Wrist and Neck Circumference Specificity and Sensitivity for Predicting Obesity In Adolescents

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Abstract. There are many anthropometry indices used for determining obesity. Wrist circumference and neck circumference are alternative clinical tools and easy to use for the indicator of obesity. This cross sectional study aimed to assess the sensitivity and specificity of obesity detection based on wrist and neck circumference. A total of 85 students aged 17-21 years was randomly sampled from 11 faculties of Diponegoro University Semarang. Measurements included height, height, waist circumference, hip circumference, waist-hip circumference ratio, wrist circumference, neck circumference, all done according to standard protocol. Correlation among data was analysed using Pearson or Spearman tests. Both wrist circumference and neck circumference showed positive association with all anthropometric measurements. Wrist and neck circumference were significantly higher in obese adolescents than normal-weight adolescents. Wrist circumference (Se 72% and Sp 71,67%) had better performance than neck circumference (Se 84% and Sp 42%) in predicting obesity. In conclusion, wrist circumference is better than neck circumference for predicting obesity in adolescents.

Keywords: Sensitivity, Specificity, Anthropometric Measurement, Neck Circumference, Wrist Circumference.

1   INTRODUCTION

Obesity is a global problem that contributes to various cardio metabolic diseases, including insulin resistance, diabetes mellitus, and metabolic syndrome [1-3]. Excessive body fat occurs due to a combination of genetic, environment, and lifestyle factors [4-5]. Obesity is on the rise in both developed and developing countries [1-2].

Adolescent obesity is on the rise over the last few decades [6]. The impact of the increasing body mass index (BMI) trend, obesity prevalence from 1975 to 2016 in children and young women increased from 0.7% to 5.6%, whereas in children and adolescent boys increased from 0,9% to 7.8% [7]. In 2018, over 340 million children aged 5-19-year-old were classified as overweight and obese [8].

Anthropometric parameters commonly used in determining obesity is the BMI, but BMI measurement cannot provide accurate information about the distribution of body fat compared to total fat mass and fat free mass [9-11]. The last few years the measurement of body fat distribution can use wrist circumference and neck circumference. Wrist circumference and neck circumference are alternative anthropometric parameters that are still new, simple, and practical. [1,4-5,10,12-15].

This study was aimed to examine the sensitivity and specificity in wrist circumference and neck circumference for detecting obesity in adolescents.

2   METHODS

This research was by cross-sectional design and carried out in February-March 2018 at the University of Diponegoro. Participants were recruited by random sampling. The subjects involved in this study were adolescents aged 17-21 years made up of 51 girls and 34 boys who met the inclusion criteria, which do not undergo goiter, not pregnant or had been pregnant, and not athletes.

Anthropometric measurements are carried out by measuring height, body weight, wrist circumference, and neck circumference. Body Mass Index (BMI) scores was determined based on height and weight. All anthropometric measurements were taken by trained personnel according to standard guidelines and in fasting conditions. Height was measured with microtoise (0.1 cm accuracy) while weight was measured with a digital scale (0.1 kg accuracy). Wrist and neck circumference were measured with a flexible measuring tape twice then averaged. Measuring the circumference of the wrist from the bulge of the right-hand ulna, while the circumference of the neck is carried out at the laryngeal border or the most prominent part of the thyroid cartilage for women and just below the protruding larynx (adam's apple) for men.

This study aims to determine differences in sensitivity and specificity in wrist and neck circumference to detect obesity in adolescents. Sensitivity is the ability to correctly identify the intended subjects, while specificity refers to the capacity to identify others who are not problematic. Receiver Operating Curve (ROC) is used to determine the cut-off point for neck and wrist circumference. A better predictor had a higher sensitivity and specificity.

Prior explanations was given to subjects who meet the requirements and are willing to participate in this research, followed by obtaining their approval through informed consent. Ethical Clearance from the Ethics Commission of the 41Faculty of Medicine of Diponegoro University has approved this study with No. /EC/FK-RSDK/I/ 2018.

3   RESULTS

This study encompassed 85 participants, 40% (n=34) were boys and 60% (n=51). Mean age of boys and girls participants were 18,38 years old and 18,47 years old. Table 1 provides the characteristics of adolescents by gender. Boys had higher values for height, body weight, BMI, wrist circumference, and neck circumference than girls. Regarding

nutritional status, girls showed a higher percentage of obesity than boys and boys had a higher percentage of underweight than girls.

