Helicopter vibration and risk of reversible myopia among military air crews

Bastaman Basuki*, T. Soemardoko†

Abstrak

Pada tulisan ini disajikan faktor vibrasi helikopter dan faktor risiko lainnya terhadap risiko miopia reversibel di antara awak helikopter militer. Desain penelitian ialah nested case-control dengan mempergunakan data rekam medik dan log board di Lembaga Kesehatan Penerbangan dan Ruang Angkasa Tentara Nasional Indonesia (TNI) Angkatan Udara (Lakespra), dan Direktorat Kesehatan TNI Angkatan Darat Tentara Nasional Indonesia (Penerbad). Kasus dan kontrol ialah pilot dan juru mesin udara (JMU) helikopter yang pada waktu mulai bertugas dari tahun 1972 sampai 1992 dengan visus emmetrop. Miopia reversibel ialah visual akuiti terkoreksi - 0,50 dioptri atau kurang. Model akhir menunjukkan terdapat kaitan antara derajat vibrasi dan lama kerja terhadap risiko miopia reversibel. Awak helikopter yang terpajan vibrasi tinggi mempunyai risiko miopia reversibel 4,5 kali lipat [rasio odds (OR) suaian = 4,47; 95% interval kepercayaan (CI) = 1,48 - 13,55] jika dibandingkan dengan awak helikopter yang terpajan vibrasi rendah. Awak helikopter yang telah bekerja lama mempunyai risiko miopia reversibel yang lebih kecil jika dibandingkan dengan yang bekerja dalam waktu singkat. Mereka yang telah bekerja sepuluh tahun atau lebih mempunyai risiko yang lebih sedikit sebanyak 85% dibandingkan dengan yang baru bekerja selama 1-4 tahun. (OR suaian = 0,15; 95% CI = 0,03 - 0,87). Awak helikopter yang terpajan vibrasi helikopter tinggi mempunyai risiko yang tinggi menderita miopia reversibel, dan risiko yang tinggi tersebut terjadi pada 4 tahun pertama masa kerja. **(Med J Indones 2002; 11: 93-6)**

Abstract

We assessed to what extend the risk of reversible myopia of the different degree of helicopter vibrations and other risk factors among military helicopter pilots and flight engineers. The study was a nested case-control design using medical record at the Institute of Aerospace Medicine of the Indonesian Air Force and Medical Directorate of the Indonesian Army (Flying Wing). Cases and controls were military helicopter pilots and flight engineers who had ametropic visual acuity at the time of entry into military service from 1972 until 1992. Reversible myopia means visual acuity corrected of - 0.50 dioptri or less. The final model indicates there was a relationship between vibration level, duration of work and risk of reversible myopia. Helicopter crews exposed to high vibration level had 4.5 times to develop reversible myopia [adjusted odds ratio (OR) = 4.47; 95% confidence intervals (CI) = 1.48 - 13.55] relative to those who exposed to weak vibration level. There was noted a healthy worker's survivor effect. Those who remain work for a longer period had less a chance to be myopia. Those who worked for 10 years or more had a lowered risk of 85% to be myopia compared with those who worked for 1-4 years (adjusted OR = 0.15; 95% CI = 0.03 - 0.87). Helicopter crews exposed to high helicopter vibration had 4.5 times to develop reversible myopia, and a higher risk occurred during the first four years of employment. **(Med J Indones 2002; 11: 93-6)**

Keywords: *helicopter vibration, reversible myopia, air crews*

One of the important medical requirements for a pilot and flight engineer which essential for safe flight is free from poor vision.[1] Therefore, it is important to explore the risk factors in air crew of becoming myopic in order to determine the need for yearly screening, and to predict air crew eligibility in environments where the use of corrected lenses may be a problem.[2]

The use of corrective lenses by myopic pilots and flight engineers may adversely affect performance. Some personal protective equipments cannot be fit at all by pilots with spectacles. Contact lenses can solve the problem of equipment incompatibility in some aircrews. However, others are not able to adjust, or have low motivation to use it, or refuse to use it. Furthermore, contact lenses may be a serious problem under dusty field conditions.[2] Therefore, early diagnosis

* *Department of Community Medicine, Faculty of Medicine, University of Indonesia, Jakarta, Indonesia*
† *Institute of Aerospace Medicine, The Indonesian Air Force, Jakarta, Indonesia*

on reversible myopia is necessary to minimize the problem of myopic personnel who needed spectacles.

