# The role of anthropometric measurements in identifying cardiometabolic diseases in obstructive sleep apnea syndrome

**REVIEW**

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## ABSTRACT

**The role of anthropometric measurements in identifying cardiometabolic diseases in obstructive sleep apnea syndrome**

*Anthropometric indices continue to be important measurements especially in predicting obesity and various diseases it causes. The fact that these measurements are very simple to apply and provide clinicians with important information especially in identifying cardiometabolic diseases cannot be overlooked. The use of these indices without the need for complex measurements or laboratory tests gives rapid results on the risks of chronic diseases. Obesity is an important risk factor in obstructive sleep apnea syndrome, and anthropometric measurements showing body fat distribution are of great importance. In addition to the diagnosis of the disease, it is extremely important that the measurements reflecting obesity which is directly related to weight should not be ignored in predicting additional cardiometabolic diseases in this patient group. An ever-increasing variety of anthropometric measurements that reflect abdominal obesity with objective data enables the diagnosis of the disease as well as the determination of cardiometabolic risks of patients with asymptomatic sleep apnea syndrome.*

**Key words:** *Obstructive sleep apnea syndrome; cardiometabolic disease; body mass index; waist circumference; mortality*

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## ÖZ

**Antropometrik ölçümlerin obstruktif uyku apne sendromunda kardiyometabolik hastalıkları belirlemedeki rolü**

*Antropometrik indeksler özellikle obezite ve beraberinde sebep olduğu hastalıkları öngörmede önemli ölçümler olmaya devam etmektedir. Uygulanması son derece basit bu ölçümlerin özellikle kardiyometabolik hastalıkların tayininde klinisyenlere önemli bilgiler sunması göz ardı edilemeyecek düzeydedir. Kompleks ölçümler veya laboratuvar testlerine gerek kalmadan bu indekslerin kullanımı kronik hastalık riskleri hakkında hızlı sonuç verir. Obezite, obstrüktif uyku apne sendromunda önemli bir risk faktörüdür ve vücut yağ dağılımını gösteren antropometrik ölçümler büyük önem taşımaktadır. Hastalığın teşhisi yanında ağırlığı ile direkt bağlantılı obeziteyi yansıtan ölçümlerinin bu hasta grubunda ek olarak kardiyometabolik hastalıkları öngörmede de göz ardı*

*edilmemesi son derece önemlidir. Özellikle abdominal obeziteyi objektif veriler ile yansıtan antropometrik ölçümlerin çeşitliği gün geçtikçe artmakta, bu da asemptomatik uyku apne sendromlu hastaların hastalık teşhisi yanında kardiyometabolik risklerini belirlemeye olanak sağlamaktadır.*

**Anahtar kelimeler:** *Obstrüktif uyku apne sendromu; kardiyometabolik hastalık; beden kitle indeksi; bel çevresi; mortalite*

## INTRODUCTION

Anthropology is a scientific discipline that studies human beings as well as their biological structure, bodily characteristics, cultural structure, and social behaviors. Medical anthropology, on the other hand, investigates the effects of biological and socio-cultural traits in human behavior on disease and health. In medical anthropology, the composition, proportions, and type of the human body are revealed and their impacts especially on chronic diseases are investigated. Bone, muscle, and fat tissue measurements can be performed using anthropometric methods. Anthropometric measurements and indices can be used as significant predictors regarding the health status of the population and the individuals that make up the population. They are among follow-up and treatment methods in case of illness and can also be useful in terms of the prediction of chronic diseases, which are becoming increasingly important, especially with their high incidence values. Due to its fast implementation, easy evaluation, and strong validation, anthropometric measurements have a very important place in the assessment of the association between chronic diseases and nutrition, and in determining and improving the health status of the individual and population. In addition, their potential to make scientific contributions in terms of improving national economies, regulating health policies, and developing feedback mechanisms is rather high.

