



# Neck Circumference as a Potent Anthropometric Predictor of Cardiovascular Diseases and Metabolic Syndrome: A Review Study

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ARTICLE INFO	ABSTRACT
<i>Article type:</i> Review Article	<b>Introduction:</b> Obesity is considered to be a major risk factor for metabolic syndrome (MetS). The present study aimed to investigate the associations of neck circumference (NC) with cardiovascular diseases and MetS in adults.
<i>Article History:</i> Received: 03 Mar 2019 Accepted: 08 Apr 2019 Published: 04 May 2019	<b>Methods:</b> This review was conducted via searching in databases such as Medline, PubMed, Scopus, and Google Scholar using various keywords, including metabolic syndrome, cardiovascular diseases, neck circumference, waist circumference, obesity, metabolic syndrome components, HDL cholesterol, triglyceride, fasting blood glucose, and blood pressure. The search aimed to retrieve the articles published during 2000-July 2017. The inclusion criteria were adults aged more than 18 years, obesity-related parameters, and a clear demarcation of MetS in the adults.
<i>Keywords:</i> Obesity Metabolic Syndrome Neck Circumference	<b>Results:</b> In total, six eligible studies evaluating 5,041 adults aged 20-85 years were included in the analysis. NC showed high sensitivity in the detection of high body mass index and MetS demarcation. In addition, NC had a strong diagnostic precision for the recognition of overweight and obesity, while it could also predict MetS in adults and elderly individuals. <b>Conclusion:</b> Neck circumference could be considered as a valid and reliable predictor of metabolic syndrome in adult population.

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## Introduction

The rate of obesity is on the rise in pandemic portions (1), and it is considered to be a major risk factor for various cardiometabolic disorders, such as diabetes, hypertension, dyslipidemia, and coronary heart disease (2). Neck circumference (NC) is measured below the level of the thyroid cartilage, perpendicular to the vertical axis of the neck (10) and is a reliable index to examine upper-body obesity and the correlations with cardiovascular risk factors, insulin resistance, and the components of metabolic syndrome (MetS) (3).

Although the location of fats may modify the health concept of body mass index (BMI), central obesity is commonly considered to be a

more important risk factor for cardiometabolic risks compared to overall obesity (4). Distribution of fats in the upper segments of the body (especially with increased visceral adipose tissue) is assumed to be the predictive factor of cardiometabolic conditions (5). Various anthropometric measures are used to assess overall obesity and its specific aspects, such as central or abdominal obesity, visceral fats, and subcutaneous fats.

Computed tomography (CT) and magnetic resonance imaging (MRI) are considered the 'gold standard' modalities for the measurement of visceral fat (VF), and dual-energy X-ray absorptiometry is considered to be highly

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reliable alternative in this regard. However, these methods are costly and not feasible for large epidemiological studies (6).

NC is a simple, less commonly used anthropometric measurement, which is correlated with waist circumference (WC) and

BMI. In addition, it has been reported to be associated with MetS and its components (7), which does not change throughout the day (8). Figure 1 depicts the significant points in some anthropometric indices, as well as the importance of selecting WC index in research.

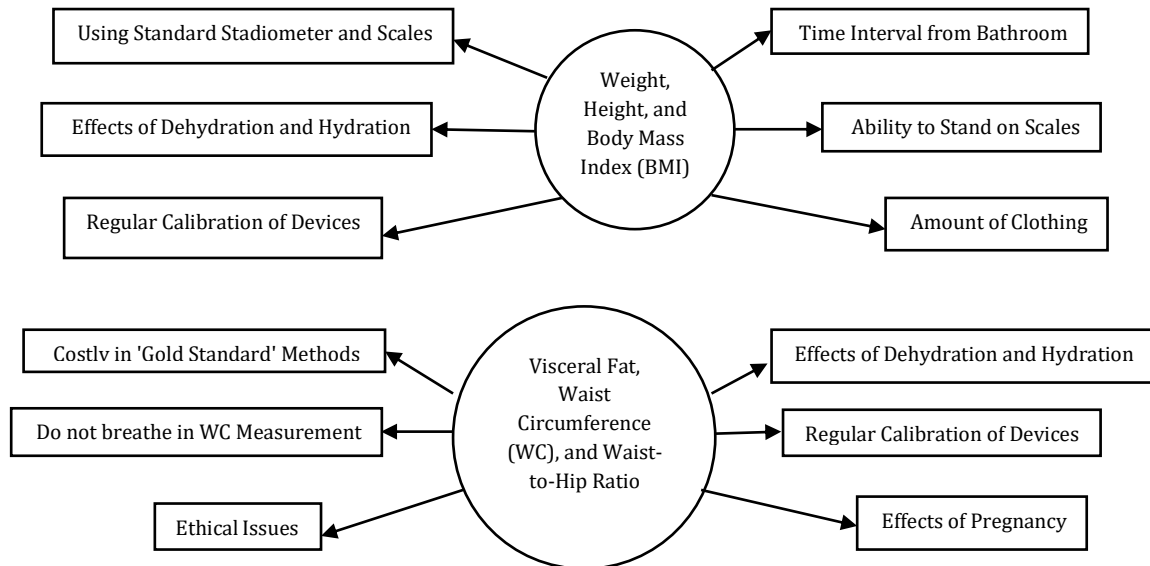


Figure 1. Significant Cases in Some Anthropometric Indices

In this regard, Stabe et al. conducted a research on patients with the BMI of 18.5-40.0 kg/m<sup>2</sup>, reporting that NC measurements were a proper approach to determining the body fat distribution in patients with type II diabetes mellitus, as well as those with normal glucose tolerance. Furthermore, the findings of the mentioned study indicated that NC was positively correlated with the risk factors for MetS, insulin resistance, and abdominal VF (7). Therefore, it could be concluded that NC predicts MetS and its components more reliably than waist circumference (9).

