Calculating blood pressure and BMI increase caused by night shift construction working using an android-based application

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Abstract. The purpose of this study was to assess cardio metabolic disorders earlier by measuring Body Mass Index (BMI), Blood Pressure and Physical Fitness (VO2max). This study was an observational study with cross sectional approach conducted on CV Harith construction by taking subject of 30 peoples by randomly purposive which met the inclusion criteria. Workers shifted morning work then performed night shift each for 2 weeks before they were measured. This study uses the Dependent t test to determine morning and night shift differences. The results showed that there were significant increased on BMI and blood Pressure with p less than 0,001 but there was no significant decreases on Physical fitness among night and day shift working. This study shows night shift in construction workers causes a significant increase in blood pressure and BMI but does not show significant changes in worker physical fitness.

1. Introduction
Large companies as good producers and service providers are related to the number of works that must be completed or services that must be provided continuously either during the day or at night, so that a shift work is needed. The definition of shift work is the time scheduled for someone or a group outside working hour (outside 08.00 -17.00). The shift work are shifting work time outside normal working hours, either rotating with the shift work method or being permanent for a 24 hour period [1,2].

Mostly the shift work is divided into three shifts, they are, morning shift, afternoon shift, and night shift. The definition of the hours specified for night worker is different, starting from working hours between 00.00 AM to 08.00 AM from 08.00 PM to 07.00 AM [3]. Night shift worker have the highest risk of accidents and health problems. In addition, night shift works can reduce work ability, increase work errors, inhibit social and family relationships, and result in increasing health risk factors [4].

There is a wrong change in the circulatory pattern on night shift worker such as in the digestive system. That system starts precisely when the body is preparing to rest then it will cause weight gain because only little energy is burned at night. In addition, a number of hormones such as cortisol and melatonin is also changed. In this case, the hormone production cycle is disturbed because the workers stay awake at night or fall asleep during the day (on the night shift). This causes changes in mood, irritability, depression and metabolic disorders as in Type II DM. Increased body weight and fat in the abdominal area were found in the worker with night shift like nurses and midwives [5-7].

About 8.6 million Americans who do shift works are associated with an increased risk of obesity, diabetes and cardiovascular disease due to a mismatch of circadian rhythms [6-7]. The endogenous circadian time system, including the superchiasmatic nucleus (SCN) in the hypothalamus and peripheral oscillator in vital organs, optimally regulates most of the physiology and behaviour when aligned with
the sleep or wake cycle [8]. Circadian rhythms are biological process regulating machines every 24 hours. This machine consists of a suprachiasmatic nucleus (Superchiasmatic nuclear = SCN) which is the centre of the pacemaker and regulates the physiological processes of the entire body through the autonomic and neuroendocrine nervous systems [9].

Shift work is generally associated with a discrepancy between the time systems of endogenous circadian rhythms and the cycle of behaviour, including sleep cycles, wake cycles and feeding cycles. SCN regulates circadian rhythms of leptin, plasma glucose, glucose tolerance, corticosteroids, and cardiovascular function through neural and, or humoral signals to tissues [2]. This incompatibility to be the main cause of metabolic and cardiovascular deregulation effects which can be detrimental to the shift workers [3].

Construction workers currently play an important role in the building industry construction. However, unfortunately the problem of occupational safety and health for the construction worker in Indonesia is still not concerned. Knowledge of occupational safety and health is inadequate both for workers and companies so that it affects work productivity, occupational safety and health [10]. So that the purpose of this study was to assess cardio metabolic disorders earlier on construction workers in their shift by measuring Body Mass Index (BMI), Blood Pressure and Physical Fitness.

2. Methods
This was a cross sectional study with purposive sampling taking subjects at CV D 'Harith Bandung, based on the inclusion criteria, namely: male workers aged 20-40 years having been worked in construction companies more than 1 year and are willing to work with the night shift schedule for 2 weeks. There were 28 workers added 10 % becoming 30 workers as a sample by the calculation of the minimum sample size of two different samples.

Night shift workers started working at 8:00 p.m to 7:00 a.m. or 00:00 a.m. to 5:00 p.m. while the morning shift started from 7:00 a.m. to 7:00 p.m. or 6:00 a.m. to 12:00 p.m. The workers did the morning shift for 2 weeks then simultaneously their BMI, Blood Pressure and VO2max were measured, as well as the night shift after two weeks working on the night shift, their BMI, blood pressure and VO2max were measured again.

