Working-room temperature is associated with increased blood pressure among air traffic controllers in the Jakarta Air Traffic Service Center

R Zuhriyanto¹, D S Soemarko²* and W Pribadi³

¹Aviation Medicine Programme, Department of Community Medicine, Faculty of Medicine, Universitas Indonesia, Jakarta, 10430, Indonesia
²Department of Community Medicine, Faculty of Medicine, Universitas Indonesia, Jakarta, 10430, Indonesia
³Dr. Saryanto Aviation and Space Health Institute, Jakarta, 12770, Indonesia

*E-mail: dewisoemarko@yahoo.com

Abstract. An increase in blood pressure (BP) can increase the risk of ischemic heart disease and stroke. This study aimed to identify risk factors for increased BP among air traffic controllers (ATCs) in the Jakarta Air Traffic Service Center (JATSC). We used a cross-sectional study design with random sampling of ATCs over 17 days from May to June 2017; 134 subjects participated in the study. Data were collected using a questionnaire, a mercury sphygmomanometer for BP, and a digital thermometer for room temperature. Increased BP was defined as systolic BP ≥ 140 mmHg or diastolic BP ≥ 90 mmHg after work. Our results showed that participants aged ≥40 years were 2.2 times more likely to have increased BP than those aged <40 years [RRa = 2.18; 95% confidence interval (CI) = 1.15–4.11; p = 0.016]. Participants who worked at a room temperature of <21°C were 2.1 times more likely to have increased BP than those who worked in a room temperature of ≥21°C (RRa = 2.10; 95% CI = 1.12–3.93; p = 0.020). In conclusion, ≥40 years of age and working-room temperature of <21°C were identified as risk factors for increased BP among ATCs.

1. Introduction

Hypertension can increase the risk of cardiovascular diseases, stroke, and kidney failure. From a starting blood pressure (BP) of 115/75 mmHg, every 20-mmHg increase in systolic pressure or 10-mmHg increase in diastolic pressure can double the risk of death from ischemic heart disease and stroke [1].

According to research conducted by the Ministry of Health in 2013, the prevalence of hypertension in Indonesia in people aged ≥18 years was 26.5% [2]. Other research with pilots and air traffic controllers (ATCs) conducted by Charles et al. indicated that the prevalence of hypertension in ATCs was 21.1%—greater than that in pilots, which was 10.6% [3].

The average temperature of the ATC working area in the Jakarta Air Traffic Service Center (JATSC) at Soekarno Hatta Airport in Tangerang is 18°C to 21 °C and decreases to 16 °C at night [4]. A report by Astuti et al. in 2008 showed a correlation between cold temperature and an increase in the
risk of qualitative workload stress for ATCs in Soekarno Hatta Airport; specifically, under conditions in which the ATCs felt the working area was too cold, there was an 11-fold increase in the risk of qualitative workload stress [4]. Likewise, a study by Shiue on Scottish people indicated that a room temperature of <18 °C increases the risk of increased BP [5].

Research on ATCs in Indonesia has not yet evaluated the impact of working environment on health. ATCs in Soekarno Hatta Airport have different tasks, workloads, and environmental exposures in the ATC tower and ATC operations room. Therefore, this research aimed to identify the risk factors for increased BP among ATCs in JATSC, with a specific focus on the correlation between working-area temperatures and BP.

2. Methods
This study used a cross-sectional design, and data were collected from May 29, 2017, to June 14, 2017. The participants were ATCs working in JATSC and were sampled randomly. The inclusion criteria were as follows: ATC working in JATSC rated in aerodrome control (ADC), approach control procedures (APP), approach control surveillance (APS), area control procedures (ACP), or area control surveillance (ACS); and agreed to be a respondent and signed the agreement form. The exclusion criteria were as follows: use of anti-hypertension medication or history of heart disease, chronic kidney disease, or diabetes. Participants were dropped from the study if they did not completely fill out the questionnaire.

