Neck Circumference and the Development of Cardiovascular Disease Risk Factors in the Framingham Heart Study

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OBSERVATIONS

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Upper-body subcutaneous adipose tissue, estimated by neck circumference (NC), is a unique fat depot that may confer additional risk for metabolic risk factors over generalized and central adiposity (1). Using a prospective study design, we now evaluate whether NC improves the prediction of incident cardiovascular disease risk factors over BMI and waist circumference (2).

Framingham Heart Study participants (n = 2,732; 54% women; mean age, 57 years) were followed for ~10 years (1995–2008) for the development of type 2 diabetes (fasting plasma glucose $\geq 126$ mg/dL), hypertension, low HDL cholesterol (<40 mg/dL), men; <50 mg/dL, women), and high triglycerides ($\geq 150$ mg/dL or lipid treatment). NC, BMI, and waist circumference were standardized within each sex to a mean of zero and an SD of one. Logistic regression models, adjusted for age, sex, and smoking, were used to test the association between 1 SD increment of NC with each outcome. C-statistics were calculated to assess the impact of adding NC to baseline models, and the net reclassification improvement (NRI) statistic was calculated to assess risk reclassification improvement (low, 0–1.9%; medium, 2.0–7.9%; high, $\geq$8% risk categories) (3,4).

In baseline models, NC was associated with diabetes ($P < 0.05$) with all outcomes. After further adjustment for BMI and waist circumference, NC remained associated only with type 2 diabetes (n = 182, odds ratio [OR] = 1.57, 95% CI [1.24–1.98], P = 0.0002). In this model, the OR for BMI was 1.03 (95% CI [0.73–1.45], P = 0.88) and the OR for waist circumference was 1.48 (95% CI [1.05–2.10], P = 0.03). Additional adjustment for baseline fasting blood glucose resulted in an OR for NC of 1.42 (95% CI [1.09–1.86], P = 0.01).

When NC was added to a model containing an established type 2 diabetes risk score (5), the OR for type 2 diabetes was 1.36 (95% CI [1.12–1.66], P = 0.002), and the NRI was 10.2% ($P < 0.0001$). When NC was added to a model containing the individual clinical characteristics used to derive the type 2 diabetes risk score (age, sex, parental history of type 2 diabetes, BMI, hypertension, HDL cholesterol, and fasting plasma glucose), the OR was similar (OR 1.53, 95% CI [1.22–1.92], P = 0.0003).

NC had a stronger effect on the incidence of type 2 diabetes in women (OR = 2.77, 95% CI [2.18–3.53], P < 0.0001) compared with men (OR = 1.76, 95% CI [1.43–2.15], P < 0.0001) ($P_{\text{interaction}} = 0.006$).

For type 2 diabetes, the addition of NC to a model containing baseline covariates and BMI resulted in a change in the C-statistic from 0.743 to 0.766 (P = 0.004) and an NRI of 7.4% (P = 0.01). When NC was added to a model with baseline levels of fasting plasma glucose and BMI, the C-statistic increased from 0.885 to 0.891 (P = 0.01) and the NRI was 4.5% (P = 0.03). Similar results were observed when waist circumference was substituted for BMI. When NC was added to a model with BMI and waist circumference, the C-statistic increased from 0.754 to 0.772 (P = 0.01) and the NRI was 4.9% (P = 0.10).

NC is associated with incident type 2 diabetes and a clinically meaningful improvement in the NRI. Our results are limited by the single fasting plasma glucose measure and the exclusion of those who did not return for follow-up. Whether measurement of NC improves type 2 diabetes prediction over traditional adiposity measures warrants further investigation.

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**References**

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