The effect of total flight hours and other factors on diastolic blood pressure among fixed-wing civilian pilots in Indonesia

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Abstrak

Latar belakang: *Jam terbang total dapat mempengaruhi sistem kardiovaskular antara lain terhadap tekanan darah diastolik (TDD) pada pilot. Tujuan penelitian ini ialah mengidentifikasi pengaruh jam terbang total dan faktor lainnya terhadap risiko TDD tinggi pada pilot sipil pesawat sayap tetap di Indonesia.*

Metode: *Penelitian menggunakan metode potong lintang dengan sampel purposif pada pilot sipil di Balai Kesehatan Penerbangan di Jakarta tanggal 1-13 Mei 2013. Karakteristik demografi, pekerjaan, kebiasaan diperoleh melalui wawancara. Data laboratorium diperoleh dari hasil pemeriksaan laboratorium. Spigmomanometer digunakan untuk mengukur TDD. Kategori TDD dibagi dua yaitu tinggi (≥ 80 mmHg) dan normal (< 80 mmHg). Analisis menggunakan risiko relatif yaitu regresi Cox dengan waktu konstan.*

Hasil: *Di antara 512 pilot yang melakukan pemeriksaan medik, 236 subjek bersedia mengikuti penelitian. Subjek yang diikutsertakan dalam analisis sebanyak 225 orang, 61,4% memiliki TDD tinggi dan 38,6% memiliki TDD normal. Subjek dengan jam terbang total 4000-29831 dibandingkan dengan 4-3999 jam berisiko 34% lebih besar TDD tinggi [rasio relatif suaian (RRa) = 1,34; 95% interval kepercayaan (CI) = 1,03-1,73]. Subjek dengan denyut nadi istirahat 80-98 kali/menit dibandingkan dengan 60-79 kali/menit berisiko 29% lebih besar TDD tinggi (RRa = 1,29; 95% CI = 1,02-1,63). Selain itu subjek berusia 50-61 tahun dibandingkan dengan 18-39 tahun berisiko 26% lebih besar TDD tinggi (RRa = 1,26; 95% CI = 1,00-1,59; P = 0,048).*

Kesimpulan: *Jam terbang total dan denyut nadi istirahat yang tinggi serta usia yang lebih tua meningkatkan risiko tekanan darah diastolik.* ***(Health Science Journal of Indonesia 2015;6:1-6)***

Kata kunci: *tekanan darah diastolik, jam terbang total, pilot sipil, Indonesia*

Abstract

Background: Total flight hour may affect the cardiovascular system including diastolic blood pressure (DBP) in pilot. This study aimed to identify whether total flight hours and other factors increase the risk of high DBP of the fixed wing civilian pilots in Indonesia.

Methods: A cross sectional study with purposive sampling was conducted in civilian pilots at Aviation Medical Center in Jakarta in May 1-13, 2013. Demographic characteristics, employment, habit was obtained through interviews. While laboratory data was obtained from laboratory tests. Sphygmomanometer was used to measure DBP. Category of DBP was classified into high (≥80 mmHg) and normal (<80 mmHg). Analysis used risk relative by Cox regression with constant time.

Results: Among the 512 pilots who conducted medical examinations, 236 subjects agreed to join the study. This analysis included 225 subjects which 61.4% had high DBP and 38.6% normal DBP. The subjects with total flight hours of 4000-29831 compared to 4-3999, had 34% increased risk to be high DBP [adjusted relative risk (RRa) = 1.34; 95% confidence interval (CI) =1.03-1.73]. The subjects with resting pulse rate of 80-98/minute compared to 60-79/minute, had 29% increased risk to be high DBP (RRa = 1.29; 95% CI = 1.02-1.63). Furthermore, subjects aged 50-61years compared to 18-39 years, had 26% increased risk to be high DBP (RRa = 1.6; 95% CI = 1.00-1.59; P = 0.048).

