Crew of Puspenerbad Semarang.

**METHODS**

The study used a cross-sectional design with the research subject being the crew of the Semarang Puspenerbad helicopter. Sampling was carried out by consecutive samples. The number of samples was 114 samples. The inclusion criteria in this study were 20-58 years old and willing to take part in the study and sign an informed consent, while the exclusion criteria were a history of previous ear surgery, an external ear and middle ear infection, a history of or had ever consumed ototoxic drugs (kanamycin). , cisplatin, carboplatin).

The independent variables of this study were exposure to flight hours, acoustic trauma, diabetes mellitus, hypertension, smoking and the dependent variable was SNHL, tinnitus. Samples that met the research criteria were subjected to an audiometric examination of the right and left ears in a room with a noise level of less than 40 dB. Ethical clearance was obtained from the Health Research Ethics Commission (KEPK), Faculty of Medicine, Diponegoro University, Semarang. Number 156 / EC / H / FK-UNDIP / VII / 2020. Hypothesis testing used the Chi-square test, Fisher's exact test, Yates correction

**RESULTS**

The results of the study obtained 114 samples with a mean age of 26.54 + 4.72, all male

**Table 1. The Characteristic of samples**

| **Variable** | **F** | **%** |
| --- | --- | --- |
| Age |  |  |
| Young adults (26-35 years old) | 108 | 94,7 |
| Old adults (36-45 years old) | 6 | 5,3 |
| Years of service |  |  |
| ≤ 5 years | 76 | 66,7 |
| 5 – 10 years | 28 | 24,6 |
| 10 – 15 years | 6 | 5,3 |
| ≥ 20 years | 4 | 3,5 |
| Total flight hours |  |  |
| ≥ 180 hours | 32 | 28,1 |
| < 180 hours | 82 | 71,9 |
| History of acoustic trauma (shooting practice) |  |  |
| Yes | 102 | 89,5 |
| No | 12 | 10,5 |
| Tinnitus |  |  |
| Yes | 24 | 21,1 |
| No | 90 | 78,9 |
| Diabetel Mellitus |  |  |
| Yes  No | 1  113 | 0,9  99,1 |
| SNHL |  |  |
| Hearing Loss | 46 | 40,4 |
| Normal | 68 | 59,6 |
| Smoking |  |  |
| Yes | 64 | 56,1 |
| No | 50 | 43,9 |
| Hypertension |  |  |
| Yes | 3 | 2,6 |
| No | 111 | 97,4 |
| Crew |  |  |
| Pilot | 60 | 52,6 |
| Avionic | 18 | 15,8 |
| Mechanic | 31 | 27,2 |
| FE | 5 | 4,4 |
|  |  |  |

**Table 2. Description of the crew with SNHL and tinnitus**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Crew** | **SNHL** | | | **Tinnitus** |
| **Mild** | **Moderate** | **Severe** | **Yes** |
| Pilot | 16 | 0 | 2 | 7 |
| Avionic | 6 | 1 | 0 | 6 |
| Mechanic | 18 | 1 | 0 | 10 |
| FE | 2 | 0 | 0 | 1 |

**Table 3. The results of the factors related to SNHL**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | | SNHL | | | | | | | | | | | P | | | RP | CI 95% | | Yates | | |
| + | | | | | | - | | | | |  | | |
| N | | | % | | | N | | | % | |  | | |
| Total flight hours  ≥ 180  < 180 | | 12  34 | | | 26,1  73,9 | | | 20  48 | | | 29,4  70,6 | | 0,698¥ | | | 0,85 | (0,37-1,96) | |  | | |
| Acoustic trauma  Yes  No | | 39  7 | | | 84,8  15,2 | | | 63  5 | | | 92,6  7,4 | | 0,151£ | | | 0,44 | (0,13-1,49) | | - | | |
| DM  Yes  No | 0  46 | | 0  100 | | | 1  67 | | | 1,5  98,5 | | 0,596£ | | | - | - | |  | | | 1,000€ | | |
| Smoking  Yes  No | | 29  17 | | | 63,0  37 | | | 35  33 | | | 51,5  48,5 | | 0,222¥ | | 1,61 | (0,75-3,46) | | | - | | |
| Hypertension  Yes  No | | 2  44 | | | 4,3  95,7 | | | 1  67 | | | 1,5  98,5 | | 0,356£ | | 3,05 | (0,27-34,6) | | | - | | |