In a cross-sectional study on 1,206 male and female patients aged 40-65 years, Joshipura et al. reported that NC had a more significant correlation with pre-diabetes comparatively. NC may be an important marker of central adiposity and VF, as well as an important risk indicator of metabolic conditions and a major measure in routine examinations in primary care clinics and other healthcare centers. In research, this index is considered to be a proper alternative to costly and sophisticated devices. Moreover, NC may be particularly useful in populations such as

pregnant women, where traditional measures could be challenging or infeasible (10).

The present study aimed to investigate the associations of NC with cardiovascular diseases and MetS in adults.

## Material and methods

### Literature Search and Study Identification

This review study was conducted via searching in databases such as Medline, PubMed, Scopus, and Google Scholar using various keywords, including body mass index, neck circumference, metabolic syndrome, waist circumference, obesity, and adults, in order to retrieve the articles published during 2000-July 2017.

The inclusion criteria were the studies conducted on adults aged more than 18 years, obesity-related parameters, and patients with the clear demarcation of MetS. Only the articles that were published in English were considered eligible. Reviews, letters, guidelines, editorials, case reports, and *in-vitro* and animal studies were excluded. The PRISMA flow chart of the study is depicted in

Figure 2.

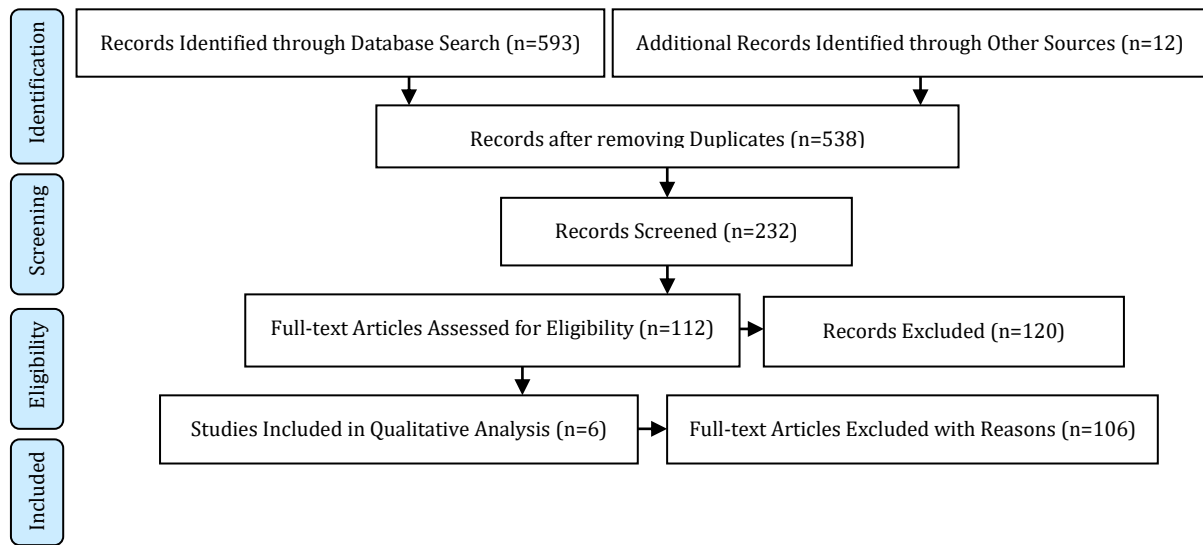


Figure 2. PRISMA Flow Chart of Study

### Eligibility Criteria

All the case-control, cross-sectional, and cohort studies were included if the study population was limited to adults aged more than 18 years.

### Results

In a study performed on 4,201 men and women aged 20-85 years in the Health Examination Centre in China, the results indicated that NC was significantly correlated with the risk factors for cardiometabolic disorders, even after adjustment for the possible confounding effects of several anthropometric indices (11). In another research conducted on 120 premenopausal, obese women and men with the mean age of  $40.5 \pm 6.9$  years and BMI of  $38.6 \pm 6.5$  kg/m<sup>2</sup>, Cizza et al. reported that higher NC was associated with MetS (12). Similarly, Saka et al. reported that higher NC was correlated with higher body weight, BMI, hip and waist circumference, and waist-to-hip ratio in 411 volunteer adults, including 237 women and 174 men. In addition, the findings of the mentioned study indicated significant associations between NC and overweight and obesity indices (13).