Conclusion: High total flight hours, resting pulse rate, and older age may increase the risk of high diastolic blood pressure among the fixed wing civilian pilots in Indonesia. ***(Health Science Journal of Indonesia 2015;6:1-6)***

Keywords: diastolic blood pressure, total flight hours, civilian pilot, Indonesia

Pilot is one of the profession that require optimal health in order to maintain the safety of flight. However, the pilot is often encountered some health problems, including high blood pressure. The prevalence of high blood pressure in military pilot is 80%, meanwhile the prevalence in the civilian pilot has not been widely studied.[1]

Pilots with high blood pressure should be given special attention due to the risk of cardiovascular events that may lead acute incapacitation while performing flight duties. Because of the possibility of acute incapacitation, pilots who have high blood pressure could have delayed of medical certification or even declared unfit.[2]

Diastolic blood pressure (DBP) is important assessment for pilot because it is a good predictor for the risk of mortality at age less than 50 years. One of the factors that affect the DBP is sympathetic activity.[3] The sympathetic activity may cause vasoconstriction because of endothelial dysfunction and decreased nitric oxide. Furthermore, the chronic sympathetic activity may lead to hypertrophy and vascular remodeling.[3]

In pilot, chronic sympathetic activity may be related to total flight hours. The previous study in Indonesian military pilots showed that high total flight hours (more than 1400 hours) had greater risk to have high DBP.[1,3]

Between civilian and military pilots there are different work environments, the rhythm of flight and aircraft used. These differences may produce different physiological effects between civilian and military pilots.[2] In Indonesia, the study of the effect of total flight hours on diastolic blood pressure, especially in the fixed-wing civilian pilot is still rare.

This study aimed to identify whether total flight hours and other factors increase the risk of high DBP among the fixed wing civilian pilots in Indonesia.

METHODS

This study used cross-sectional design with purposive sampling. The population was fixed wing civilian pilots who conducted routine medical examinations in Aviation Medical Center *(Balai Kesehatan Penerbangan)* in May 1-13, 2013 from 7:00 to 12:00 am. The Data collection of demographic characteristics, employment, habit, and physical, used questionnaires through interviews and physical examination by researchers. While laboratory data was obtained from the results of laboratory tests.

The measurement of blood pressure used a calibrated sphygmomanometer. Measurements were performed in a sitting position, after the subjects rested for at least 5 minutes. Measurements were performed at least 2 times and the distance of at least 2 minutes. If the difference between the two measurements were more than 5 mmHg, additional measurements was performed. The average value of these measurements was the result of blood pressure.[4] Diastolic blood pressure was considered high if 80 mmHg or more and normal if less than 80 mmHg.[4]

The main risk factor in this study was total flight hours. Total flight hours was calculated from the subject began to fly until the time of examination. Total flight hours was divided into 2 categories: 4-4499 hours and 4500-29831 hours. Both of these categories were classified based on the mean value from the results of this study. The other factors which studied were annual flight hours (last 12 months) and monthly (last 30 days). Both of these factors were classified based on the mean value from the results of this study. Annual flight hours was divided into 2 categories: 0-449 hours and 450-1130 hours. While monthly flight hours was divided into 2 categories: 0-34 hours and 35-150 hours.

Another employment factor was length of employment. The length of employment was calculated based on the length of the subject as a pilot until the time of examination. The length of employment were divided into 2 categories: 1-9 years and 10-45 years. Rank was divided into 4 categories: SPL, PPL, CPL and ATPL.[2] The type of flight was divided into 3 categories: short haul (<3 hours), medium haul (3-6 hours) and long haul (> 6 hours). The last flight time was divided into 2 categories: 1-39 days and 40-365 days.

Age, one of the demographic factors in this study, was divided into 3 categories: 18-39 years, 40-49 years and 50-61 years. Sex was divided into 2 categories, man and woman. Race was divided into 2 categories: Asian and Caucasian. The last demographic factors was history of family hypertension.

The habits factors were examined included exercise habits during the past 12 months, which was divided into three categories: never (not once did aerobic exercise), appropriate (with a frequency of aerobic exercise at least 3 times per week and a minimum duration of 30 minutes per time) and not appropriate (not in accordance with the above criteria). The other habit factors included smoking, consumption of coffee and alcohol were assessed during the last 3 months. Smoking habits were divided into 3 categories: never smoking, ex, and current. While consumption of coffee and alcohol habits were each divided into 3 categories: never, 1-2 times per week and ≥ 3 times per week.

