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ANTHROPOMETRIC MEASUREMENT OF METABOLIC AGE USING NECK CIRCUMFERENCE

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Abstract

Excessive fat accumulation in the obese body causes chronic low-grade inflammation. The continuous occurrence will affect health, which may lead to damage to cell metabolism related to metabolic age. Therefore, anthropometric application by measuring neck circumference (NC) and body mass index (BMI) was performed. The aim of this study is to determine NC cut-off which can be used to identify the increase of metabolic age in an individual. This study is a diagnostic study using cross sectional design using subjects who met the criteria needed for this study (n = 82). BMI and NC anthropometric measurements were performed. Metabolic age was measured using Bioelectrical Impedance Analyzer (BIA). Data were analyzed using 2 x 2 diagnostic table and Receiver Operating Characteristic (ROC) curve to obtain Area Under Curve (AUC). The results show that the highest BMI was obese (65.8%) with the most common age of 30-57 years old. The result of ROC-AUC NC on metabolic age shows that AUC value of NC measurement was 0.77, cut-off ≥ 33 cm, sensitivity 71.2%, and specificity 69.6%. This study concludes that the cut-off value of NC in predicting the increase of metabolic age has good sensitivity and specificity.

Keywords: *metabolic age; body mass index; neck circumference*

1. Introduction

The prevalence of obesity in Indonesian adults in 2018 reached twice the number in 2007 (Riskesdas, 2018). Especially in Central Kalimantan, the increase of obesity in adults in 2018 also increased to 1.2 fold compared to that in 2007 (Kementerian Kesehatan Republik Indonesia, 2018). The rise of obesity prevalence in Indonesian adults even in line with the increase of non-infectious diseases such as diabetes mellitus, cancer, cardiac disease and hypertension (Riskesdas, 2018). This is following previous studies, which stated that obesity increased the risk of metabolic syndrome, cardiac disease, diabetes, stroke, and cancer (Jung & Choi, 2014; Nuttall, 2015; Sarnali & Moyenuddin, 2010; Vucenik & Stains, 2012).

Excessive fat accumulation in the obese body causes chronic low-grade inflammation (Ellulu et al, 2017; Lee et al, 2013). This chronic low-grade inflammation occurs because adipose tissue releases pro-inflammatory substrates (interleukin-1, interleukin-6, TNFα- and IFNγ) triggered by adipose tissue hypoxia which undergoes progressive hyperplasia, thus reducing blood supply to adipocytes (Ellulu et al., 2017). Continuous low-grade inflammation will interfere and cause damage to cell metabolism concerning metabolic age (Ellulu et al., 2017; Garcia-Rubira et al., 2018).

Metabolic age is obtained from the comparison of Basal Metabolic Rate (BMR) with the average BMR based on the chronological age group. Metabolic age reflects metabolic status which affects someone's health (Majzoub et al., 2017). Metabolic age measurement that requires BMR measurement still uses indirect calorimetry, dual-energy X-ray absorptiometry (DXA), and bioelectrical impedance analyzer (BIA) (Jylhävä et al, 2017; Schrack et al, 2014). Metabolic age measurement is not commonly

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used. Albeit previous studies stated that Metabolic age had synergically relation to risk of cardiovascular disease and inflammatory process (Garcia-Rubira et al., 2018).

Neck circumference (NC) measurement is known to have a positive correlation with body fat accumulation, visceral fat, BMI and central obesity and metabolic syndrome (Ang & Raboca, 2011; Huang et al., 2015; Yang et al., 2010; Yuliani et al, 2017). The cut-off value of NC for overweight/obese for men and women in Indonesia was ≥ 37 cm (sensitivity 78.3%; specificity 75.5%) and ≥ 33.5 cm (sensitivity 76.6%; specificity 66.7%) (Lindarto 2016).

Neck circumference measurement is a simple and practical anthropometry, which can be applied in the field. However, the use of NC measurement as the metabolic age screening has not been studied. This study aims to determine the cut-off value of NC measurement which can be used to identify the increase of metabolic age in individuals.

2. Methods

This is a diagnostic study using a cross-sectional design. The location of the sampling was in Palangka Raya University, Central Kalimantan.

The subjects of this study were men and women with the inclusion criteria: they were obese, overweight, and normoweight BMI, 30-57 years old, not yet menopause, did not participate in a diet program, and did not consume steroids. The exclusion criteria include a tumor in the neck, edema, asthma, anatomical abnormalities, and Cushing syndrome. The subjects who met the requirements were given signed an informed consent sheet.

The anthropometric measurements performed were BMI and NC. Neck circumference was measured under laryngeal prominence and perpendicular to the long neck axis, and the circumference was recorded with at least 0.1 cm precision (Joshipura et al, 2016). The body weight was measured using a digital scale (using light clothing without wearing footwear); body height was measured using a stadiometer (without wearing footwear).