In a case-control study performed on 215 subjects by Hingorio et al. (14) NC was reported to have a strong correlation with adiposity

indices. Therefore, it could be used as an effective adjunct for the clinical screening of MetS. Furthermore, the mentioned research demonstrated that the optimal NC cutoff points to determine MetS were >38 centimeters for men and >34 centimeters for women.

In a cross-sectional study by Kaulgud et al., which was conducted on 48 patients undergoing elective coronary angiography, the mean NC was estimated at  $36.87 \pm 4.37$  centimeters in men and  $36.04 \pm 3.65$  centimeters in women. The authors suggested that NC could be used as an efficacious, simple tool for the risk assortment of patients with coronary heart disease (15).

In this regard, Aoi et al. examined the associations between NC and the markers of insulin resistance, atherosclerosis, and lipid metabolism in 64 healthy, postmenopausal women, reporting that NC was significantly associated with the indices of VF accumulation, including BMI, waist circumference, and general obesity (16).

### Discussion

Diverse pathophysiologic factors are associated with cardiometabolic diseases, such as obesity and metabolic issues. Among these factors, obesity is considered to be a major risk factor for cardiometabolic diseases (17). The present study aimed to assess NC as a potent

anthropometric predictor of cardiovascular diseases and MetS. As is shown in Figure 1, many anthropometric indices have limitations in terms of their measurement and prediction of MetS, none of which are correlated with NC. According to the results of the present study, the patients with cardiometabolic diseases had higher NC compared to the adult controls. The results of the present study provide invaluable data for the evaluation of the patients suspected of cardiometabolic diseases by recognizing the anthropometric characteristics associated with cardiometabolic diseases.

According to Hingorjo et al., NC is significantly correlated with adiposity indices and has a certain cutoff point. Therefore, it could be used as an effective appendant for the clinical screening of MetS (14). According to the findings of Assyov et al., NC could perform better than waist circumference in the assessment of metabolic health in the individuals with drastic obesity.<sup>18</sup> Previous studies have also indicated that NC increases in the adults (men and women) with increased BMI and waist circumference (5, 7, 19). Several studies have also indicated a significant, positive correlation between triglyceride and NC increment (14, 20). In this regard, Aswathappa et al. claimed that NC was significantly higher in diabetic patients compared to non-diabetic subjects. In addition, higher NC than 36 centimeters in diabetic patients and higher NC than 37 centimeters in non-diabetic patients were considered to be the foremost cutoff points to detect the individuals with central obesity (21).

In another study, Abdolahi et al. reported an inverse correlation between high-density lipoprotein (HDL) and NC in women (22). In another research by Preis et al., which was conducted on 3,307 men (52%; mean age=51 years; BMI=27.8 kg/m<sup>2</sup>; mean NC=40.5 cm in men and 34.2 cm in women). According to the findings, NC was significantly correlated with HDLc and fasting plasma glucose. Nonetheless, women had more significant risk factors in terms of the NC compared to the men regarding all the risk factors. Meanwhile, the results of the present study regarding the correlation between blood pressure and NC indicated that in men, increased NC by 2.9 centimeters was associated with a significant increase in the systolic blood pressure (SBP) by 2.4 mmHg. Further

adjustment of the visceral adipose tissue was also reported to cause an increase in the SBP (1.3 mmHg (P=0.002) per 1SD increase in the NC.<sup>5</sup>

Addition of NC to the definition of MetS should be considered in further investigations in this regard. Since the measurement of NC has been identified as a reliable tool as a complementary method to waist circumference measurement. Furthermore, it is easy to measure, reproducible, and not affected by stomach fullness or respiration phases (14). Some parameters that are generally used to evaluate obesity (e.g., waist circumference) may be difficult to apply since they require the adequate training of the evaluators and due to clothing restrictions, differences in the measurement sites, social and religious factors, climatic conditions, and spent time (23).

It has been suggested that NC is an indicator of subcutaneous fats in the body NC could be a substitute marker for upper-body subcutaneous fats (24), which is more lipolytically active compared to lower-body fats (25) due to its association with the impairment of glucose uptake, insulin resistance, endothelial dysfunction, and atherosclerosis. The brown adipose tissue could be another possible mechanism to determine the correlation of NC with the risk factors for MetS. Since the brown adipose tissue is often located in the neck and supraclavicular areas, which play a key role in the energy homeostasis (14), it could secrete adipokines (e.g., leptin and interleukin-6), which could be involved in metabolic disorders (26).

## Conclusion

According to the results, NC is easy to measure, reproducible, and not affected by respiration phases or stomach fullness since it has high diagnostic accuracy for the recognition of obesity and overweight and may be used as a reliable predictor of MetS in adults and the elderly.

## Limitations of the Study

Due to the heterogeneity of the studies, the synthesis of data and their meta-analysis was not possible.

## Authors' Contributions

S. H. T: review of the study, data collection,

and preparation of the first draft of the manuscript; M. A. F: idea provision, review of the studies, manuscript revision, and project supervision. All the authors read and approved the manuscript.

### Data Availability and Materials

The data and materials were available if the scientists had reasonable requests.

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### Conflicts of interest

None declared.

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