

The Cardiovascular Function Profile and Physical Fitness in Overweight Subjects

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Abstract. Obesity in children and young adult is associated with cardiovascular risk in short term and long term. The aim of this study was to describe the profile of the cardiovascular functions parameters and physical fitness in overweight. This is an analytical observational study with cross sectional approach. The samples of this study were 85 randomly selected subjects aged 18 to 24 years with normoweight and body mass index <40. The parameters measures were body mass index (BMI), waist circumference (WC), waist-hip ratio (WHR), cardiovascular function parameters (resting pulse, blood pressure, and peak flow meter) and physical fitness parameters (VO2max dengan McArdle step test). The mean BMI was $24,53 \pm 4,929$. The WC and WHR mean were $86,7 \pm 14,10$ cms and $0,89 \pm 0,073$ cm respectively. The mean of resting pulses were higher in normoweight subject ($p=0,0209$). The mean systole were lower in normoweight subject ($p=0,0026$). No differences VO2 max between groups ($p=0,3888$). The peak flow meter was higher in normoweight ($p=0,0274$). The result of this study indicate that heart rate, systole and peak flow meter are significantly different between groups. The heart rate and the peak flow meter in the overweight subjects were lower meanwhile the systole blood pressure was higher compared to normoweight subjects.

1. Introduction

The prevalence of overweight has risen by two folds in the world since 1980. In 2014, more than 1.9 billion adults (age 18 years old or more) were identified as overweight and more than 600 million of them were obesity [1]. In Indonesia, the prevalence of adults with overweight and obesity (age more than 18 years old) in 2013 were 13.3% and 15.34%, respectively [2].

Overweight tends to become obesity and obesity was recognized as health problem as it increases the risk of many chronic diseases, such as hypertension, dyslipidemia, diabetes, cardiovascular diseases, asthma, sleep apnea, osteoarthritis, and many cancer diseases in adults [3]. The cost of health care for these chronic diseases is heavy price [4]. It becomes a burden for many countries not only in the developed countries but also on the developing countries [1]. One of cardiovascular diseases that



come with obesity is hypertension, 75% of hypertension is associated with hypertension and can contribute to left ventricular hypertrophy in adults [4].

There are changes of cardiovascular function on obesity. There is increased of total body oxygen consumption, cardiac output, total body volume, left ventricular preload and structural changes of the heart such as the increased of left ventricular cavity dimension and wall stress. Obesity also affects the respiratory function, an increased amount of fat in chest wall and abdomen, reduces lung volume and alters the patterns of ventilation [5].

Study that conducted on 8889 adults aged 18 to 64 years using questionnaires found that there was association between overweight and obesity with poor levels of subjective health status, especially physical well-being [6]. And another cross-sectional survey that was done in Iran on 18 year old and older urban populations showed the high prevalence of overweight and obesity were 36.1% and 26.1% respectively. This study showed that association of obesity by waist circumference (WC) with hypertension were stronger than other indexes in women and by body mass index (BMI) with hypertension is slightly stronger than other indexes in men [7].

Because of the high prevalence of obesity in adult aged 18 years old in the world and Indonesia too. Then the higher risk of developing chronic diseases especially cardiovascular diseases in obesity. It is important to describe the cardiovascular functions in overweight individual. The aim of this study was to determine the cardiovascular function profile and physical fitness in overweight subject.

2. Method

The subjects for this study were students of Universitas Sumatera Utara with age between 18 – 24 years old. Body mass index was used to categorize the subject into the two study groups, the normal weight group was if the body mass index between 18.5 – 22.9 kg/m² and the overweight group is 23 – 29.9 kg/m² [5]. Waist circumference (WC) and waist hip ratio (WHR) measured to consider the central obesity. To determine the WC was by measuring the midpoint between the lower margin of the least palpable rib and the top of the iliac crest, using a stretch-resistant tape. The hip circumference is determined by measuring around the widest portion of the buttocks, with the tape parallel to the floor [8]. To determine the cardiorespiratory fitness, the parameters that were used are resting pulse, resting blood pressure, peak flow meter, and VO₂ max. VO₂max value was based on the indirect method of Mc Ardle step test. The subject steps up and down on 41.3 cm bench height at a rate of 22 steps per minute for females and at 24 steps per minute for males, for a total of 3 minutes. The subject immediately stops on completion of the test, and the heart beats are counted for 15 seconds from 5 - 20 seconds of recovery [9]. The statistical analysis was done by Student's t-test and Pearson correlation test.

3. Results and Discussions

In this study, to determine the nutritional status, we used the body mass index categorizations, the size of waist circumference and waist hip ratio. The parameters to determine the cardiovascular functions and physical fitness are the value of blood pressure, resting pulse, peak flow meter, and VO₂max.

