The effect of workload and other risk factors of metabolic syndrome among short-haul commercial pilots in Indonesia

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Abstrak

Latar belakang: *Sindroma metabolik (MS) dapat menyebabkan kecacatan di antara pilot di Indonesia. Tujuan dari penelitian ini adalah untuk mengidentifikasi faktor-faktor risiko MS antara pilot komersial jarak pendek di Indonesia.*

Metode: *Penelitian potong lintang dengan sampling purposif yang dilakukan di antara pilot komersial yang melakukan uji medik di Balai Kesehatan Penerbangan Sipil, Jakarta tanggal 27 Juli-30 Agustus 2014. Sindroma metabolik dinilai menurutkriterian National Cholesterol Education Program Adult Treatment Panel III. Faktor risiko diperoleh dengan menggunakan kuesioner self-reporting anonim. Data laboratorium diperoleh dari catatan medis. Regresi Cox digunakan untuk mengidentifikasi faktor-faktor risiko yang dominan dari MS.*

Hasil: *Selama pengumpulan data, 2135 pilot melakukan uji medik. Jumlah pilot Asia laki-laki memenuhi kriteria inklusi adalah 864 pilot. Prevalensi MS adalah 18,28%. Dibandingkan dengan kelompok 20-35 tahun, yang berusia berusia 56-65 tahun memiliki risiko 88% lebih tinggi untuk MS [risiko relatif sesuaian (RRa) = 1,88; P = 0,019]. Jika ditinjau dari jumlah sektor dalam 24 jam terakhir, dibandingkan dengan 0-3 sektor, subyek yang memiliki 6-7 sektor mempunyai risiko 66% lebih tinggi untuk MS (RRa = 1,66; P = 0,033), sedangkan yang memiliki 8 atau lebih sektor dalam 24 jam memiliki 82% lebih berisiko untuk MS (RRa = 1,82; P = 0,072).*

Kesimpulan: *Pilot berusia tahun-56-65, yang memiliki 6 atau lebih sektor dalam 24 jam terakhir, memiliki risiko lebih tinggi untuk sindroma metabolik antara jarak pendek pilot komersial di Indonesia. (**Health Science Journal of Indonesia 2015;6:81-6)***

Kata kunci: *Sindroma metabolik, jumlah sektor, pilot, Indonesia*

Abstract

Background: Metabolic syndrome (MS) could cause sudden incapacitation among pilots in Indonesia. The aim of this study was to identify risk factors of MS among short-haul commercial pilots in Indonesia.

Methods: A cross-sectional study with purposive sampling was conducted among commercial pilots taking medical examination at the Civil Aviation Medical Center, Jakarta from July 27-August 30th, 2014. Metabolic syndrome was assessed according to the National Cholesterol Education Program Adult Treatment panel III criteria and criteria. Risk factors were collected using anonymous self-reporting questionnaire. The laboratory data were extracted from medical records. Cox regression was used to identify dominant risk factors of MS.

Results: During data collection, 2135 pilots taking medical examination, Total male Asian pilots met the inclusion criteria was 864 pilots. Prevalence of MS was 18.28%. Compared to 20-35 year-old group, subjects aged 56-65 years-old had 88% higher risk for MS [adjusted relative risk (RRa) = 1.88; P = 0.019]. In term of number of sectors in the last 24 hours, compared to 0-3 sectors, subjects who had 6-7 sectors in the last 24 hours had 66% higher risk for MS (RRa = 1.66; P = 0.033), while subjects who had 8 or more sectors in 24 hours had 82% more risk for MS (RRa = 1.82; P = 0.072).

Conclusions: The pilot aged 56-65 years-old, who had 6 or more sectors in the last 24 hours, had higher risk for metabolic syndrome among short-haul commercial pilots in Indonesia. ***(Health Science Journal of Indonesia 2015;6:81-6)***

Keyword: metabolic syndrome, number of sectors, pilots, Indonesia

Metabolic syndrome is associated with development of cardiovascular disease, stroke, and diabetes mellitus.[1,2] Those conditions could cause an onboard sudden incapacitation among commercial pilots thus increase the risk of accidents in Indonesia. Moreover, metabolic syndrome has been associated and characterized with elevated cortisol level which also have been shown increase acutely in response to work demands, sleep deprivation and fatigue.[1,2]

Sleep deprivation and fatigue are major concern among commercial pilots that lead to great risk for aviation safety.[3] The causes of pilot fatigue are primarily related to sleep loss for both long-haul and short-haul flights. Night flights and jet lag are the most important factors that generated fatigue in long-haul flights.[4] While other studies revealed that fatigue in short-haul operation was caused by the number of sectors,[4,5] more than one unplanned flights in a month,[3,6] cumulative flight time in the preceding week,[5] and sleep restriction.[7]

Indonesia is an archipelago nation and short-haul domestic flights between cities or small islands play an important role. High domestic passenger rate and tense competition among airlines in Indonesia[8] pushed airline management to a culture of short-haul pilots flying more sectors, flying unplanned flights during rest periods and cumulatively flying close to legal maximum of flight and duty time limitations, as was clarified by 30% of subjects during preliminary study. This condition may adversely affect the safety of short-haul flights in Indonesia

The aim of this study was to identify the dominant risk factors related to metabolic syndrome among short-haul commercial pilots in Indonesia.