The outcome measure for this study was BP as measured using a manual mercury sphygmomanometer after working (commanding a plane). BP measures were classified according to JNC 7 and categorized as “increased” if diastolic BP was ≥140 mmHg and systolic BP was ≥90 mmHg after working (compared with BP measurements before working). The recommended limit for working pilots and ATCs, according to ICAO, is a BP of 140/90 mmHg [6].

The working area temperature was measured using a digital thermometer during the entire time participants were working, and their perception of the temperature was noted. For analysis, the temperature was classified as <21 °C and ≥21 °C according to ICAO guidelines for ATC room temperature [7].

Each participant’s age was calculated as the difference between the date of birth and the date of data collection. We limited our analyses to participants aged <40 years old as BP begins to increase at this age [8].

The ATC working units were divided into the ATC tower and operations room. Rating or authority level was based on licenses earned, such as ADC, APP/APS, or ACP/ACS. Total working duration was classified as 0–10 years, 11–20 years, and > 20 years.

Body mass index (BMI) was classified as normal (≤25 kg/m²) and overweight (>25 kg/m²). Working factors, namely working duration inside the room and resting duration between the 2-h working time, were classified into <2 h and ≥2 h. Smoking habit was classified according to the Brinkman index into light (1–599) and heavy (≥600) [9]. Physical activity was classified based on total exercise duration in a week, according to the American College of Sports Medicine that recommends ≥75 min/week.

Alcohol-drinking habit was noted for the 30 days before the study. Intake of salted, flavored, and instant foods was recorded as daily frequency. Coffee intake was recorded as the number of cups per day.

Analyses started with a descriptive overview of each variable, followed by a bivariate analysis. Variables with p < 0.25 were subjected to multivariate analysis with cox regression on constant time using the backward likelihood ratio (LR) method in SPSS 20. P < 0.05 were considered statistically significant.

3. Results
Of the 158 individuals who agreed to participate, 134 completed the study (after exclusion criteria and study drop out). Six participants were excluded for taking hypertension medication; five were
excluded because of heart disease, chronic kidney disease, or diabetes; and 18 were dropped because they did not complete the questionnaire. Distribution of age, working duration, body mass index, and working-room temperature can be seen in Table 1 and distribution of average blood pressure shown in Table 2.

**Table 1. Distribution of age, working duration, body mass index, and working-room temperature (n = 134)**

|                          | Mean ± SD  | Median (min–max) |
|--------------------------|------------|------------------|
| Age (years)              | 35.2 ± 10.7 | 32.5 (21–63)     |
| Total working duration (years) | 13.1 ± 9.9  | 9.5 (1–40)       |
| Body mass index         | 25.8 ± 3.6  | 25.6 (17.4–46.2) |
| Working-room temperature (°C) | 22.2 ± 2.1  | 21.5 (19.0–25.9) |

**Table 2. Distribution of average blood pressure (n = 134)**

| Blood pressure (mmHg)                      | Mean ± SD  | Median (min–max) |
|------------------------------------------|------------|------------------|
| Systolic before work                     | 115.5 ± 9.1 | 120 (90–140)     |
| Diastolic before work                    | 75.0 ± 6.3  | 80 (60–90)       |
| Systolic after work                      | 119.9 ± 9.9 | 120 (100–155)    |
| Diastolic after work                     | 80.8 ± 7.7  | 80 (60–100)      |

As shown in Table 3, most participants had prehypertension before work (59.7%) and after work (46.3%). Notably, we observed hypertension (systolic BP ≥ 140 mmHg or diastolic BP ≥ 90 mmHg) in 41 participants (30.6%) after work.