3.1. Subjects Characteristics

Subjects characteristics are shown by table 1.

Table 1. The characteristics of subjects

Variable	Normoweight (n=42)	Overweight (n=43)	p value
Sex			
Women	23	9	
Men	19	34	
Age (years)	19.48 ± 1.37	19.79 ± 1.07	
Positive family history			
Diabetes	9	10	0.8400
Hypertension	15	13	0.5910
Smoking	2	7	

*Values are mean ± SD

Table 1 shows the comparison of gender, age, family history with diabetes and history of smoking between study groups. Women in the normoweight group are 54%, but in the overweight group men percentage are 79%. This result in contrast with the previous study in a rural adult population of West Bengal, India that found the percentage of higher BMI was in female [10]. The subjects' age in both study groups are similar around 19 years old. The percentage of family history with diabetes and hypertension in overweight group is 53%, meanwhile the normoweight group is 57%. Obesity is related with the condition of hypertension. It is known that the prevalence of hypertension is 15% in those with BMI <25 and 42% if BMI is >30; in women, these are 15% and 38% respectively [11]. The subjects who are smoking in the overweight are 16.27%, while in the normoweight is only 4.76%.

Table 2. Comparison of cardiovascular functions and physical fitness between study groups

Variable	Normoweight (n=42)	Overweight (n=43)	p value
Waist circumference	76.21 ± 6.38	96.94 ± 11.87	
Waist Hip Ratio	0.85 ± 0.06	0.92 ± 0.06	0.0000
Resting pulse	83.38 ± 10.06	77.74 ± 10.24	0.0209
Resting blood pressure			
Systole	108.21 ± 10.06	114.88 ± 10.32	0.0026
Diastole	73.69 ± 18.64	73.95 ± 8.21	
Peak Flow Meter	107.88 ± 10.66	101.88 ± 16.10	0.0274
VO ₂ max	38.97 ± 3.60	43.69 ± 9.20	0.3888

*Values are mean ± SD

3.2. Comparison of cardiovascular function and physical fitness

Table 2 shows that the waist circumference differed between study groups. In the overweight group, the waist circumference is 96.94 ± 11.87 and in normoweight group is 76.21 ± 6.38. The waist hip ratio in the overweight group was significantly higher in the overweight group compared to normoweight group (p value 0.0000). The value of WHR in the overweight group was beyond normal value (>0.9 in male, >0.85 in female).

Obese people have an increased risk of arrhythmias and sudden death and extremely obese patients have a dilated cardiomyopathy and fatal arrhythmia [12]. This study found that the resting pulse in

overweight group was significantly lower compared to normoweight group (p value 0.0209) but still in normal range (60 – 100 times per minute). In contrast with previous study that stated a 10% increase in body weight is associated with a decline in parasympathetic tone accompanied by a rise in mean heart rate [12].

The resting blood pressure between the study groups are the systole in the overweight group was significantly higher than the normoweight group (p value 0.026) but the diastole is similar. Previous study found that every a 10 kg higher body weight is associated with a 3.0 mmHg higher systolic and 2.3 mmHg higher diastolic blood pressure. These increases related to an estimated 12% increased risk for cardiovascular disease and 24% increased risk for stroke. Factors that contributed to higher blood pressure in obesity are the higher of blood volume, stroke volume, and cardiac output. In obesity also increasing of peripheral vascular resistance originated from endothelial dysfunction, insulin resistance, sympathetic nervous system, substances released from adipocytes (interleukin [IL]-6, tumor necrosis factor [TNF], etc.), and sleep apnea [12].

The peak flow meter in the normoweight group was significantly higher compared to overweight group (p value 0.0274). This result similar with the previous study that peak expiratory flow rate (PEFR) of overweight students are significantly less than normal weight and less than underweight students. This finding could be related with altering of respiratory muscle activity due to adiposity, altered airway caliber, increase resistance and remodeling of respiratory passage due to circulating inflammatory mediators [13].

This study also found that the VO_2 max in the overweight group was higher compared to normoweight group but not significant. This similar with the previous study that found a negative correlation between VO_2 max and body fat percentage but was not statistically significant [14]. Mc Ardle step test was chosen based on the result of previous study on thirty male students of Shiraz University that Mc Ardle step test can be applied to produce a good estimation of maximum oxygen uptake [15].

4. Conclusions

The prevalence of men with overweight was higher than women. The cardiovascular profile of the overweight subjects showed that the heart rate was lower compared to the normoweight group but the systole blood pressure was higher. The peak flow meter of the overweight group were lower but there was no difference of the VO_2 max between the two groups.

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