Blood pressure is a pressure calculated based on the Mean Arterial Pressure using a sphygmomanometer then categorized according to JNC [8]. Body mass index is a tool to measure nutritional status by measuring body height and weight. Body weight and height measurements were performed using microtoise and digital scales. The BMI data was then averaged and also categorized based on the category of adult nutritional status guidelines according to the Ministry of Health of the Republic of Indonesia. Physical fitness was examined using the Harvard Steps test to measure pulse at 1.2 seconds, and 3 then entered the formula to measure VO2max and categorized based on Beashel and Taylor 1997 [11].

Univariate analysis in the characteristics of research subjects included age, BMI data, blood pressure and VO2max both on morning shift and night shifts workers in the mean and standard deviation. Before the bivariable analysis was carried out, the normality of MABP, IMT and VO2max data were tested by saphiro willk for a sample size of less than 50 workers and it would be stated that it was normal distribution if the p value was > 0.05.

Bivariate analysis aimed to assess differences in BMI, blood pressure and VO2max on the morning and night shift workers. Calculation with the numerical data would use a dependent t test if the BMI, blood pressure and VO2max were normal but it would use Wilcoxon test if the data was not normally distributed. Data analysis was carried out using the SPSS version21 program at 95% confidence level.

3. Results
The table below shows that in this study, there were 17 building construction workers in CV D'Harith Bandung aged 30-40 years old, twelve workers aged 20-30 years old and one workers above 40 years old.
Table 1. Description of the study subjects on the morning and night shift construction workers.

| Variable                  | Morning shift n=30 | Night shift n=30 |
|---------------------------|--------------------|------------------|
| Age                       |                    |                  |
| 20-30                     | 12                 | 12               |
| 30-40                     | 17                 | 17               |
| >40                       | 1                  | 1                |
| Blood Pressure (MABP)     |                    |                  |
| Normal                    | 21                 | 7                |
| High normal               | 7                  | 11               |
| Hypertension              | 2                  | 12               |
| BMI                       |                    |                  |
| Underweight               | 5                  | 1                |
| Normal                    | 22                 | 24               |
| Overweight                | 3                  | 5                |
| Obese                     | 0                  | 0                |
| VO2max                    |                    |                  |
| Poor                      | 0                  | 0                |
| Below Average             | 0                  | 0                |
| Average                   | 12                 | 16               |
| Above Average             | 12                 | 9                |
| Excellent                 | 6                  | 5                |

In table 1 showed that they were 21 workers in morning shift workers who had normal blood pressure, 7 workers who had high normal pressure and 2 workers who had hypertension, while in night shift there were 7 workers who had normal pressure, 11 workers who had high normal pressure and 12 workers in night shift workers who had hypertension. It means there were increased blood pressure that 4 workers became high normal pressure and 10 workers became hypertension after they were in night shift working.

In morning shift they were 5 workers in underweight category, 22 workers in normal category and 3 workers in overweight category, otherwise after they were in night shift 1 workers in underweight category, 24 workers in the normal category and 5 workers in overweight category. It means there were increasing in BMI which is 2 person in normal category and 2 workers in overweight category after they worked in night shift.

VO2max in morning shift were 12 workers in average category, 12 workers in above average category and 6 workers in excellent category, whether on night shift they were 16 workers in average category, 9 workers in above average category and 5 worker in excellent category. It means there were decreased in their VO2max which is 3 person in above average and 1 worker in excellent category.

Table 2. Average result of MABP, BMI and VO2 max on morning and night shift workers.

| Value                  | Morning shift | Night shift | P   | PR  |
|------------------------|---------------|-------------|-----|-----|
| MABP (mmHg)            | 108.06±9.14   | 119.57±7.14 | 0.00* | 1.1 |
| BMI (kg/m2)            | 20.93±2.6     | 22.11±2.7   | 0.00* | 1.67|
| VO2max(mL/kg.min)      | 82.48±8.30    | 81.11±7.47  | 0.196 | 1.3 |

*p<0.05 with Dependent t test

Table 2 above shows that MABP in the morning shift was averaged 108.06, while in the night shift increased to 119.57. Statistical test results using Dependent t Test at 95% confidence level showed that
The BMI average on the construction workers in the morning shift were 20.93 while the workers in the night shift increased into 22.11. Statistical test results using dependent t test at 95% confidence level showed that statistically there were significant difference between the morning shift and night shift with p = 0.00.