**Table 3. Increased blood pressure distribution (n=134)**

| *Blood pressure (JNC 7) | Before work | After work |
|-------------------------|-------------|------------|
|                         | n   | %  | n   | %  |
| Normal                  | 52  | 38.8| 31  | 23.1|
| Prehypertension         | 80  | 59.7| 62  | 46.3|
| Hypertension 1          | 2   | 1.5 | 40  | 29.9|
| Hypertension 2          | 0   | 0  | 1   | 0.7 |

*Classification of blood pressure according to Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7)
- Normal: <120/<80 mmHg
- Prehypertension: 120-139/80-89 mmHg
- Hypertension 1: 140-149/90-99 mmHg
- Hypertension 2: ≥160/≥100 mmHg

For participants with a total working duration of 11–20 years and APP or APS ratings, the incidences of increased BP and non-increased BP were equally distributed (Table 4). Comparison of basic demographic factors revealed that men aged ≥40 years who (1) had a family history of hypertension, (2) were overweight, (3) had worked as an ATC for >20 years, (4) were working in the ATC operations room, and (5) had ACP and ACS ratings seemed to be at a high risk of increased BP after work.
Table 4. Correlation of demographic characteristics and increased blood pressure

|                     | Increased blood pressure | Crude relative risk | Confidence interval 95% | P       |
|---------------------|--------------------------|---------------------|--------------------------|---------|
|                     | Increased (n = 41)       | Not increased (n = 93) |                        |         |
|                     | n  | %   | n   | %   |                 |         |
| Age                 |    |     |     |     |                 |         |
| ≥40 years           | 24 | 50.0| 24  | 50.0| 1.61            | 1.19–2.17| 0.000   |
| <40 years           | 17 | 19.8| 69  | 80.2| 1.00            |  Recommended |
| Gender              |    |     |     |     |                 |         |
| Male                | 38 | 34.9| 71  | 65.1| 1.35            | 1.11–1.65  | 0.025   |
| Female              | 3  | 12.0| 22  | 88.0| 1.00            | Recommended |
| Family history of hypertension: | |     |     |     |                 |         |
| Yes                 | 12 | 40.0| 18  | 60.0| 1.20            | 0.88–1.65 | 0.205   |
| No                  | 29 | 27.9| 75  | 72.1| 1.00            |  Recommended |
| Body Mass Index     |    |     |     |     |                 |         |
| Overweight          | 28 | 36.4| 49  | 63.6| 1.21            | 0.97–1.51  | 0.092   |
| Thin/normal         | 13 | 22.8| 44  | 77.2| 1.00            |  Recommended |
| Total working duration |   |     |     |     |                 |         |
| >20 years           | 19 | 63.3| 11  | 36.7| 2.21            | 1.36–3.59  | 0.000   |
| 11–20 years         | 9  | 25.7| 26  | 74.3| 1.09            | 0.87–1.37 | 0.417   |
| 0–10 years          | 13 | 18.8| 56  | 81.2| 1.00            |  Recommended |
| Working unit        |    |     |     |     |                 |         |
| Operation room      | 32 | 42.1| 44  | 57.9| 1.46            | 1.17–1.82  | 0.001   |
| Tower               | 9  | 15.5| 49  | 84.5| 1.00            |  Recommended |
| Rating              |    |     |     |     |                 |         |
| ACP and ACS         | 24 | 44.4| 30  | 55.6| 1.47            | 1.08–2.01 | 0.031   |
| APP and APS         | 13 | 22.4| 45  | 77.6| 1.06            | 0.83–1.34 | 0.769   |
| ADC                 | 4  | 18.2| 18  | 81.8| 1.00            |  Recommended |

ACP: Area control procedural
ACS: Area control surveillance
APP: Approach control procedural
APS: Approach control surveillance
ADC: Aerodrome control

Among ATCs who worked for ≥2 h, had a resting duration of <2 h, or worked a morning and night shift, the incidences of increased and non-increased BP were distributed equally (Table 5). Considering each basic comparison of working characteristics, participants who worked in room temperature of <21 °C and those who reported an uncomfortable perception of the room temperature were at a high risk of increased BP.