Tables 2 provide cut off points, sensitivities, specificities, and positive and negative predictive values of wrist circumference and neck circumference for IR screening in adolescents. Table 2 showed the sensitivity of wrist circumference for predicting obesity in boys is 81.82%, indicating that wrist circumference category can detect 81.82% of obese people. The specificity of wrist circumference for predicting obesity in boys is 82.61%. This figure means that wrist circumference can detect 82.61% of people who are not obese. The Positive Predictive Value (PPV) of the wrist circumference category for predicting obesity is 69.23%. This figure gives the meaning that people are obese, 69.23% of those who have a large wrist circumference. The Predictive Negative Value (NPV) category of wrist circumference in predicting obesity is 90.48%. This figure gives the meaning of people who are not obese, 90.48% of those who have a small wrist circumference.

Table 1. Characteristic of Adolescents by Gender

	Boys (n=34)	Girls (n=51)
Age	18.38 ± 0.652	18.47 ± 0.644
Nutrition Status (Based on BMI)		
Underweight ($\leq$18.49 kg/m^2)	7 (20.6%)	11 (21.6%)
Normal (18.5-22.9 kg/m^2)	10 (29.4%)	11 (21.6%)
Overweight (23-24.9 kg/m^2)	6 (17.6%)	15 (29.4%)
Obesity ($\geq$25 kg/m^2)	11 (32.4%)	14 (27.5%)
Height (cm)	169.38 ± 6.340	153.88 ± 4.25
Body Weight (kg)	67.99 ± 16.945	54.92 ± 11.903
BMI (kg/m^2)	23.62 ± 5.398	23.17 ± 4.763
Wrist Circumference (cm)	15.84 ± 1.083	14.61 ± 1.135
Neck Circumference (cm)	34.34 ± 2.49	30.48 ± 2.12

The sensitivity of neck circumference for predicting obesity in boys is 100%. This figure means that the neck circumference category can detect 100% of obese people. The specificity of neck circumference for predicting obesity in boys is 8.7%. This figure means that neck circumference can detect 8.7% of people who are not obese. The Positive Predictive Value (PPV) of the neck circumference category for predicting obesity is 34.38%. This figure gives the meaning that people are obese, 34. 38% of those who have a large neck circumference. The Predictive Negative Value (NPV) category of neck circumference in predicting obesity is 100%. This figure gives the meaning of people who are not obese, 100% of those who have a small neck circumference.

Table 2. Cut off Points, Sensitivities, Specificities, and Positive and Negative Predictive Values of Wrist Circumference and Neck Circumference for IR Screening in Adolescents

	Cut off point	Se (%)	Sp (%)	PPV (%)	NPV (%)
Wrist circumference					
Boys	≥16.0	81.8	82.6	69.2	90.4
Girls	≥14.5	64.2	64.8	48.9	82.7
Neck Circumference					
Boys	≥30.7	100	8.7	34.3	100
Girls	≥29.	71.4	62.1	41.6	85.1

4   DISCUSSION

Obesity is a major chronic health issue that need to be watched out because of the subsequent elevated risks of cardiovascular and metabolic disorders. Therefore, we need a diagnostic tool for obesity that is fast, precise, and accurate so that early detection and intervention prevention can be done in adulthood [12,16]. Over the years the determination of obesity is commonly done by measuring BMI, waist circumference, and hip waist ratio. In recent years the determination of obesity can be done by measuring wrist circumference and neck circumference as an easy, simple, and sensitive anthropometric index [4,5,10,12,13,17,].

The CASPIAN IV study in a large population shows the fact that wrist circumference is easy to use as an easy clinical marker for predicting obesity. Wrist circumference is positively and significantly associated with a number of anthropometric measurements, such as BMI, waist circumference, hip circumference, and waist-to-hip ratio in both male and female. In addition, wrist circumference can be used to classify subjects into abdominal obesity, overweight, obesity [1].