METHODS

This cross-sectional study was conducted among the population of active pilots working for commercial airlines in Indonesia. Subjects were selected by purposive sampling from commercials pilots taking medical examinations at the Civil Aviation Medical Center in Jakarta from May 5 – 26, 2014.

The inclusion criteria were male Asian commercials pilots who actively having flight duty in the last 7 days prior to data collection and holding an Airline Transport Pilot License (ATPL) or Commercial Pilot License (CPL) type license, and operating in short-haul flights of less than 2 hours flight time per sector. The exclusion criteria were subjects has been diagnosed with diabetes mellitus or taking hypnotics or stimulants.

Subjects willing to participate signed an informed consent letter, then were asked to fill in a self-reporting questionnaire regarding demographics, smoking habits, type rating, and pilots' workload including flight time in the last 30 and 7 days; flight time in the last 24 hours; number of sectors in the last 24 hours; frequency of unplanned flight and flight time during unplanned flights in the last 30 days, and fatigue using Fatigue Severity Scale (FSS).

Metabolic syndrome was assessed using the National Cholesterol Education Program (NCEP) Adult Treatment Panel-III (ATP-III) criteria as having three or more of the following: fasting blood glucose of at least 110 mg/dl, blood pressure at least 130/85 mmHg, waist circumference of greater than 90 cm for Asian men or 102 for Caucasian men, triglycerides greater than 150 mg/dl, and HDL cholesterol of less than 40 mg/dl in men. Data were collected from medical record.[1,2]

The risk factors were age, smoking habits, type license, type rating, and pilots' workload including flight time in the last 30 and 7 days; flight time in the last 24 hours; number of sectors in the last 24 hours; frequency of unplanned flight and flight time during unplanned flights in the last 30 days, and fatigue using Fatigue Severity Scale (FSS).

The number of sectors was defined as any flight which has a take-off and landing at different airports which are not less than 50 nautical miles apart in the last 24 consecutive hours.[9] Flight time was considered as total elapsed time from the moment the aircraft first moved under its own power for takeoff, until the time it comes to rest at the end of the flight. This variable was divided into flight time in the last 24 hours, in the last 7 days and 30 days.[9]

Unplanned flight was considered as flight duty, performed by the pilot, which was not in their schedule or during their day-off, in the last 30 consecutive days. This variable was divided into frequency and flight time of unplanned flight.

Fatigue was measured using Fatigue Severity Scale (FSS) that consisted of 9 questions relating to fatigue and its impact on functioning and behavioral aspects in the past week. The FSS questions were: (1) my motivation is lower when I am fatigued; (2) exercise brings on my fatigue; (3) I am easily fatigued; (4) fatigue interferes with my physical functioning;

(5) fatigue causes frequent problem for me; (6) my fatigue prevents sustained physical functioning; (7) fatigue interferes with carrying out certain duties and responsibilities; (8) fatigue is among my most disabling symptoms; and (9) fatigue interferes with my work, family, or social life. Subjects answered the questions on a scale of "1" indicating agrees to and "7" indicating disagrees to. This variable was divided into clinical fatigue if mean FSS score was greater than 5.[10]

Ethical clearance was granted from the Research Ethical Commission of Faculty of Medicine Universitas Indonesia and data collection was approved by the Head of the Civil Aviation Medical Center.

Cox regression was used to identify dominant risk factors related to metabolic syndrome,[11] variable sub-group were categorized using Receiver Operating Characteristic (ROC) and computed using Stata released 9.

RESULTS

In the 25-day data collection period, there were 2135 pilots taking medical examination and 1545 pilots willing to participate. There were pilots who did not meet the inclusion criteria including 461 pilots flying intermediate and long haul flights,190 pilots not actively flying in the past 7 days because of taking annual leave, having no schedule for flight duty or being a ground instructor and 3 female pilots. There were 891 pilots met the inclusion criteria of had short-haul flight duty in the last 7 days but 27 pilots were excluded because has been diagnosed with diabetes mellitus. None of the subjects excluded for taking hypnotics or stimulant medication. Finally, the subject in this study was 864 commercial pilots.