Previous studies reported that causes of myopia include age, late onset of myopia in adult, increasing service time, ethnicity, high speed aircraft, illness, incipient growth of myopia among helicopters personnel who exposed to different degree of helicopter vibration.[2-5] In Indonesia, the multiple risk factors related to reversible myopia among helicopter aircrews are not well detected yet.

This study assessed to what extend the risk of reversible myopia of the different degree of helicopter vibrations and other risk factors among military helicopter pilots and flight engineers.

METHODS

The study design was a nested case-control study. Data extracted from medical records during the period of 1972 to 1992 at the Institute of Aerospace Medicine of Indonesian Air Force and Medical Directorate of the Indonesian Army (Flying Wing) in 1996. Cases and controls were male helicopter pilots or flight engineers who served for Indonesian Air Force and Army who had emmetropic visual acuity at the time of entry into military service.

Reversible myopia case was a subject that had visual acuity corrected of - 0.50 dioptri or less on either one or both eyes (personal communication, Tredici, United States Air Force School of Aerospace Medicine). Cases were identified by ophthalmologists during annual medical check-up. The control subject was those who had a normal visual acuity during the period of 1972 until 1994. Each cases was matched by five controls by year of diagnosis of the cases. The controls were randomly selected from available medical records by year of diagnosis of the cases.

As part of annual medical check-up, visual acuity was measured using a Visual Testing Apparatus Near and Distant (VTAND). If myopia was suspected, the examination will be continued using a phoropter and Snellen chart to confirm to what extend diopters must be added. Refraction was tested by professional ophthalmometrists, and methodology did not vary over time. All subjects who undergone medical check-up had not to be exposed to helicopter vibration at least for 24 hours before the eye examination.

Information regarding the risk factors related to reversible myopia were extracted by two special physicians trained specifically for this study from the medical records and the logboards.

For cases and controls, information collected pertained to exposures and characteristics prior to the year of reversible myopia. The information extracted were profession (pilot or flight engineers), year of start service, age of start service, age at diagnosis, the type of helicopter, total flying hours, and total duration on service. Total flying hours and total duration on service until date of diagnosis (for cases), and at reference year for controls.

We ordered helicopter vibration level into three subgroups (weak/moderate/high). Weak vibration level consisted of Allouet and Bell helicopters, moderate vibration level consisted of Bolco helicopters, while high vibration level consisted of Twin Pac, Sikorsky, and Puma.

A number of risk factors were examined as potential confounders and/or effect modifiers. Logistic regression analysis[6] was used in order to control for the confounding effects of risk factors on the relationship between the risk factors and reversible myopia. A risk factor was considered to be a potential confounder if upon completing of the univariate test has a P-value < 0.25 which will be considered as a candidate for the multivariate model along with all risk factors of known biological importance.[7] Characteristics that fulfilled this definition as confounders are included by the method of maximum likelihood. Ninety-five percent confidence intervals were based on the standard error of coefficient estimates. Calculation using unconditional logistic methods, and based on candidate of potential risk factors using Egret software.[8]

RESULTS

We found the 254 medical records for this study. In this analysis, 25 reversible myopia cases and 125 controls were identified. The shortest helicopter exposure of reversible myopia case was 182 hours, and the longest was 3019 hours (mean = 1146 hours; 95% confidence intervals = 830 to 1462 hours).

Table 1 shows that cases were more than controls to be flight-engineers, and those who had longer average flying hours yearly. On the other hands, control were more than cases with respect to recent year of start service, age start service, age at diagnosis, and those who had longer total flying hours.

Table 1. Characteristic of subjects and risk of reversible myopia

	Myopia (N=25)		Normal (N=125)	
	n	%	n	%
Profession				
Pilot	16	64.0	107	85.6
Flight engineer	9	36.0	18	14.4
Year at start service				
1990 - 1992	6	24.0	9	7.2
1985 - 1989	13	52.0	58	46.4
1972 - 1984	6	24.0	58	46.4
Age at start service				
17 - 24 years	14	56.0	72	57.6
25 - 29 years	4	16.0	36	28.8
30 - 44 years	7	28.0	17	13.6
Age at diagnosis				
21 - 29 years	5	20.0	29	23.2
30 - 34 years	18	72.0	55	44.0
35 - 47 years	2	8.0	41	32.8
Average flying hours yearly				
19 - 100 hours	4	16.0	54	43.2
101 - 300 hours	12	48.0	41	32.8
301 - 850 hours	9	36.0	30	24.0
Total flying hours				
69 - 499 hours	4	16.0	31	24.8
500 - 999 hours	10	40.0	37	29.6
1000 - 8156 hours	11	44.0	57	45.6

Those who had a longer duration of services had a lower risk to develop reversible myopia. Compared with the helicopter who had duration of services for 1 to 4 years, those who had longer duration of services had less risk to develop reversible myopia. It was pronounced among those who had 10 to 21 years of military services had 85% less to develop reversible myopia.