The average of VO2 max on the construction in the morning shift was 82.48 while the VO2 max decreased into 81.11 but the statistic test results using dependent t test at 95% confidence level showed that there was no significant difference between VO2max in the morning shift and in the night shift p> 0.05.

4. Discussion
Changes in circadian rhythms on the workers with the shift rotation method have been associated with the risk of hypertension because blood pressure was apparently due to the differences in sleep patterns associated with night shift rotation that strengthens the risk of hypertension [12]. Other studies showed that circadian rhythms in the night shift workers who are active at night can affect sleep quality, cortisol, melatonin and body temperature which can increase the risk of hypertension and other cardiovascular disorders [13].

Research conducted by Mohamad Nazri in 2015 showed that the workers in the morning shift had a prevalence rate of 4.2% hypertension while the workers in the night shift had a prevalence of hypertension rate of 22.3% with a p-value of 0.001 [14].

Shift work has a higher risk of hypertension because the regulation of blood pressure can be affected by a disturbance in the circadian rhythm [8]. The effect of circadian rhythms on blood pressure can be influenced by neurohormonal sleep factors, sympathetic nervous system activity, cardiac output, heart rate, physical and psychosocial stress, and increased salt retention [12]. The disturbance of factors that affect blood pressure can lead to higher blood pressure during night shift due to disruption in the circadian rhythm earlier [13].

In addition, changes in sleep patterns interfering with physiological rhythms can also affect metabolic deregulation which has an impact on weight gain, obesity, and the risk of type 2 diabetes mellitus as a result of impaired energy balance, changes in dietary time and amount of food intake, impaired glucose tolerance in body, and impaired insulin sensitivity [15,16].

The shift workers do have the Shift Workers Disorder (SWD) risk [17]. The main factors that can affect shift workers are changes in sleep patterns, circadian rhythms that affect hormonal work disorders and the risk of cardiovascular disease [18]. The research conducted in the United States showed that the shift work is a risk of obesity as measured by BMI on the shift workers in that study, there was an increase in BMI on the night shift workers with an odds ratio of 1.4 both in men and women [15].

Changes in hormone regulation at night can affect metabolism in the body. One of indicator to see body mass is by measuring BMI. Occurrence of overweight and obesity is more common on night shift workers [16]. Sleep time and circadian rhythm control daily physiological patterns that are important for normal metabolic health. The increasing food intake, appetite, and metabolic processes at night are associated with increased income, energy and increased metabolic deposits in the body, thus increasing the composition of fat in the body. This is related to an increase in body weight which affects the increase in BMI [18].

The study based on the previous BMI results showed that the incidence of overweight and obesity was more common on the night shift workers. Sleep time and circadian rhythm controlled daily physiological patterns that are important for metabolic health. While one study in Europe for 10 days showed when subjects ate and slept about 12 hours from the habitual phase, there were decreased leptin, increased glucose, increased insulin, reversed daily cortisol rhythm, increased average arterial pressure, and reduced sleep efficiency [19].
In this study, significant differences (P=0.00) were observed between BMI and MABP after the participants worked during the night shift. The prevalence rate was 1.1 for BMI and 1.67 for MABP. This indicates an increased risk of obesity and high blood pressure if working during the night shift.

This study measured physical using the Maximum Oxygen Consumption indicator (VO2 max). VO2 max is the most important indicator in body fitness and is well related to cardiovascular health. A decrease in fitness could lead to health problems such as easily becoming unwell and weak cardio-respiratory endurance [20]. VO2 max is the maximum amount of oxygen in millimetres that can be used in one minute per kilogram of body weight. People with good fitness have higher VO2 max values and can do activities better than those who are not in good condition [21]. Research that measured changes in fitness on people who work from night to morning using the Simulator Sickness Questionnaire (SSQ) data showed that the driver’s physical fitness in the morning has a significant effect [22].

The table of subject characteristics presented that the construction workers had sufficient fitness in the morning shift included in the average category (12); above average (12) and excellent (6) because they had sufficiently good training ability so that the night shift changes did not significantly affect their fitness. There was a decrease in the fitness category because there was only 1 worker in the excellent category and 3 workers in the above average category as compared to one level in the below category. The results of this study indicated that the results of VO2 max were not different, possibly because the VO2 max value was dependent on the cardiovascular condition, respiration, hematology, and exercise ability [21].

5. Conclusion
The construction worker after night shift caused a significant increase in their Blood Pressure and Body Mass Index. However, there were decreased in their physical fitness but unfortunately not significant. This might be because the worker before night shift have good physical performance so that this was not impact too much.

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