Table 1 showed that the prevalence of metabolic syndrome among subject were 18.28%. The highest prevalence of metabolic syndrome criteria was prehypertension at 62,28%, followed by HDL cholesterol level less than 40 mg/dl at 36.3% and waist circumference greater than 90 cm at 34.71%. More than half (56.0%) of the subjects had clinical fatigue.

Table 2 showed that the subjects who had and did not have metabolic syndrome were similarly distributed with respect to type rating, clinical fatigue, flight time in the last 7 days, frequency of unplanned flights, as well as flight time of unplanned flights.

Table 1. Percentage of metabolic syndrome subjects by respective characteristic of subjects

	n	%
Category of BMI		
Underweight	10	1.16
Normal	372	43.11
Overweight	371	42.94
Obese	111	12.85
Waist Circumference > 90 cm	300	34.71
Triglycerides > 150 mg/dl	116	13.43
Fasting blood glucose > 110 mg/dl	132	15.28
Prehypertension > 130/85 mmHg	538	62.27
HDL < 40 mg/dl	314	36.34
Clinical fatigue	484	56.02
Metabolic syndrome	484	56.02

Compared with pilot who had Boeing rating group, the pilot who had Avions de transport regional (ATR) rating group were more likely had higher risk to be metabolic syndrome. On the side, compared with pilot who had flight time in the last 30 days for 15-69 hours, those who had 70-89 hours were less likely had 21% to be metabolic syndrome.

Table 3 showed that age group, flight time in the last 24 hours, and number of sectors in the last 24 hours three dominants factors related were related to metabolic syndrome.

Furthermore, compared to 20-35 year-old group, subjects aged 56-65 years-old had 88% higher risk for metabolic syndrome [adjusted relative risk (RRa) = 1.88; P = 0.019]. In term of number of sectors in the last 24 hours, compared to 0-3 sectors, subjects who had 6-7 sectors in the last 24 hours had 66% higher risk for metabolic syndrome (RRa = 1.66; P = 0.033), while subjects who had 8 or more sectors in 24 hours had 82% more risk for metabolic syndrome (RRa = 1.82; P = 0.072).

DISCUSSION

In interpreting this study, it should be considered that there are unmodifiable factor such as age, ethnic, gender, metabolic genes, and it takes time to develop.[1,2] This effect has been minimize by selecting male and Asian, subjects. There are also other factor related to hypercortisolism resulted from chronic fatigue that were not measured in this study such circadian rhythm, psychological factor that lead to chronic stress and sleep deprivation.[2]

Table 2. Several demographis and workload characteristis and risk of metabolic syndrome

	Metabolic syndrome				Crude Relative Risk	95 % confidence interval	p
	No (n=706)		Yes (n=158)				
	n	%	n	%			
Type of license							
Commercial pilot License	412	83.2	83	16.8	1.00	Reference	
Airline transport pilot License	294	79.7	75	20.3	1,21	0,88-1,65	0,227
Type rating							
Boeing	397	82.4	85	17.7	1.00	Reference	
Airbus	105	86.1	17	13.9	0.79	0.46-1.33	0.375
Avions de transport regional	44	74.6	15	25.4	1.44	0.83-2.49	0.191
Others	160	79.6	41	20.4	1.15	0.79-1.67	0.444
Smoking habits							
Never	562	81.0	132	19.0	1.00	Reference	
1-7 cigarettes/day	34	75.6	11	24.4	1.28	0.69-2.37	0.424
8-15 cigarettes/day	39	90.7	4	9.3	0.48	0.18-1.32	0.159
15-21 cigarettes/day	51	82.3	11	17.7	0.93	0.50-1.72	0.825
22 or more cigarettes/day	20	100	0	0	n/a*		
Clinical fatigue							
No	312	82.1	68	17.9	1.00	Reference	
Yes	394	81.4	90	18.6	1.04	0.75-1.42	0.811
Flight time in the last 30 days							
15-69 hours	334	79.7	85	20.3	1.00	Reference	
70-89 hours	244	85.0	43	15.0	0.73	0.51-1.06	0.105
90-109 hours	104	83.9	20	16.1	0.79	0.48-1.29	0.356
110 or more hours	24	70.6	10	29.4	1.44	0.75-2.79	0.267
Flight time in the last 7 days							
5-19 hours	343	80.5	83	19.5	1.00	Reference	
20-24 hours	183	82.1	40	17.9	0.92	0.63-1.34	0.667
25-29 hours	137	84.0	26	16.0	0.81	0.52-1.27	0.373
30 or more 30 hours	43	82.7	9	17.3	0.88	0.44-1.76	0.736
Frequency of unplanned flights in the last 30 days							
Never	528	`	121	18.6	1.00	Reference	
Once	100	83.3	20	16.7	0.89	0.55-1.43	0.642
2 times	57	80.3	14	19.7	1.05	0.60-1.83	0.843
3 times	13	86.7	2	13.3	0.71	0.17-2.89	0.638
4 times	8	88.9	1	11.1	1.07	0.14-7.67	0.944
Flight time of unplanned flights in the last 30 days							
Never	558	81.4	128	18.6	1.00	Reference	
1-5 hours	97	83.6	19	16.4	0.87	0.54-1.42	0.596
6-10 hours	23	71.9	9	28.1	1.50	0.76-2.96	0.234
11-16 hours	17	89.5	2	10.5	0.59	0.14-2.40	0.467