DISCUSSION

There are several limitations, which must be considered in the interpretation of the findings. Firstly, cases ascertainment, although based on medical records from the Institute of Aerospace Medicine of Indonesian Air Force and Medical Directorate of the Indonesian Army (Flying Wing) may be incomplete, as some medical records were missing. Secondly, our data based on the results of annual medical check up and logboards, therefore, we have no data regarding other risk factors related to reversible myopia, such as the diseases related to reversible myopia, high aircraft speed, the practice of using correct prevention tools. Thirdly, we have no data on the incipient growth of myopia, aspect of the most recent duration of flying hours that might have allowed us to more specifically examine risk factors associated with the last time of recent flying hours. Furthermore, all of our subjects were almost Malay ethnic. Therefore, we are not able to analyze the difference risk in developing reversible myopia related to ethnicity. Fourthly, we did not have a possibility to interview directly the subjects, because a number of subjects had been retired, or not available for an interview. Lastly, different individuals' ophthalmologist and ophthalmometrists carried out the examination. However, all of them were professional and had been similarly trained in conducting the medical examination.

Table 2. The relationship between vibration level, duration of work and risk of reversible myopia

	Myopia (N=25)		Normal (N=125)		Adjusted odds ratio*	95% confidence intervals	*P*
	n	%	n	%			
Vibration level							
Weak	5	20.0	60	48.0	1.00	Reference	
Moderate	4	16.0	28	22.4	2.57	0.60 - 11.19	0.207
High	16	64.0	37	29.6	4.47	1.48 - 13.55	0.008
Duration of service							
1 - 4 years	10	40.0	23	18.4	1.00	Reference	
5 - 9 years	13	52.0	62	49.6	0.48	0.18 - 1.50	0.225
10 - 21 years	2	8.0	40	32.0	0.15	0.03 - 0.87	0.034

* Odds ratio adjusted each other for risk factors on this table

In spite of these limitations, the restriction of our study population to military personnel, our results more directly applicable to the military helicopter personnel.

Our final model noted that the degree of helicopter vibration levels and duration of services were the most dominant risk factors. The effect of vibration on visual performance are describe by previous studies[4,9,10] A study in the eyes of guinea pigs and rabbits subjected to vibration reveals that vibration changed the metabolism of sulfomucopolysaccharides in the eyes.[9]

Previous study indicates that in the cockpit thermal discomfort and high vibration levels are common,[4] Furthermore, other study revealed that mechanical vibration may lead to a decrease in visual performance. This may expected if the natural frequency of the eye is exited.[10]

Our final model which indicates that increase service time increased risk reversible myopia. This is in accordance with the previous study.[2] In addition, our final model which indicates higher helicopter vibration levels increased risk reversible myopia is similar with the other previous study.[4] It was recommended that the head should be avoided to prevent a decrease in visual performance.

Results from crude analysis (Table 1) reveals that recent year of start service, starting age for service at 30-44 years old, age at diagnosis, and more total flying hours more likely lowered risk for developing reversible myopia. In contrast, flight engineers and more average flying hours increased risk to reversible myopia. However, these risk factors were "hidden" by the dominant risk factors in this analysis.

Our final model noted a healthy worker's survivor effect. Those who remain served for a longer period had lower risk to be myopia. Compared with those who served for 1-4 years, those who served for 10 years or more had a lowered risk of 85% to be myopia. While for those who served for 5-9 years had a moderate decreased risk for 52% to be reversibel myopia (P = 0.225). This describe a continuing selection process such that who remain served tend to be healthier than hose who leaved services.[11]

In conclusion, military helicopter crews exposed to high helicopter vibration had 4.5 times to develop reversible myopia, and a higher risk occurred during the first four years of employment.

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