Wrist circumference is a simple, fast, easy to do measurement and there is no need for calculations in the formula [1,18]. It is also relatively stable because it's not easily changed and not affected by respiration and abdominal distention [18,19]. Wrist circumference can assess body frame, bone size, and describe peripheral fat distribution [9,18-21]. An increasing bone mass will cause an increase in the size of the wrist circumference so that it can affect the risk of abnormal body metabolism [5,20]. Furthermore wrist circumference is a good parameter for analyzing bone metabolism associated with hyperinsulinemia, especially insulin-like growth factor 1 (IGF-1) levels [21].

Research conducted by Alzeidan et al in 3063 people in Saudi Arabia shows that measurements of neck circumference have a good performance in predicting obesity. Neck circumference is more easily socially accepted, stability of measurement is not influenced by physical conditions and pathophysiological conditions, such as

postprandial conditions, respiration movements, and the use of thick clothes [22]. Neck circumference measurement illustrates the distribution of upper body fat. Upper body subcutaneous fat contributes to the circulation of free fatty acids which have more active lipolytic activity than lower body subcutaneous fat [23].

Anthropometric measurements are simple evaluation tools and can describe body fat disposition and metabolic complications. Besides, anthropometric measurements are cheaper and can be used as a limitation in the use of gold standard methods, such as computed tomography and magnetic resonance [23]. The Present study shows that wrist and neck circumference can be used as a predictive tool of obesity in adolescents. Measurement of wrist circumference and neck circumference has advantages over other anthropometrics, such as simple, affordable, fast, socially acceptable, clear measuring points, size does not change throughout the day, comfortable for examiners and respondents, and can be implemented in clinical practice or large-scale epidemiological studies [4,5,13,19,23,].

5   CONCLUSION

The present study demonstrated that wrist and neck circumference are reliable anthropometric measurements to detect obesity in adolescents. Wrist circumference is better than neck circumference for predicting obesity in adolescents Wrist circumference has superior sensitivity and specificity for predicting obesity in adolescents, especially in boys. Both wrist circumference and neck circumference are alternative measurements that are simple, affordable, fast, and can be used in clinical practice and in large scale epidemiological studies.

References

1. Shafiee G, Qorbani M, Heshmat R, Djalalinia S, Motlagh ME, Arefirad T, Gorabi AM, Najafi F, Asayesh H, Kelishadi R. Wrist circumference as a novel predictor of obesity in children and adolescents: the CASPIAN-IV study. Journal of Pediatric Endocrinology and Metabolism. 2018 Jul 1;31(7):717-25.
2. Hai AA, Iftikhar S, Latif S, Herekar F, Javed S, Patel MJ. Prevalence of metabolic syndrome in overweight and obese patients and their measurement of neck circumference: A cross-sectional study. Cureus. 2019 Nov;11(11).
3. Namazi N, Djalalinia S, Mahdavi-Gorabi A, Asayesh H, Mansourian M, Noroozi M, Qorbani M. Association of wrist circumference with cardio-metabolic risk factors: a systematic review and meta-analysis. Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity. 2020 Feb;25:151-61.

4. Tatar BT, Ersoy C, Kacan T, Kirhan E, Sarandol E, Sigirli D, Kacan S, Demircan C, Imamoglu S. Neck and wrist circumferences propose a reliable approach to qualify obesity and insulin resistance. Medicine Science. 2014;3(1):1013-25.

5. Fitriyanti AR, Tjahjono K, Sulchan M, Sunarto S. Sensitivitas dan spesifisitas lingkar pergelangan tangan sebagai prediktor obesitas dan resistensi insulin pada remaja akhir. Jurnal Gizi Indonesia (The Indonesian Journal of Nutrition). 2019;7(2):121-6.

6. Mazidi M, Banach M, Kengne AP, Lipid and Blood Pressure Meta-analysis Collaboration Group. Prevalence of childhood and adolescent overweight and obesity in Asian countries: a systematic review and meta-analysis. Archives of medical science. 2018 Oct 31;14(6):1185-203.

7. Bentham, J. et al., 2017. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults. The Lancet, 390(10113), pp.2627–2642.

8. World Health Organization, 2018. Obesity and Overweight. Available at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.