The physical factors were examined included resting pulse rate, which was divided into 2 categories: 60-79 times per minute and 80-98 times per minute. Both of these categories were classified based on the mean value from the results of this study. Body mass index was divided into 4 categories: normal, overweight, obesity and underweight. Body mass index was obtained from the results of anthropometric measurements on a combination of body weight (kg) divided by height squared (m) with unit kg/m2. Waist circumference was divided into 2 categories: normal and high. For Asian, waist circumference was considered normal in women if ≤ 80 cm and in men if ≤ 90 cm. As for the Caucasian, in woman was considered normal if ≤ 88 cm and in men if ≤ 102 cm. High waist circumference was classified if exceed the above values. The total cholesterol was divided into 2 categories: normal (≤ 200 mg / dl) and high (> 200 mg / dl). Fasting blood sugar was divided into 2 categories: normal (<126 mg / dl) and high (≥ 126 mg / dl).

The analysis in this study used Cox regression with time constant. Data were analyzed using STATA version 9. Ethical approval was obtained from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Indonesia. This study was conducted after obtaining the approval from the Chief of *Balai Kesehatan Penerbangan*.

RESULTS

Among the 612 pilots who conducted routine medical examinations, 236 subjects agreed to join the study. A total of 11 subjects were excluded in the analysis because were taking anti-hypertension drug or a rotary wing pilot. Thus, subjects were included in the analysis were 225 pilots. By 61.4% of them had high DBP and 38.6% had normal DBP.

Table 1 shows that subjects who had normal and high diastolic blood pressure were similarly distributed in terms of gender, race, family history of hypertension, exercise habits, smoking habits, Alcohol and coffee consumption habits.

Table 1. Several demographic, habits characteristics and risk of high DBP

	Diastolic blood pressure				Crude relative risk	95% confidence interval	p
	Normal (n=87)		**High (n=138)**				
	n	%	n	%			
Gender							
Male	85	38.3	137	61.7	1.00	Reference	
Female	2	66.7	1	33.3	0.54	0.08-3.86	0.539
Race							
Asian	75	37.7	124	62.3	1.00	Reference	
Caucasian	12	46.2	14	53.8	0.86	0.50-1.50	0.605
Family history of hypertension							
No	72	40.2	107	59.8	1.00	Reference	
Yes	15	32.6	31	67.4	1.13	0.76-1.68	0.557
Exercise habits							
Never	44	33.6	87	66.4	1.00	Reference	
Appropriate	37	45.7	44	54.3	0.82	0.57-1.17	0.277
Not appropriate	6	46.2	7	53.8	0.82	0.37-1.75	0.593
Alcohol consumption habits							
Never	71	36.0	126	64.0	1.00	Reference	
1-2 times/week	12	54.5	10	45.5	0.71	0.37-1.35	0.299
≥ 3 times/week	4	66.7	2	33.3	0.52	0.13-2.11	0.361
Coffee consumption habits							
Never	32	42.1	44	57.9	1.00	Reference	
1-2 times/week	10	29.4	24	70.6	1.22	0.74-2.00	0.435
≥ 3 times/week	45	39.1	70	60.9	1.05	0.72-1.53	0.795
Smoking habits							
Never	41	42.1	44	57.9	1.00	Reference	
Ever	5	29.4	24	70.6	1.12	0.59-2.12	0.726
Current	41	39.1	70	60.9	0.98	0.69-1.39	0.917

Table 2 shows that subjects who had length of employment 10-45 years compared to 1-9 years seemed to have an increased risk of 46% for high DBP. Long haul flight compared to short haul flight seemed to have an increased risk of 55% for high DBP. The subjects who had normal and high diastolic blood pressure were similarly distributed in terms of rank, annual flight hour, monthly flight hour and last flight time.

Table 3 showed that the subjects who had normal and high diastolic blood pressure were similarly distributed in terms of body mass index, waist circumference, total cholesterol and fasting blood glucose.