Comparison of participants with a light smoking habit, less than recommended physical activity, alcohol habit, and salted food intake (once per day) revealed that the incidences of increased and non-increased BP were equally distributed (Table 6). Comparatively, participants who engaged in the recommended amount of physical activity were at a low risk of increased BP, whereas participants who were heavy smokers, ate salted food twice per day, and had coffee ≥thrice per day were at a high risk of increased BP.
### Table 5. Correlation of working characteristics and increased blood pressure

| Working-room temperature | Increased blood pressure | Crude relative risk | Confidence interval 95% | P     |
|--------------------------|--------------------------|---------------------|-------------------------|-------|
|                          | Increased (n = 41) | Not increased (n = 93) |                           |       |
|                          | n | % | n | % |                           |       |
| <21 °C                   | 21 | 52.5 | 19 | 47.5 | 1.66 | 1.18–2.33 | 0.000 |
| ≥21 °C                   | 20 | 21.3 | 74 | 78.7 | 1.00 | Reference |       |
| Perception on temperature|             |                           |                           |       |
| Uncomfortable            | 17 | 54.8 | 14 | 45.2 | 1.70 | 1.14–2.54 | 0.001 |
| Comfortable              | 24 | 23.3 | 79 | 76.7 | 1.00 | Reference |       |
| Working duration         |             |                           |                           |       |
| ≥2 h                     | 24 | 27.6 | 63 | 72.4 | 0.88 | 0.69–1.13 | 0.303 |
| <2 h                     | 17 | 36.2 | 30 | 63.8 | 1.00 | Reference |       |
| Resting duration         |             |                           |                           |       |
| <2 h                     | 17 | 33.3 | 34 | 66.7 | 1.07 | 0.84–1.35 | 0.590 |
| ≥2 h                     | 24 | 28.9 | 59 | 71.1 | 1.00 | Reference |       |
| Shift                    |             |                           |                           |       |
| Night                    | 19 | 34.5 | 36 | 65.5 | 1.08 | 0.69–1.37 | 0.695 |
| Morning                  | 17 | 27.4 | 45 | 72.6 | 0.97 | 0.75–1.55 | 1.000 |
| Evening                  | 5  | 29.4 | 12 | 70.6 | 1.00 | Reference |       |

### Table 6. Correlation of habitual characteristics and increased blood pressure

| Increased blood pressure | Crude relative risk | Confidence interval 95% | P     |
|--------------------------|---------------------|-------------------------|-------|
|                          | Increased (n = 41) | Not increased (n = 93) |                           |       |
|                          | n | % | n | % |                           |       |
| Smoking                  |             |                           |                           |       |
| Heavy                    | 13 | 68.4 | 6 | 31.6 | 2.42 | 1.24–4.74 | 0.000 |
| Light                    | 7  | 26.9 | 19 | 73.1 | 1.05 | 0.81–1.36 | 0.728 |
| No smoking               | 21 | 23.6 | 68 | 76.4 | 1.00 | Reference |       |
| Physical activity        |             |                           |                           |       |
| Recommended              | 8  | 21.6 | 29 | 78.4 | 0.84 | 0.66–1.06 | 0.171 |
| Less than recommended    | 7  | 33.3 | 14 | 66.7 | 0.99 | 0.70–1.39 | 0.940 |
| Never                    | 26 | 34.2 | 50 | 65.8 | 1.00 | Recommended |       |
| Alcohol                  |             |                           |                           |       |
| Yes                      | 2  | 50.0 | 2 | 50.0 | 1.40 | 0.52–3.75 | 0.586 |
| No                       | 39 | 30.0 | 91 | 70.0 | 1.00 | Recommended |       |
| Salted food              |             |                           |                           |       |
| 2×/day                   | 4  | 80.0 | 1 | 20.0 | 3.56 | 0.62–20.66 | 0.032 |
| 1×/day                   | 8  | 28.6 | 20 | 71.4 | 1.00 | 0.77–1.30 | 0.988 |
| Never                    | 29 | 28.7 | 72 | 71.3 | 1.00 | Recommended |       |
| Coffee                   |             |                           |                           |       |
| ≥3×/day                  | 3  | 75.0 | 1 | 25.0 | 3.12 | 0.57–17.10 | 0.046 |
| 1-2×/day                 | 23 | 37.1 | 39 | 62.9 | 1.24 | 0.99–1.56 | 0.060 |
| Never                    | 15 | 22.1 | 53 | 77.9 | 1.00 | Recommended |       |
Our final multivariate analysis using backward stepwise procedure with LR showed that age and working-room temperature were the dominant factors associated with increased BP (Table 7). ATCs aged ≥40 years were 2.2 times more likely to have increased BP than ATCs aged <40 years. Further, ATCs who worked at room temperature of <21°C were 2.1 times more likely to have increased BP than ATCs who worked at a room temperature of ≥21°C (Table 7).