Obstructive sleep apnea syndrome (OSAS) is a syndrome characterized by repeated complete or partial obstructions of the upper airway that are often accompanied by decreased blood oxygen saturation and arousal during sleep. Its risk factors include obesity, age, male gender, endocrine disorders, craniofacial abnormalities, family history, sedative hypnotics, smoking, and alcohol consumption. Anthropometric measurements not only contain information about the severity of OSAS, but they can also provide important information in predicting cardiovascular, metabolic, and endocrinological complications, which are among the most common consequences of the disease. In this paper, the importance of anthropometric measurements in OSAS in identifying car-diometabolic diseases (CMD) will be discussed in light of the literature.

### Anthropometric Measurements

Chronic or noncommunicable diseases are defined as conditions that last one year or longer, require medical attention, and limit daily life activities. Cardiovascular diseases (CVD), type 2 diabetes, obesity, certain cancer types, and some lung diseases constitute the majority of chronic diseases. These diseases, as a serious public health problem, impact individuals and societies at an ever-increasing pace every year. They also have a negative impact on the economies of countries through their treatment and recovery processes. Anthropometric measurements that also include some field methods regarding the measurement of body composition are a reflection of individuals' phenotypes. Besides they provide significant information in terms of chronic diseases. In this context, along with some routinely used anthropometric measurements, there are measurements that are not often used in routine but can give important information about chronic diseases.

Routinely evaluated anthropometric measurements:

a. Body Mass Index (BMI)

b. Waist Circumference and Waist/Hip Circumference Ratio (WC, WHR)

c. Waist Circumference/Height Ratio (WHtR)

Anthropometric measurements not routinely evaluated:

a. Neck Circumference

b. Upper Middle Arm Circumference

c. Body Shape Index

### Body Mass Index

BMI, an index based on height and body weight, is the most frequently used anthropometric index at both individual and community levels. BMI is used both in protein-energy malnutrition (PEM) and the evaluation of obesity. It shows a good correlation between body fat and waist circumference. BMI is calculated with

the equation of body weight (kg)/square of height ($m^2$).

BMI is an important anthropometric index because it is closely associated with mortality. Regardless of the cause of death, it forms a U-shaped graph with all mortality rates (1). The classification proposed by the World Health Organization (WHO) is generally used in the evaluation of BMI, and it is known that the mortality rate is lower in the BMI range of 18.5-24.99 kg/$m^2$. However, recent studies have asserted that the BMI value with the least mortality increased from 23 kg/$m^2$ to 27.3 kg/$m^2$. In meta-analyses conducted, in patients with a BMI of over 25 kg/$m^2$, for every 5 kg/$m^2$ BMI increase, the mortality risk has been reported to increase by 30% in the general population, 40% in CVD, 60-120% in diabetes, 10% in renal, hepatic and neoplastic diseases and 20% in respiratory system diseases. BMI less than 22.5 kg/$m^2$ has been found to have a very clear positive association with ischemic heart disease, as well as a strong association with respiratory diseases, including cancer.

**Waist Circumference and Waist/Hip Circumference Ratio**

Waist circumference is the most commonly used simple anthropometric predictor of abdominal adiposity in clinical and large-scale epidemiological studies. Despite being associated with both abdominal and subcutaneous adipose tissue, previous studies conducted have shown that waist circumference is the best predictor of visceral adiposity compared to other simple anthropometric measurements (2). According to WHO, the waist/hip ratio should be less than 0.90 in men and less than 0.85 in women (3). The accumulation of body fat in the upper part of the body (android/apple type/male type) is a condition indicating an increased disease risk. On the other hand, the disease risk is lower in the obesity type (gynoid/pear type/female type) in which the body fat accumulates in the lower part of the body (hips). The android type of obesity raises the risk of developing cardiovascular disease, hypertension, diabetes, and certain cancers (breast, colon, etc) (4).