9. Fitriyanti AR, Sulchan M, Tjahjono K, Sunarto S. Prediction of insulin resistance in late adolescent based on anthropometric index. Jurnal Gizi dan Pangan. 2019 Jul 30;14(2):53-60.

10. Magalhães EI, Sant'Ana LF, Priore SE, Franceschini SD. Waist circumference, waist/height ratio, and neck circumference as parameters of central obesity assessment in children. Revista Paulista de Pediatria. 2014;32:273-81.

11. Kerkadi A, Hassan AS, Al Thani AA, Al Chetachi W, Akram H, Bawadi H, Vinodson B, Risk NM. Prevalence of general and abdominal obesity among adolescents attending independent schools in Qatar. Nutrition & Food Science. 2019 Aug 12;49(4):687-99.

12. Hatipoglu N, Mazicioglu MM, Kurtoglu S, Kendirci M. Neck circumference: an additional tool of screening overweight and obesity in childhood. European journal of pediatrics. 2010 Jun;169:733-9.

13. Onat A, Hergenç G, Yüksel H, Can G, Ayhan E, Kaya Z, Dursunoğlu D. Neck circumference as a measure of central obesity: associations with metabolic syndrome and obstructive sleep apnea syndrome beyond waist circumference. Clinical nutrition. 2009 Feb 1;28(1):46-51.

14. Zhou JY, Ge H, Zhu MF, Wang LJ, Chen L, Tan YZ, Chen YM, Zhu HL. Neck circumference as an independent predictive contributor to cardio-metabolic syndrome. Cardiovascular diabetology. 2013 Dec;12:1-7.

15. Joshipura K, Muñoz-Torres F, Vergara J, Palacios C, Pérez CM. Neck circumference may be a better alternative to standard anthropometric measures. Journal of diabetes research. 2016;2016(1):6058916.

16. Ayhan NY, Iplikçi G, Ozturkk ME, Er NT, Yilmaz HÖ. The Relationship between Neck Circumference and Obesity in Children and Adolescents. International Journal of Food Engineering. 2018 Jun;4(2).

17. Luordi C, Maddaloni E, Bizzarri C, Pedicelli S, Zampetti S, D'Onofrio L, Moretti C, Cappa M, Buzzetti R. Wrist circumference is a biomarker of adipose tissue dysfunction and cardiovascular risk in children with obesity. Journal of Endocrinological Investigation. 2020 Jan;43:101-7.

18. Campagna G, Zampetti S, Gallozzi A, Giansanti S, Chiesa C, Pacifico L, Buzzetti R. Excellent intra and inter-observer reproducibility of wrist circumference measurements in obese children and adolescents. PloS one. 2016 Jun 13;11(6):e0156646.

19. Öztürk A, Çiçek B, Mazıcıoğlu MM, Zararsız G, Kurtoğlu S. Wrist circumference and frame size percentiles in 6-17-year-old turkish children and adolescents in Kayseri. Journal of clinical research in pediatric endocrinology. 2017 Dec;9(4):329.

20. Kelishadi R, Heidari-Beni M, Qorbani M, Motamed-Gorji N, Motlagh ME, Ziaodini H, Taheri M, Ahadi Z, Aminaee T, Heshmat R. Association between neck and wrist circumferences and cardiometabolic risk in children and adolescents: The CASPIAN-V study. Nutrition. 2017 Nov 1;43:32-8.

21. Khadilkar V, Chiplonkar S, Ekbote V, Kajale N, Mandlik R, Khadilkar A. Reference centile curves for wrist circumference for Indian children aged 3–18 years. Journal of Pediatric Endocrinology and Metabolism. 2018 Jan 26;31(2):185-90.

22. Alzeidan, R. et al., 2019. Performance of neck circumference to predict obesity and metabolic syndrome among adult Saudis: A cross-sectional study. BMC Obesity, 6(1), pp.1–8.

23. Stabe C, Vasques AC, Lima MM, Tambascia MA, Pareja JC, Yamanaka A, Geloneze B. Neck circumference as a simple tool for identifying the metabolic syndrome and insulin resistance: results from the Brazilian Metabolic Syndrome Study. Clinical endocrinology. 2013 Jun;78(6):874-81.LNCS Homepage, http://www.springer.com/lncs, last accessed 2023/10/25