### Table 7. Correlation of age and working room temperature with increased blood pressure

|                              | Increased blood pressure | Net Relative Risk | Confidence Interval 95% | P  |
|------------------------------|--------------------------|-------------------|--------------------------|----|
|                              | Increased (n = 41) | Not increased (n = 93) |                            |    |
| Age                          |                          |                  |                          |    |
| ≥40 years                    | 24 50.0                  | 24 50.0          | 2.18                     | 1.15–4.11 | 0.016 |
| <40 years                    | 17 19.8                  | 69 80.2          | 1.00 (Recommended)       |    |
| Working-room temperature     |                          |                  |                          |    |
| <21 °C                       | 21 52.5                  | 19 47.5          | 2.10                     | 1.12–3.93 | 0.020 |
| ≥21 °C                       | 20 21.3                  | 74 78.7          | 1.00 (Recommended)       |    |

### 4. Discussion

Age was one of the dominant risk factors for increased BP in this study population. Compared with ATCs aged <40 years, those aged ≥40 years were 2.2 times more likely to have increased BP (RRa = 2.18; 95% CI = 1.54–4.11; p = 0.016). Our results are similar to those of a study by Framingham in which BP tended to increase after 40 years of age [10]. Likewise, a study by Ereminas reported that BP began to increase at 41 years of age, with an evident increase observed in the 45–55-year-old age group [11]; this increase was caused by the stiffening of arteries and blood vessel constriction. For individuals aged 40–89 years, every 20-mmHg increase in systolic BP or 10-mmHg increase in diastolic BP doubles the risk of ischemic heart disease and more than doubles the risk of stroke [10].

In this research, the average age of participants was 33 years, with an average diastolic BP of 80.8 ± 7.7 mmHg. This study was similar to one by Strandberg et al. in which diastolic hypertension (systolic BP < 140 mmHg and diastolic BP ≥ 90 mmHg) was observed in ≥10% individuals aged <45 years. In the same study after a 32-year follow-up, although death from cardiovascular disease was not observed, the mortality rate of individuals with diastolic hypertension was 2.7 times higher when combined with the increased systolic pressure [10].

Working-room temperature was another dominant risk factor for increased BP in our study population. We used the temperature limit of 21 °C recommended by the ICAO for ATC working rooms and found that ATCs who direct airplane commands at a room temperature of <21 °C were 2.1 times more likely to have increased BP than those who worked at a room temperature of ≥21 °C (RRa = 2.10; 95% CI = 1.12–3.93; p = 0.020). These findings can be explained by the theory of sympathetic response to cold temperatures, in which peripheral vasoconstriction increases, as does the venous backflow rate. Alternatively, the activation by temperature of the adrenal medulla releases epinephrine and norepinephrine, which might increase the intensity of heart muscle contractions [12]. Both mechanisms increase BP by increasing cardiac output and peripheral resistance.

Although our study did not investigate the same temperature range as Shiue et al. did in their study (<18°C), they stated that cold temperature might increase the risk of increased BP [13]. The differences in response to temperature in their study could also be due to different perceptions of cold by people in Indonesia and Scotland. In the current study, 23.1% participants felt uncomfortable with
the room temperature. Compared with participants who felt comfortable, those who felt uncomfortable were more likely to experience increased BP (RR = 1.70; 95% CI = 1.14–2.54; p = 0.001). This was caused by the cold room temperature, which became the additional stressor for ATCs while working. Stress might activate the sympathetic nervous system and adrenal glands, thus increasing BP and heart rate over a short time; however, recurrent adrenergic stimulation could damage blood vessels and cause hypertension [10].