Table 2. Several occupation characteristics and risk of high DBP

	Diastolic blood pressure				Crude relative risk	95% confidence Interval	P
	Normal (n=87)		High (n=138)				
	n	%	n	%			
Rank							
SPL	5	35.7	9	64.3	1.00	Reference	
PPL	4	50.0	4	50.0	0.78	0.24-2.53	0.676
CPL	59	50.4	58	49.6	0.77	0.38-1.56	0.468
ATPL	19	22.1	67	77.9	1.21	0.60-2.43	0.588
Annual flight hours							
Less than 449 hours	49	45.8	58	54.2	1.00	Reference	
450-1130 hours	38	32.2	80	67.8	1.25	0.89-1.75	0.195
Monthly flight hours							
0-34 hours	54	45.0	66	55.0	1.00	Reference	
35-150 hours	33	31.4	72	68.6	1.25	0.89-1.74	0.196
Length of employment							
1-9 years	70	47.0	79	53.0	1.00	Reference	
10-45 years	17	22.4	59	77.6	1.46	1.05-2.05	0.030
Type of flight							
Short haul	71	44.1	90	55.9	1.00	Reference	
Medium haul	12	35.3	22	64.7	1.16	0.73-1.84	0.539
Long haul	4	13.3	26	86.7	1.55	1.00-2.40	0.049
Last flight time							
1-39 days	67	38.3	108	61.7	1.00	Reference	
40-365 days	20	40.0	30	60.0	0.97	0.65-1.46	0.891

Table 3.Several physical and laboratory findings and risk of high DBP

	Diastolic blood pressure				Crude relative risk	95% confidence Interval	p
	Normal (n=87)		High (n=138)				
	n	%	n	%			
Body mass index							
Normal	22	51.2	21	48.8	1.00	Reference	
Overweight	27	41.5	38	58.5	1.20	0.70-2.03	0.508
Obesity	35	31.0	78	69.0	1.41	0.87-2.29	0.159
Underweight	3	75.0	1	25.0	0.51	0.07-3.81	0.513
Waist circumference							
Normal	59	44.7	73	55.3	1.00	Reference	
High	28	30.1	65	69.9	1.26	0.90-1.77	0.170
Total cholesterol							
Normal	34	34.7	64	65.3	1.00	Reference	
High	53	41.7	74	58.3	0.89	0.64-1.25	0.504
Fasting blood glucose							
Normal	85	39.5	130	60.5	1.00	Reference	
High	2	20.0	8	80.0	1.32	0.65-2.70	0.442

Table 4 showed the final model of this study. There were three dominant factors which included age, total flight hours and resting pulse rate. The subjects who had total flight hours of 4000-29831 compared to 4-3999, had 34% increased risk to have high DBP [adjusted relative risk (RRa) = 1.34; 95% confidence interval (CI) = 1.03-1.73]. The subjects with resting pulse rate of 80-98/minute compared to 60-79/minute, had 29% increased risk to have high DBP (RRa = 1.29; 95% CI = 1.02-1.63). Furthermore, subjects aged 50-61years compared to 18-39 years, had 26% increased risk to have high DBP (RRa = 1,.6; 95% CI = 1.00-1.59; P = 0.048).

DISCUSSION

This study has several limitations such as the possibility of recall bias during the interview. If the answer during interview were not appropriate, the examiner saw log book or flight data from past medical records to reduce recall bias.

In this study, the percentage of high DBP on fixed wing civilian pilot was 61.3%. The percentage of this study was less than in the study of fixed and rotary wing military pilots in Indonesia by Siagian (2009), which was 84.4%.[1] Greater aviation exposure such as vibration, noise, acceleration and hypoxia, on military pilot, may be the cause of the prevalence of high DBP was greater than civilian pilot. In civilian pilots, the aviation exposure are not as much as a military pilot, because the civilian aircraft was designed with particular attention to comfort and safety.[5, 6]

High total flight hours related to the duration of flight exposure. In this study, subject who had total flight hours of 4.000-29.831 hours compared to 4-3999 hours had increased risk for high DBP. The value of total flight hours which was lead to high DBP in civilian pilot is higher than the value in military pilot. This is also because of the differences in aviation exposure between civilian and military pilot which is reflected by total flight hours.[5-6]

