Can neck circumference be used as a tool to identify the metabolic syndrome and insulin resistance?

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Metabolic syndrome is defined as a nexus of cardiometabolic risk factors and is diagnosed by three or more of the following criteria: abdominal obesity, hypertriglyceridaemia, low high-density cholesterol, hypertension or impaired fasting glucose. The development of the metabolic syndrome is not only influenced by the degree of obesity but also by the distribution and location of adipose tissue. Visceral adiposity is a strong predictor of metabolic dysfunction as well as cardiovascular risk. Imaging techniques are considered to be more accurate in measuring visceral adiposity. However, there are a number of anthropometric measurements validated as surrogate markers in the assessment, as well as predictors, of metabolic dysfunction, e.g. waist circumference (WC), waist to hip ratio (WHR), thigh circumference and abdominal skin-fold thickness. Recently, the use of neck circumference has been shown to be positively associated with metabolic syndrome risk, insulin resistance and visceral fat, when using established cut-off values for the prediction of metabolic syndrome risk and insulin resistance.1

The Brazilian Metabolic Syndrome Study (BRAMS)

In a cross-sectional population based analysis, Stabe et al. in the Brazilian Metabolic Syndrome Study1 investigated the relationship of neck circumference with metabolic syndrome and insulin resistance. Study subjects comprised 1053 patients (301 males; 752 females) out of a pool of 3498 patients enrolled between 1998 and 2011 from outpatient clinics for type 2 diabetes, metabolic syndrome and obesity conducted in five cities. Metabolic syndrome was identified in 94 (31.2%) men and 243 (32.3%) women, and insulin resistance was found in 77 (34%) men and 177 (31%) women by euglycaemic-hyperinsulinaemic clamp studies.

Neck circumference: BRAMS findings

Anatomically, neck circumference was measured below the level of cricothyroid cartilage in both men and women in order to standardise the measurement by avoiding laryngeal prominence. The investigators examined the correlation between neck circumference, obesity and metabolic syndrome risk markers, adjusting for age, and found neck circumference to be associated with the obesity markers, WC and BMI, in men and women, while the neck circumference correlated with WHR only in men.

Neck circumference was found to be positively correlated with fasting triglycerides and fasting glucose, and showed a negative association with high-density lipoprotein cholesterol in both men and women. Neck circumference was also found to be positively correlated with glycaemic control (HbA1c), adiponectin and HOMA-IR levels in both groups. On the basis of euglycaemic-hyperinsulinaemic clamp studies, neck circumference showed a negative association with adiponectin and insulin sensitivity index; it was also positively associated with HOMA-IR. On ROC analysis, neck circumference presented the largest AUC for insulin resistance in women compared with men, and was similar to that for WC. However, for metabolic syndrome risk, the WC showed the largest AUC in both genders (0.81 and 0.87 for men and women, respectively), followed by BMI (0.78 and 0.84), WHR (0.79 and 0.78), and neck circumference (0.73 and 0.74). A cut-off neck circumference >40cm was established in this population to predict both metabolic syndrome risk and insulin resistance.

In essence, when comparing with WC, the investigators were successful in demonstrating the utility of neck circumference in assessing insulin resistance. However, WC showed the best correlation for determining metabolic syndrome risk, followed by BMI and WHR, with neck circumference being closely associated with metabolic syndrome risk – which is not surprising since WC is inherent in the definition of metabolic syndrome risk. However, this is the first study of its kind to use the gold standard method for assessing insulin resistance, i.e. euglycaemic-hyperinsulinaemic clamp, compared with previous studies using the HOMA-IR index.

Study limitations

There are number of limitations to this study. Neck circumference cut-off values cannot be generalised at a larger population level; and to derive precise population-based neck circumference cut-off values for a larger population using similar methodology (i.e. euglycaemic-hyperinsulinaemic clamp) would be an extremely complicated study to be undertaken. There are no established guidelines to define anatomical location for neck circumference measurement, as correctly pointed out by the authors themselves (above cricothyroid cartilage,2 at the upper level of the margin of the thyroid cartilage,3 just below the laryngeal prominence).4 Data support that neck circumference correlates more strongly with visceral adipose tissue (VAT) than subcutaneous adipose tissue (SAT), and adults have a higher VAT to SAT ratio compared with children and adolescents who have a higher proportion of SAT, i.e. a lower VAT to SAT ratio.8

Further considerations

The authors postulate that insulin resistance was found to be strongly associated with neck circumference in their study as neck circumference, being considered to be a surrogate marker of upper body subcutaneous (SC) fat which is supposed to be more lipolytically active than lower body SC fat, contributes to circulating free fatty acids (FFAs), and because FFA concentrations are directly associated with insulin resistance, very low-density lipoprotein production, and endothelial dysfunction.3 Obstructive sleep apnoea (OSA) has been strongly associated with neck circumference, and more so for neck circumference...
corrected for the height of the individual.\(^9\)\(^10\) In addition, the repetitive nocturnal hypoxaemia experienced by OSA causes neural, humoral, thrombotic, metabolic and inflammatory dysfunction, leading to increased insulin resistance.\(^11\)\(^12\) The modified Mallampati score has shown to be an independent predictor of OSA;\(^12\) perhaps OSA was a confounder and the investigators could have utilised this score in their assessment, since a large metropolitan area based apnoea survey among the adult population of Sao Paulo, Brazil, observed a high prevalence of OSA (32.8\%).\(^13\) Therefore, this possibly represents another major limitation that OSA prevalence was not addressed in this study, which could explain neck circumference correlation with insulin resistance in this cohort.

**Conclusion**

Ultimately, the utilisation or development of any clinical or anthropometric tool should translate into improved clinical outcomes, i.e. cardiovascular risk reduction in this case; and, due to the various limitations associated, each method has its own capabilities and pitfalls just like neck circumference in this study. However, we agree that clinical outcomes can be improved by the use of simple and appropriate tools, which will need larger studies to be validated on a broader scale.

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**Declaration of interests**

There are no conflicts of interest declared.

**References**