The Body Mass Index was interpreted according to the Asia-Pacific population criteria by the Western Pacific Regional Office of the World Health Organization. The normal BMI was 18.5-22.9 kg/m^2, overweight 23-24.9 kg/m^2, obese ≥ 25 kg/m^2.

Metabolic age was measured using Bioelectrical Impedance Analyzer (BIA) Karada Scan HBF 701 Pro (Japan). The positive result was given if the subject had older metabolic age than chronological age; and negative one if the metabolic age was the same as chronological age.

Data were analyzed using SPSS (Statistical Package for the Social Sciences) application with a 2 x 2 diagnostic table and Receiver Operating Characteristic (ROC) curve to obtain the Area Under Curve (AUC).

3. Results and Discussion

Subject Characteristics

The total subjects were 82 people. The highest BMI was obese (65.8%) in 30-57 years old subjects.

Table 1. Subject Characteristics

	N	Mean ±SD	Min-Max
Age (years)	82	41,6±9,95	30-57
Gender			
- Male	23		
- Female	59		
Body Mass Index (kg/m^2)		29,6±3,7	25-41,3
- Normoweight	23		
- Overweight	5		
- Obese	54		
Neck Circumference (cm)		34,1±2,6	27,5-39,8
Metabolic age (years)		50±13	18-80

The result of ROC curve analysis to determine AUC area of NC measurement can be seen in Figure 1.

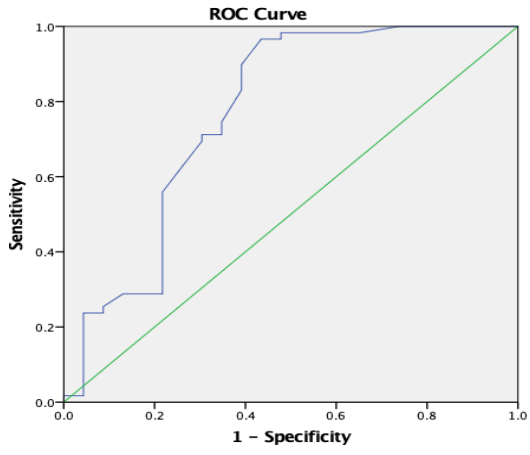

Figure 1. *Area Under Curve as NC validity to detect metabolic age*

The results of ROC-AUC NC on metabolic age show that the AUC value of NC measurement was 0.77 (p < 0,001; CI 95% 63.4–90.3%).

Tabel 2. The cut-off point, sensitivity, and specificity of neck circumference measurement on metabolic age

Analysis results	
Cut off	≥ 33 cm
AUC	76,8%
Sensitivity	71,2%
Spesificity	69,6%

Discussion

Neck circumference is one of the newly developed anthropometries with a positive correlation to the increase of weight, BMI, abdominal circumference, and the risk of cardiometabolic diseases such as type 2 diabetes mellitus, hypertriglyceridemia, hypertension, and HDL decrease. (Aswathappa et al, 2013; Hingorjo et al, 2012; Zhou et al., 2013). The increment of adipose tissue in the neck had a strong correlation with the increased total body fat and visceral fat (Yuliani et al., 2017). The increase of adipose tissue and metabolic age is known to have a positive correlation with increased inflammatory parameters (IL-1β) and the risk of cardiovascular disease (Garcia-Rubira et al., 2018).

According to this study, the AUC value of 0.768 (CI 95%) revealed that if NC measurement was performed on 100 people, the correct conclusion in metabolic age increase determination should be found in 77 people. AUC value of 0.77 is considered good validity. The result of NC cut-off value in this study was ≥ 33 cm with 71.2% sensitivity and 69.6% specificity. This result shows that the metabolic age increase occurred in ≥ 33 cm NC.

There has been no study that determines the cut-off value of NC on metabolic age. Previous studies only analyzed the cut-off value of NC on overweight, obesity, central obesity, and metabolic syndrome. The (Ang & Raboca, 2011; Aswathappa et al, 2014; Hingorjo et al., 2012; Huang et al., 2015; Zhou et al., 2013). In Indonesia, the study related to cut-off value of NC for overweight/obese screening was conducted by Lindarto et al. with the result of cut-off value in men and women was ≥ 37 cm (78.3% sensitivity; 75.5% specificity) and ≥ 33.5 cm (76.6% sensitivity; 66.7% specificity), respectively (Lindarto et al., 2016). The cut-off value of NC in this study was smaller than that of Lindarto et al. This can be caused by an increase of metabolic age which occurs during adipose tissue accumulation as an effect of chronic low-grade inflammation in obesity, thus disrupting cell metabolic function (Ellulu et al., 2017; Lee et al., 2013).

This study has several limitations that can be completed in further studies, such as subject division according to gender and gold standard of metabolic age measurement that can be improved using better tools.

4. Conclusion and suggestion

The cut-off value of NC in predicting metabolic age increase has a good sensitivity and specificity, thus can be expected to be an early screening for cell metabolic disorder. Similar studies should be developed related to the use of better gold standard usage.

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