n.b: \* significant (p<0,05), ¥chi-square,£Fisher’s exact,€Yates correction

**Table 4. The result of the factors associated with tinnitus**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | | Tinnitus | | | | | | | | | | P | | RP | | CI 95% | | | yates | |
| + | | | | | - | | | | |  | |
| n | | | % | | N | | % | | |  | |
| Total flight hours  ≥180  <180 | | 6  18 | | | 25  75 | | 26  64 | | 28,9  71,1 | | | 0,706¥ | | 0,82 | | (0,29-2,30) | | | - | |
| Acoustic trauma  Yes  No | | 22  2 | | | 91,7  8,3 | | 80  10 | | 88,9  11,1 | | | 0,516£ | | 1,38 | | (0,28-6,74) | | | - | |
| DM  Yes  No | 0  24 | |  | 0  100 | | | 1  98,9 | | 1,1  98,9 | | | 0,789£ | | - | | |  | 1,000€ | | | |
| Smoking  Yes  No | | 12  12 | | | 50  50 | | 52  38 | | | 57,8  42,2 | | 0,495¥ | | 0,73 | | (0,30-1,80) | | | - | |
| Hypertension  Yes  No | | 2  22 | | | 8,3  91,7 | | 1  89 | | | 1,1  98,9 | | 0,112£ | | 8,09 | | (0,70-93,3) | | | - | |

n.b : \* significant (p<0,05), ¥chi-square, £Fisher’s exact,€Yates correction

**Table 5. The results of the logistic regression multivariate test on SNHL**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | P | RP | CI95% | Explanation |
| Acoustic trauma | 0,188 | 0,442 | 0,130 – 1,504 | Not significant |
| Smoking | 0,227 | 1,608 | 0,131 – 1,490 | Not significant |

**Table 6. Crew with flight hours <180 who experience hearing loss and tinnitus**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Kru** | **SNHL** | | | | | | **Tinnitus** |
|  | | **Mild** | | **Moderate** | | **Yes** |
| Pilot |  |  | 15 |  | 0 |  | 6 |
| Avionic |  |  | 4 |  | 1 |  | 5 |
| Mechanic |  |  | 13 |  | 1 |  | 7 |
| FE |  |  | 0 |  | 0 |  | 0 |
| Total |  |  | 32 |  | 2 |  | 18 |

**DISCUSSION**

The results showed that 114 samples were divided into flight time ≥ 180 hours and flight hours <180 were not related to the incidence of hearing loss with a value of p = 0.698. This is in accordance with previous research where pilots with 200-1000 flight hours of flight hours did not get hearing loss, but for pilots with 1000-3000 flight hours, there was hearing loss due to noise (Atalay, Babakurban, & Aydin, 2016),(Kartika, 2017). This can be due to the sample under study having a total flight time of less than 200 flight hours so that it lacks intensity and time of exposure to noise, and flight routines are not carried out every day and only carried out on a predetermined schedule. There was no significant relationship between total flight hours and tinnitus. This can be due to the fact that the samples examined are junior members who have low flight hours, so the incidence of tinnitus is small. Based on the theory, the higher the intensity and duration of noise exposure, the greater the occurrence of hearing loss such as tinnitus. Tinnitus is associated with hearing loss and hearing loss that occurs accompanied by complaints of tinnitus. Tinnitus is an early sign of impaired sensorineural hearing loss (Choirunisa, 2017).

In the sample who participated in shooting training, there were 39 people (41.2%) with hearing loss and 5 people within normal limits with a value of p = 0.151. The results are not much different from previous research conducted at the state police school Surabaya, from 50 samples of police students, 28 samples (56%) obtained hearing loss related to acoustic trauma (Gonzalez, 2017).Hearing loss that occurs can be caused by damage to the end of the stereocilia and actin filaments of stereocilia. The damage to the stereocilia ends will be repaired in 24-120 hours, while the damage to the sterociliary actin filaments will be repaired in 48 hours, while the stiffness of the outer hair cells will improve in 2 weeks. This also occurs because of the length of noise exposure where the frequency of shooting exercises is more routinely carried out on educational students because it is still in the formation stage (Atalay et al., 2016). In this result, there was no significant relationship between acoustic trauma and tinnitus incidence in military helicopter crews (p = 0.516). This can be due to the frequency of shooting drills that are not carried out every day, so that the noise exposure received does not cause the effect of tinnitus and when shooting practice the members use ear protection. The results of this study are in accordance with previous studies which reported 17% complained of tinnitus from 204 personnel Swedish infantry. Tinnitus that occurs can be caused by damage to the hair cells when exposed to loud noises (Humes, Joellenbeck, & Durch, 2010). Short-term exposures ranging from 1-4 hours found several levels of hair cell damage. Damage can also be found in buffer cells, blood vessels and afferent fibers. At high intensity noise in a short time can cause hair cell damage due to cell disruption (Atalay et al., 2016).

