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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 ≥126 mg/dL or treatment), hypertension, low HDL cholesterol (<40 mg/dL, men; <50 mg/dL, women), and high triglycerides (≥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, ≥8% risk categories) (3,4).

In baseline models, NC was associated ($P < 0.05$) 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], $P < 0.0001$) ($P_{interaction}$ = 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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DOI: 10.2337/dc12-0738

Acknowledgments—This work was supported by the National Heart, Lung, and Blood Institute's Framingham Heart Study (N01-HC-25195). J.B.M. is supported in part by a National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) grant (K24 DK080140). R.S.V. is supported in part by an NIDDK/National Institutes of Health grant (RO1DK080739).

No potential conflicts of interest relevant to this article were reported.

S.R.P. researched data and wrote the manuscript. M.J.P. researched data and reviewed and edited the manuscript. R.B.D. and J.B.M. reviewed and edited the manuscript. R.S.V. reviewed and edited the manuscript and contributed to discussion. C.S.F. researched data, reviewed and edited the manuscript, and contributed to discussion. S.R.P. and C.S.F. are the guarantors of this work and, as such, had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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