In our study, gender was not a dominant factor that influenced the risk of increased BP. However, based on bivariate analysis results, men tended to have higher BP than women [RR = 1.35; 95% CI = 1.11–1.65; p = 0.025]. Similarly, androgen (male) hormones have pro-hypertension characteristics, whereas estrogen (female) hormones have protective characteristics, even though the effects of estrogen on BP are not as well understood as those of androgens [10].

With respect to total working duration, a significant positive correlation was observed between increased BP and a total working duration of >20 years (RR = 2.21; 95% CI = 1.36–3.59; p < 0.000). These results are similar to those reported in the study by Rose et al., which states that after 20 years of working, approximately 17% (of 218) of ATCs had hypertension, and 23 years of work as an ATC was the critical limit for hypertension [14].

Compared with working in the ATC tower, working in the ATC operations room was significantly correlated with the risk of increased BP (RR = 1.46; 95% CI = 1.17–1.82; p = 0.001). On the other hand, the type of ATC rating (ACP and ACS) held by participants was also significantly correlated with the risk of increased BP (RR = 1.47; 95% CI = 1.08–2.01; p = 0.31). These two factors were also associated with age and room temperature of <21 °C, i.e., ATCs in the operations room had an average age of 40 years, were rated as ACP/ACS, and were working at a room temperature lower than that in the ATC tower.

Here, no significant correlation was observed between the family history of hypertension and increased BP (p = 0.205; α = 0.05). This differed from the results of the study by Ransinghe et al., which showed that a family history of hypertension increases the risk of hypertension by 2–4 times [11].

Further, no significant correlation was observed between BMI and increased BP (p = 0.092; α = 0.05). This differed from the results of the study by Framingham, which stated that hypertension is correlated with obesity [10].

Increased BP was not found to be correlated with working duration, resting duration, or working shift (p > 0.05). This was because the participants with increased BP were distributed equally with respect to working duration, resting duration, and working shift. ATCs in the JATSC adhered to regulations on the maximum working duration of 2 h with a minimum resting duration of 45 min [15].

Heavy smoking, as classified by the Brinkman index, was significantly correlated with increased BP (RR = 2.42; 95% CI = 1.24–4.74; p < 0.000). Further, chronic effects of smoking increase arteriole stiffness, thereby increasing peripheral resistance [10]. Such a correlation between the Brinkman index and arteriole stiffness was also reported by Kubozono et al. [16].

Physical activity level and alcohol-drinking habit were not associated with increased BP. This contrasts with the theory stating that physical activity increases vessel elasticity and decreases peripheral resistance, thereby lowering BP [17]. Corenissen and Smart also concluded that aerobic exercise lowers BP [18]. In our study, it appeared that physical activity did not significantly affect the incidence of increased BP (p = 0.171; α = 0.05), although these data could have been affected by the memory and honesty of each respondent while filling the questionnaire. On the other hand, few participants reported alcohol use (3%), which may not have been reported honestly. According to a current theory, the effects of alcohol on BP are dependent on alcohol amount and drinking frequency. Specifically, alcohol intake greater than the recommended amount per day should increase BP [10].

Eating salted food more than twice per day and drinking coffee more than thrice per day were also significantly correlated with increased BP. However, eating salted food once per day and drinking coffee once or twice per day were not associated with increased BP. These findings are similar to those of the study by Atun et al., which showed that consuming more than 2.4 g of sodium per day
increases the risk of BP [19]. However, Zhang et al. stated that drinking more than three cups of coffee per day does not affect BP [20].

One limitation of our study is that BP could have been affected by foods or drinks consumed by the participants before BP was measured. This is despite asking participants not to eat and drink before their BP measurements and to log foods eaten in the last 8 h.

Another limitation is recall bias about total working duration, smoking habit, physical exercise, salted food consumption, and coffee intake. This study attempted to control for this by reviewing the participants’ logbooks and time allocation to recall.