Table 4. The relationship between age, total flight hours. resting pulse rate and risk of high diastolic blood pressure

	Diastolic blood pressure				Adjusted relative risk*	95% confidence Interval	p
	Normal (n=87)		High (n=138)				
	n	%	n	%			
Age							
18-39 years	75	44.4	94	55.6	1.00	Reference	
40-49 years	11	30.6	25	69.4	1.01	0.76-1.35	0.938
50-61 years	1	5.0	19	95.0	1.26	1.00-1.59	0.048
Total flight hours							
4-3999 hours	68	47.9	74	52.1	1.00	Reference	
4000-29831 hours	19	22.9	64	77.1	1.34	1.03-1.73	0.027
Resting pulse rate/minute							
60-79 beats	49	50.5	48	49.5	1.00	Reference	
80-98 beats	38	29.7	90	70.3	1.29	1.02-1.63	0.030

*Adjusted each other between risk factors listed on this table

Aviation exposure may activate the sympathetic nervous system. This stimulation may cause endothelial dysfunction and decreased nitric oxide resulting in vasoconstriction. If it happens in the long term, the chronic activation of the sympathetic nervous system may cause hypertrophy and remodeling of blood vessels which exacerbates peripheral resistance resulting in an increase in DBP.[7]

The most possible exposure may lead to increased DBP on fixed wing civilian pilot, is high level of preparedness when operating the airplane, during take-off and landing, also in anticipation of problems related to weather and aircraft engines. Study by Melhado (2000) on the civilian pilot showed that there was an increase in urinary catecholamines during the flight than before and after.[8]

Several study showed that high resting pulse rate may be a predictor of increased DBP. High resting pulse rate associated with high sympathetic tone. This high sympathetic tone may lead to increased peripheral resistance, which in turn cause increasing blood pressure. In this study, a high resting pulse rate may be caused by long exposure to the factors that may lead to increased DBP.[9]

Age may affect blood pressure. Age affects the stiffness of the arterial wall that may affect vascular compliance. A study showed that DBP will increase until the age of 50 years and then it will be stable or decrease. Other studies showed that DBP is likely to decline from the age of 60 years.[3] In this study aged 50-61 years increased risk of high DBP. The downward trend of DBP has not been seen because only one subjects with age above 60 years.

In conclusion high total flight hours, high resting pulse rate and older age may increase the risk of high diastolic blood pressure.

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REFERENCES

1. Siagian M, Basuki B, Kusmana D. High intensity interior aircraft noise increases the risk of high diastolic blood pressure in Indonesian Air Force Pilot. Med J Indones. 2009;18:276-82.
2. International Civil Aviation Organization. Annex 1. Personal licensing. 2008.
3. Oparil S, Zaman A, Calhoun D. Pathogenesis of hypertension. Ann Intern Med. 2003;139:761-76.
4. Joint National Committee on Prevention Detection, Evaluation, and Treatment of High Blood Pressure. The seventh report of the Joint National Committee on Prevention Detection, Evaluation, and Treatment of High Blood Pressure. JAMA. 2003;289:2560-72.
5. Grossman A, Barenboim E, Azaria B, et al. Pre-hypertension as a predictor of hypertension in military aviators. ASEM. 2006;77:1162-5.
6. Batchelor AJ. Hypertension. In Ernsting's aviation medicine. Rainford DJ, Gradwell DP, Editors. New York: Edward Arnold. 2006. p. 605-10.
7. Otsuka Y, Onozawa A, Kikukawa A, et al. Effects of flight workload on urinary catecholamine responses in experienced military pilots. Percept Mot Skills. 2007;105:563-71.
8. Melhado VE, Tavores A, Kohlman O, et al. Blood pressure and sympathetic activity in normotensive aviator during short haul fixed wing flight. ASEM. 2000;71:531-5.
9. Palatini P, Casiglia E, Pauletto P, et al. Relationship of tachycardia with high blood pressure and metabolic abnormalities. Hypertension. 1997;30:1267-73.