Diabetes mellitus was not associated with SNHL (p = 1,000) and tinnitus (p = 0.789) in military helicopter crews. This is because the research sample is predominantly young adults so that those suffering from DM are few, the length of time intensity of noise exposure is obtained so that tinnitus complaints are not found in the helicopter crew. In contrast to other studies that reported, on pilots, there was a significant relationship between diabetes mellitus and the occurrence of hearing loss with a p value <0.05, the longer a person has diabetes the higher the risk of hearing loss (Krismanita & Naftali, 2017). Diabetes mellitus can cause disturbances in blood vessels such as microangiopathy which can cause hearing loss. Ringing in the ears, discomfort in the ears are the initial complaints commonly found in acoustic trauma (Krismanita & Naftali, 2017).

Smoking was not associated with SNHL (p = 0.222) and tinnitus (p = 0.495). The results of the previous study found that there was a significant relationship between smoking behavior and hearing loss, where smokers were 1,224 times more likely to experience hearing loss than nonsmokers. Another study reported that differences in nicotine levels in kretek cigarettes 1.306 mg and nicotine levels in filter cigarettes 1.140 mg had a chronic effect on endothelial nicotine exposure related to the process of arteriolar dilation in the form of capillary congestion, endothelial necrosis, stria vascular necrosis, vascular degeneration and cochlear hair cell necrosis so that affect the occurrence of SNHL (Krismanita & Naftali, 2017). The results of other studies report that there is a significant relationship between the number of cigarettes consumed and the incidence of hearing loss and the risk of hearing loss increases with the number of cigarettes consumed, so that the higher and more frequent exposure to nicotine and carbon monoxide will increase the incidence of hearing loss (Krismanita & Naftali, 2017). This study did not analyze the nicotine dose in cigarettes and the types of cigarettes smoked. Smoking is reported as a direct ototoxic (nicotine effect) and as a trigger for cochlear ischemia through the reproductive mechanism of carboxy hemoglobin, vasospasm, increasing blood viscosity, this mechanism which results in hearing loss (Sari & Adnan, 2017),(Safitri, 2017).

The results showed that hypertension was not associated with SNHL (p = 0.356) and tinnitus (p = 0.112). This was due to the larger number of samples of young adults so that the incidence of hypertension was less. One of the potential causes of hypertension-related hearing loss is due to abnormal blood flow to the cochlea, severe hypertension can cause bleeding in the inner ear leading to hearing loss. Poor blood flow from an arteriosclerosis can cause perfusion or inadequate blood flow to the cochlea (Krismanita & Naftali, 2017)5. Hypertension can cause tinnitus, presumably due to microcirculation damage to the cochlea due to decreased blood flow to the cochlea due to impaired autoregulation of blood flow throughout the body. The vascular in the cochlea functions as nourishment for the cochlea, and protects the cochlea, and maintains endococcal stability. Vascular damage can cause ischemic cochlea and will cause clinical manifestations of hearing impairment, such tinnitus and hearing loss (Krismanita & Naftali, 2017).

Pilots and mechanics who have flight hours less than 180 hours are the helicopter crew who mostly suffer from SNHL and tinnitus, this is probably due to the higher noise exposure received by mechanics, it can also be caused by the type of ear protection equipment used, as well as the discipline in using ear protector.

**CONCLUSION**

There was no relationship between flying hours, acoustic trauma, diabetes mellitus, hypertension, smoking and hearing loss in the military helicopter crew of the Puspenerbad, Semarang.

**CONFLICT OF INTEREST**

Authors declare there is no conflict of interest within this manuscript

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