**Waist Circumference/Height Ratio**

In studies using the waist circumference to height ratio as an anthropometric predictor, a strong association has been found between this parameter and impaired blood pressure, cardiovascular problems

and related mortality, type 2 diabetes, and metabolic syndrome; in addition, it has been stated that the waist/height ratio is a good anthropometric predictor in assessing such diseases (5). The cut-off value of the waist/height ratio has been determined as 0.5, and it has been reported that the ratios between 0.4 and 0.5 are considered normal, and the ratios of 0.5 and above are associated with various disease risks (6).

Neck circumference, which is not routinely measured but contributes significantly to CMD and mortality, has been linked to obesity-related cardiovascular risk factors such as metabolic syndrome and insulin resistance. Furthermore, it has been demonstrated that neck circumference can be used to predict cardiovascular disease (7). Upper middle arm circumference is generally used as a handy measurement to evaluate malnutrition in children and geriatric age groups. Body shape index, on the other hand, has a very weak correlation with height, weight, and BMI, which indicates that it is independent of other anthropometric variables in predicting mortality (8).

**DISCUSSION**

Anthropometric measurements, in the field of medicine, enable us to reach important data regarding the prognosis of diseases, patients' existing comorbidities, and especially in mortality prediction. The effect of anthropometric measurements on mortality rates has been and continues to be the subject of many comprehensive studies around the world. In the European Prospective Cancer and Nutrition Research (EPIC), one of the most comprehensive studies examining the association between BMI, waist circumference (WC), waist-to-hip ratio, and mortality risk, it was reported that among 359.387 participants from nine countries, 14.723 individuals died from different causes during an average follow-up duration of 9.7 years. The study revealed that of the deceased individuals, the lowest mortality risk was associated with a BMI value of 25.3 kg/$m^2$ in males and 24.3 kg/$m^2$ in females, and WC and waist-to-hip ratio was significantly correlated with mortality risk (9). In a prospective study conducted with the involvement of 40 centers and researchers from 14 European countries, 46.651 (47.1% women) participants aged 24 to 99 years whose median follow-up duration varied from 2.5 to 21.8 years were included. During the course of the study, 1.071 males (45%) and 339 females (32.1%) died from CVD, and it was revealed that in these patients, all anthropometric measurements of abdominal obesity had a positive

linear association with CVD mortality (10). Similarly, in the study aiming to compare the body shape index and the other five conventional anthropometric indices related to obesity (body mass index, waist circumference, hip circumference, waist-hip ratio, waist-height ratio) in terms of their value in predicting cardiometabolic risk factors and CVDs in the Chinese population; in all models, a positive association was observed between each anthropometric index and cardiometabolic risk factors or CVDs. However, it was concluded that the new body shape index is not a better predictor of cardiometabolic risk factors or CVDs than other traditional obesity-related indices (11). A cross-sectional study investigating the association between cardiometabolic risk and BMI, WC, and WHtR and including 21.038 males and 15.604 females who participated in a health check-up revealed that a WHtR of greater than 0.5 is a simple but efficient predictor of overall obesity and related cardiometabolic risk, even among individuals considered 'healthy' according to BMI and WC (12). It was concluded in a meta-analysis with a population size of 137.256 participants that all three predictors (WC, WHR, and BMI) among anthropometric measurements are good screening tools to predict CVDs and CMDs (13). A summary of the characteristics of studies on the association of anthropometric parameters with cardiometabolic, cardiovascular, and mortality risk are presented in Table 1. In the literature, there are studies emphasizing the importance of anthropometric measurements reflecting obesity in the prediction of CMDs. The study conducted in 1993, which can be considered to be the first study on the clinical benefit of these measurements specifically in OSAS, revealed that males with OSAS have a significant excess of body fat that is not always reflected in body weight or BMI measurements and that upper body obesity, hypertension, and impaired glucose tolerance are also more common than expected in this population. In addition, it was concluded that severe adiposity not only favors the development of respiratory abnormalities of OSAS but may make a direct contribution to the increased cardiovascular risk associated with OSAS (14). According to the results of home-based polysomnography conducted on 75 patients whose cardiometabolic risk (CMR) scores were calculated using WC, glucose, HDL, triglycerides, and mean arterial blood pressure, Roche et al. reported that 60.7% of the participants were overweight/obese, 61.3% were hypertensive and 29.3% had undiagnosed OSAS and that older age and having a higher

