Greater hand-grip strength predicts a lower risk of developing type 2 diabetes over 10 years in leaner Japanese Americans

Running title: Hand-grip strength and risk of diabetes

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Abstract

Objective: Much is known about body composition and type 2 diabetes risk but less about body function such as strength. We assessed whether hand-grip strength (HGS) predicted incident diabetes.

Research Design and Methods: We followed 394 nondiabetic Japanese-American subjects (mean age 51.9) for the development of diabetes. We fit a logistic regression model to examine the association between HGS at baseline and type 2 diabetes risk over 10-years, adjusted for age, sex, and family history.

Results: A statistically significant (p = 0.008) and negative (coefficient -0.208) association was observed between HGS and diabetes risk that diminished at higher BMI levels. Adjusted ORs for a 10-kg HGS increase with BMI set at the 25th, 50th or 75th percentiles were 0.68, 0.79, and 0.98, respectively.

Conclusions: Among leaner individuals, greater HGS was associated with lower risk of type 2 diabetes, suggesting it may be a useful marker of risk in this population.
Both muscle mass and strength have been shown to differ in persons with type 2 diabetes compared to healthy controls. In cross-sectional studies, hand-grip strength (HGS) was lower in individuals with diabetes than in those without(1; 2), and type 2 diabetes has recently been shown to be associated with skeletal muscle loss over time(3). Whether loss of skeletal muscle mass and strength precedes the development of diabetes is not known. Therefore we tested whether baseline differences in HGS might serve as a marker for the subsequent development of type 2 diabetes in a nondiabetic population.

Research Design and Methods

Study subjects were taken from the Japanese-American Community Diabetes Study, a cohort of second- and third-generation Japanese Americans of 100% Japanese ancestry. Subjects were chosen through community-wide recruitment and were representative of Japanese-American residents of King County, WA, as described in greater detail elsewhere(4). Subjects included in this analysis were nondiabetic at baseline, had available baseline measurements of HGS and all covariates, and had diabetes status assessed at the 10-year follow-up. Overall 80% of subjects eligible at baseline completed the 10-year follow-up assessment(5). HGS was measured at baseline with a Harpenden R dynamometer (British Indicators Ltd, St Albans, England) in kilograms three times on the dominant hand (reset to 0 each time). The value entered was the average of the two highest values. Presence of diabetes was assessed using the oral glucose tolerance test (75 g load) and defined as fasting glucose $\geq 126$ mg/dl and/or 2-hr glucose $\geq 200$ mg/dl (6), or use of diabetes medication. Body mass index (BMI) was defined as weight in kg divided by height in meters squared. Logistic regression was used to estimate the association
between HGS and odds of incident diabetes while adjusting for covariates known to be associated with type 2 diabetes (age, family history of diabetes in a parent or sibling and BMI) and sex (7-9). Interactions between HGS and model covariates were assessed using first-order interaction terms inserted in the logistic model. Odds ratios (OR) and 95% confidence intervals (CI) for continuous variables are shown for a 1-unit increment. A p-value of <0.05 was considered statistically significant. Analyses were performed with Stata (version 9.2; StataCorp, College Station, TX).

Results
The study population consisted of 394 Japanese-American subjects (mean age 51.9 years, range 34-75). The subject population was made up slightly more of males (53%) and had a mean BMI of 24.1 (range 16.6 to 36.9) kg/m² with a mean HGS of 50.4 (range 21.5 to 86.5) kg. The 10-year cumulative incidence of diabetes was 18.5%. Higher age (OR 1.06, 95% CI 1.02-1.09), BMI (OR 1.11, 95% CI 1.01-1.21), and positive family history of diabetes (OR 2.76, 95% CI 1.60-4.77) were all significantly associated with an increased risk of diabetes. Sex was not associated with diabetes (OR 0.78, 95% CI 0.28-2.15), and there was no significant association between HGS and incident diabetes. However, when we modeled interaction, there was a significant positive interaction between BMI and HGS (interaction term coefficient 0.008, 95% CI 0.002-0.0135, p-value 0.007), such that among the lean individuals in the study population, greater HGS was associated with lower risk of type 2 diabetes (Figure 1). The diminution in risk however was attenuated at higher BMI levels. The coefficient for HGS was negative (-0.208) and statistically significant (p=0.008). Adjusted ORs for a 10-kg increase in HGS when BMI was set to
the 25th, 50th or 75th percentiles were 0.68 (95% CI 0.43-1.09), 0.79 (95% CI 0.52-1.20),
and 0.98 (95% CI 0.67-1.43) respectively. No other significant interaction between HGS
and other model covariates was present.

Conclusions

These data suggest that among leaner individuals higher muscle strength was associated
with lower risk of type 2 diabetes, an interesting finding in light of current understanding
of muscle physiology and protein metabolism in diabetes. Both muscle strength and
muscle quality, defined as muscle strength per unit regional muscle mass, are affected by
the disease(10). However, recent data demonstrate that individuals with undiagnosed
diabetes show greater declines in appendicular lean mass than those with longstanding
disease, suggesting that the effect of type 2 diabetes on skeletal muscle mass seems to be
manifested in the early stages of the disease or may precede disease onset. It has been
suggested that these changes may be due to associated abnormalities in protein
metabolism that may negatively affect muscle mass(11). If these abnormalities are linked
to a higher risk of diabetes then this might explain the association that we observed. Also,
HGS may reflect physical fitness(12) and it has been repeatedly shown that higher
physical activity is associated with a lower diabetes risk(13). Therefore, HGS may serve
as a cumulative marker of exercise over time. HGS may relate more directly to resistance
exercise, which is associated with improved levels of glycemia in persons at higher risk
for the development of type 2 diabetes(14). The association between HGS and diabetes
risk was diminished at higher levels of BMI. The reasons for this are not clear, but
suggest that if the association is causal then the known effects of adiposity on diabetes
risk may override any potential benefit associated with greater grip strength and its correlates.

This study has several potential limitations. HGS was measured only at baseline and diabetes status determined at baseline and 10-year follow-up. Variability in the performance of these tests over time may have introduced error in these analyses, although the error is probably random and therefore any bias created would probably have been towards the null value. Therefore the associations we report may be underestimates. The 20% loss to follow-up could have introduced bias if such loss was related to both diabetes risk and HGS. Nevertheless, this rate is low for a prospective study of this type conducted over a prolonged period of time, which demanded a good deal of subject time to complete study measurements.

In summary, this analysis suggests a potential novel method to assist in the estimation of diabetes risk in leaner persons, but additional research will be needed to confirm its value.
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Disclosure

The authors of this study have no conflicts of interest to disclose.
References

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Figure Legend

Probability of 10-year incident type 2 diabetes by baseline hand-grip strength (continuous measurement). Probabilities are shown for persons with BMI set to the 25th percentile (solid line), median (long-dashed line), or 75th percentile (short-dashed line) and average age, sex and family history for this cohort.
Probability of developing diabetes vs. grip strength

- BMI 21.7 kg/m² (25th percentile)
- BMI 23.6 kg/m² (median)
- BMI 26.2 kg/m² (75th percentile)