* n/a = not applicable

Age was the highest dominant factor to significantly increase the risk of metabolic syndrome which subjects age 56-65 year-old had 88% higher probability to metabolic syndrome compared to subject age less than 35 years old. This result was not consistent with the research performed in the Naval Submarines Medical Research Laboratory among 199 submarines involving in stressful working condition. This study revealed that submariner age 30-44 year-old had 25% probability of metabolic syndrome. This difference between these study probably because of the number and the community of subjects were different although they might had similar work stress related condition. Other than that, age is one of an unmodifiable risk factors of metabolic syndrome.

Other dominant factor was number of sectors in the last 24 hours, which subjects flying 6-7 sectors in the last 24 hours had an increase of 66% probability for metabolic syndrome compared to subjects flying less

Table 3. Several dominant factors and risk of metabolic syndrome

	Metabolic syndrome				Adjusted Relative Risk	95 % confidence interval	p
	No (n=706)		Yes (n=158)				
	n	%	n	%			
Age group							
20-35 year-old	281	84.9	50	15.1	1.00	Reference	
36-45 year-old	291	80.6	70	19.4	1.28	0.92-1.78	0.138
46-55 year-old	105	80.2	26	19.8	1.31	0.85-2.01	0.209
56-65 year-old	29	70.7	12	29.3	1.88	0.55-3.00	0.019
Flight time in the last 24 hours							
0-5 hours	376	78.7	102	21.3	1.00	Reference	
6-8 hours	303	85.1	53	14.9	0.67	0.48-0.93	0.009
9 or more hours	27	90.0	3	10.0	0.42	0.13-1.35	0.116
Number of sectors in the last 24 hours							
0-3 sectors	333	83.9	64	16.1	1.00	Reference	
4-5 sectors	299	81.3	69	18.7	1.20	0.88-1.63	0.239
6-7 sectors	57	76.0	18	24.0	1.66	1.04-2.64	0.033
8 or more sectors	17	70.8	7	29.2	1.82	0.94-3.51	0.072

than 3 sectors in the last 24 hours. This study showed that number of sectors which consisted of multiple take-offs and landings as critical phase of flight induced an acute-stress response in the hypothalamo-pituitary-adrenocortical axis.[1] This response resulting in elevated cortisol level that accumulatively associated with fatigue as one of primary causes of hypercortisolism and has been linked to metabolic syndrome.

Short-haul commercial pilots flying 6-8 hours in the last 24 hours had 23% lower probability to metabolic syndrome compared to pilots flying less than 5 hours in the last 24 hours. This result probably because of healthy worker effect among pilots flying more than 9 hours in the last 24 hours.

In addition, cardio-metabolic disorder associated with chronically elevated cortisol such as central obesity, insulin resistance, glucose intolerance, dyslipidemia, and stress-mediated hypertension are also drastically improved with regular exercise.[1,2]

This study revealed that short-haul pilots who are prone to early starts and late finishes can result in sleep restriction and disrupt circadian rhythm thus lead to sleep deprivation and cumulative fatigue. This condition ultimately resulting in elevated cortisol level and has been linked to metabolic syndrome. Certain measures, however can be taken to help reduce the vulnerability to hypercortisolism including regular exercise, efficient rest periods that are sufficient in length, and mental relaxation techniques.[1,2]

As a member ICAO, Indonesia strives to implement Fatigue Research Management System (FRMS) to our regulations. This study was conducted as first step of FRMS implementation, to gather data and information on risk factors of fatigue, mainly workload related factors and the effect of workload on metabolic syndrome among short-haul commercial pilots in Indonesia. Further studies are suggested to establish the presence of metabolic syndrome and fatigue in different operations and organize a cooperative arrangement between The Ministry of Transportation Republic of Indonesia, every operating airline in Indonesia, as well as airport operator to work in harmony for adopting every step of FRMS as amended by the ICAO.

In conclusion, the pilot aged 56-65 years-old, who had 6 or more sectors in the last 24 hours, had higher risk for metabolic syndrome among short-haul commercial pilots in Indonesia.

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