BMI and WC were associated with OSAS, while severe apnea-hypopnea index (AHI), and female gender were associated with a higher CMR score (15). Schäfer et al. investigated whether there is an association between the degree of obstructive sleep apnea and traditional risk factors for CVD and regional fat distribution, particularly the type of central obesity and increased parapharyngeal fat pads. In the study, it was found that in patients presenting with suspected OSAS, there was a significant association between the degree of the sleep-related breathing disorder and anthropometric measurements of obesity (i.e., body weight and BMI) and that regional body fat distribution detected by magnetic resonance imaging had a significant correlation with the amount of intra-abdominal fat, a borderline significant correlation with subcutaneous abdominal fat and no correlation with parapharyngeal fat pads or subcutaneous fat of the neck region; and it was concluded that the increase in regional fat distribution brings along the CMD and CVD risks (16). Balat et al. investigated the association between conventional as well as newly defined anthropometric measurements whose relationship with OSAS has not yet been explored, such as Body Shape Index (BSI), Waist/Height Ratio (WHtR), Body Fat Index (BFI), Abdominal Volume Index (AVI), Conical Index (CI), and disease severity, polysomnography (PSG) parameters and cardiometabolic diseases in OSAS cases. In the study, 367 males (65%) and 143 females (35%), were divided into four groups according to the AHI, and the comparison of these groups in terms of anthropometric measurements indicated that the measurements reflecting abdominal obesity were significantly associated with the presence of CMD as much as OSAS severity in patients with OSAS (17).

## CONCLUSION

In addition to the fact that anthropometric parameters provide significant information about the severity of the disease in OSAS, the high values of these parameters are noteworthy in terms of pointing to the presence of cardiometabolic diseases in these cases. Today, the holistic treatment approach should aim to provide positive effects on health through the inclusion of exercise programs and lifestyle changes towards the correction of abdominal obesity rather than focusing solely on making patients lose weight. Even if patients with abdominal obesity are asymptomatic, their examination and treatment for OSAS are critical for the early prevention of many complications, particularly cardiometabolic diseases.

**Table 1.** Characteristics of studies on the relationship between anthropometric parameters with cardiometabolic, cardiovascular risk, and mortality risk

| Study | Study type | Partipitans (n) | Average follow-up duration | Evaluated anthropometric parameters | Results |
|---|---|---|---|---|---|
| Pischon T et al. (9) | Multi-center retrospective study | 359.387 | 9.7 | BMI WC WHtR | Lowest mortality risk was associated with a BMI value of 25.3 kg/m$^2$ in males and 24.3 kg/m$^2$ in females, and WC and WHtR was significantly correlated with mortality risk |
| Song X et al. (10) | Meta-analysis study | 46.651 | 7.9 | BMI WC WHtR WHR ABSI | All anthropometric measurements of abdominal obesity have a positive linear association with CVD mortality |
| Liu J et al. (11) | Retrospective, observational study | 44.048 | - | BMI WC HC WHtR WHR | A positive association has been observed between each anthropometric index and cardiometabolic risk factors or CVDs |
| Li WC et al. (12) | Cross-sectional study | 36.642 | - | BMI WC WHtR | Patients of either sex with a normal BMI or WC level, but with an elevated WHtR, had higher levels of various cardiometabolic risk factors in comparison with their normal BMI or WC, but low WHtR, counterparts |
| Darbandi M et al. (13) | Systematic review | 137.256 | - | BMI WC WHR | All 3 indicators are good screening tools for estimating CVD' and CMDs Indices of abdominal obesity, especially WHR, can better predict CVD occurrence |

BMI: Body mass index, WC: Waist circumference, WHtR: Waist/hip circumference ratio, WHR: Waist circumference/height ratio, ABSI: A Body shape index, HC: Hip circumference, CVD: Cardiovascular diseases, CMD: Cardiometabolic diseases.

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