This study was unique in that it specifically assessed the risk of increased BP in ATCs, which has not previously been evaluated in Indonesia. One major strength is that the researchers filled in the questionnaires for the participants and measured BP; therefore, any issues were resolved immediately.

5. Conclusion
In this study, we found that age (≥ 40 years old) and working room temperature (< 21 °C) were the main factors to significantly increase the risk of increased BP in ATCs. Other factors associated with increased BP included biological sex (male), total working duration (> 20 years), working in the ATC operations room, ACP/ACS rating, heavy smoking habit, consuming salted foods twice per day, and consuming coffee more than thrice per day.

References
[1] Chobanian A V et al 2003 Seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. Hypertension. 42 1206–52
[2] Kesehatan D and RI K 2013 Riset kesehatan dasar. Jakarta: Badan Penelitian dan Pengembangan Kesehatan Republik Indonesia
[3] Booze Jr C F and Simcox L S 1984 Blood pressure levels of active pilot compared with those of air traffic controllers. Aviat. Space Environ. Med. 56 1092–6
[4] Astuti D, Basuki B and Muljadi H 2011 Cold working temperature increased moderate/severe qualitative work stressor risk in air traffic controllers. HSJI. 2 58–65
[5] Neild P, Syndercombe D, Keating W, Donaldson G, Mattock M and Caunce M 1994 Cold induced increased in erythrocyte count, plasma cholesterol and plasma fibrinogen of elderly people without a comparable rise in protein c or factor x. Clin. Sci. 86 43–8
[6] ICAO doc 8984 2012 Manual of civil aviation medicine. International Civil Aviation Organization.
[7] ICAO circular 241-AN/145 1993 Human digest No.8. Human factors in air traffic control. International Civil Aviation Organization.
[8] Katritsis D G, Gersh B J and Camm A J 2013 Clinical Cardiology: Current Practice Guidelines edition 1st (UK: Oxford University Press)
[9] Miyatake N, Wada J, Kawasaki Y, Nishii K, Makino H and Numata T 2006 Relationship between metabolic syndrome and cigarette smoking in the Japanese population. Int. Med. 45 1039–43
[10] Kaplan N M, Victor R G and Flynn J T 2015 Kaplan’s Clinical Hypertension edition 11th (Wolter Kluwer)
[11] Ranasinghe P, Cooray D N, Jayawardena R and Katulanda P 2015 The influence of family history of hypertension on disease prevalence and associated metabolic risk factors among Sri Lankan adults. BMC Public Health. 15 576–84
[12] Huether S and McCance K 2012 Understanding Pathophysiology edition 5th (Elsevier Mosby)
[13] Shiue I and Shiue M 2014 Indoor temperature below 18°C accounts for 9% population attributable risk for high blood pressure in Scotland. Int. J. Cardiol. 171 e1–2
[14] Ereminas D 2009 An observational workplace study of cardiovascular variables in air traffic controllers. Aviation. 13 50–5
[15] Guilliams T G and Edwards L 2010 Chronic stress and HPA axis clinical assessment and therapeutic considerations. The standard. Point Institute of Nutraceutical Research. 9.
[16] Kubozono T, Miyata M, Ueyama K, Hamasaki S, Kusano K, Kubozono O and Tei C 2011 Acute and chronic effects of smoking on arterial stiffness. *Circ. J.* 75 698–702
[17] McAllister R M and Laughlin M H 2006 Vascular nitric oxide: effects of physical activity, importance for health. *Essays Biochem.* 42 119–31
[18] Diaz K M and Shimbo D 2013 Physical activity and prevention of hypertension. *Curr Hypertens. Rep.* 15 659–68
[19] Atun L, Siswati T and Kurdanti W 2014 Asupan sumber natrium, rasio kalium natrium, aktivitas fisik, dan tekanan darah pasien hipertensi. *MGMI.* 6 63–71
[20] Zhang Z, Hu G, Caballero B, Appel L and Chen L 2011 Habitual coffee consumption and risk of hypertension: a systematic review and meta-analysis of prospective observational studies. *Am. J. Clin. Nutr.* 93 1212–9.