

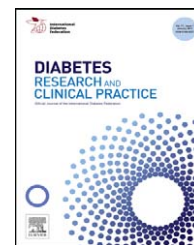


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Greater hand-grip strength predicts a lower risk of developing type 2 diabetes over 10 years in leaner Japanese Americans

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ABSTRACT

Aims: 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 predicted incident diabetes.

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 hand-grip strength 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 hand-grip strength and diabetes risk that diminished at higher BMI levels. Adjusted ORs for a 10-pound hand-grip strength 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 hand-grip strength was associated with lower risk of type 2 diabetes, suggesting it may be a useful marker of risk in this population.

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Much is known about body composition and type 2 diabetes risk. The association between diabetes and obesity is well established [1]. They are national epidemics that seem to travel together, but evidence suggests that the association between abnormalities of body composition and performance and diabetes are complex. 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 (hand-grip strength) was lower in individuals with diabetes than in those without [2,3], and type 2 diabetes has recently been shown to be associated with skeletal muscle loss over time [4]. Additionally, both strength and muscle quality, defined as muscle strength per unit regional muscle mass, were

significantly lower in individuals with diabetes, with each being worse with longer duration and poorer control [5].

Hand-grip strength (HGS) is an established marker for conditioning, and has specifically been shown to be associated with overall fitness in persons with type 1 diabetes [6]. Whether loss of skeletal muscle mass and strength precedes the development of diabetes is not known, although circumstantial evidence does suggest that even within the normal range of blood glucose, higher glucose level is associated with lower grip strength [3]. Therefore we tested whether baseline differences in hand-grip strength might serve as a marker for the subsequent development of type 2 diabetes in a nondiabetic population.

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1. Methods

We followed 394 nondiabetic Japanese-American subjects for the development of diabetes at 10 years. Study subjects were taken from the Japanese-American Community Diabetes Study, a cohort of second- and third-generation Japanese Americans of 100% Japanese ancestry, and were representative of Japanese-American residents of King County, WA, in age, residential distribution, and parental immigration pattern. A comprehensive mailing list and telephone directory that included almost 95% of the Japanese-American population of King County, WA, was used to identify and contact potential study subjects. Subjects returned for follow-up 10–11 years after a baseline evaluation. Selection and recruitment have been described in greater detail previously [7].

Overall 80% of subjects eligible at baseline completed the 10-year follow-up assessment. Hand-grip strength was measured at baseline with a Harpenden R dynamometer (British Indicators Ltd., St. Albans, England) in pounds 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 ≥ 126 mg/dl and/or 2-h glucose ≥ 200 mg/dl [8], or use of diabetes medication. Body mass index (BMI) was defined as weight in kg divided by height in meters squared. Physical activity in leisure time was obtained from a modified Paffenbarger questionnaire and calculated as weekly kilocalories of energy expenditure.

Logistic regression was used to estimate the association between hand-grip strength 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 [9–11]. Interactions between hand-grip strength 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 10-pound increment in hand-grip strength. A p -value of <0.05 was considered statistically significant. Analyses were performed with Stata (version 9.2; StataCorp, College Station, TX).

2. Results

Table 1 shows baseline characteristics by diabetes status at 10-year follow-up. 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 16.6–36.9) kg/m² with a mean hand-grip strength of 50.4 (range 21.5–86.5) 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 hand-grip strength and incident diabetes. However, when we modeled interaction, there was a significant positive interaction between BMI and hand-grip strength (interaction term coefficient 0.008, 95% CI 0.002–

Table 1 – Baseline characteristics of study subjects by diabetes status at 10-year follow-up, and the odds ratio for incident diabetes over this time period.

	Diabetes	No diabetes	OR (95% CI) ^a
Age	57.4 \pm 0.6	50.6 \pm 1.3	1.06 (1.02–1.09)
% Male	60% \pm 6	52% \pm 3	0.78 (0.28–2.15)
Family history	58% \pm 6	31% \pm 3	2.76 (1.60–4.77)
BMI	25.2 \pm 0.4	23.8 \pm 0.2	1.11 (1.01–1.21)
HGS, lbs	50.0 \pm 1.6	50.5 \pm 0.8	1.00 (0.96–1.04)

^a Odds ratios for continuous variables are shown for a one-unit increase in value.

0.0135, p -value 0.007), such that among the lean individuals in the study population, greater hand-grip strength was associated with lower risk of type 2 diabetes (Fig. 1). The diminution in risk however was attenuated at higher BMI levels. The coefficient for hand-grip strength was negative (-0.208) and statistically significant ($p = 0.008$) (Table 2).

Adjusted ORs for a 10-pound increase in hand-grip strength 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 (Table 3). Similar results were seen with adjustment for baseline fasting plasma glucose and physical activity measured as weekly kilocalories of energy expenditure (data not shown). No other significant interactions between hand-grip strength and other model covariates were present.

3. Discussion

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. It is known that muscle strength and quality are affected by the natural course of diabetes [5]. 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

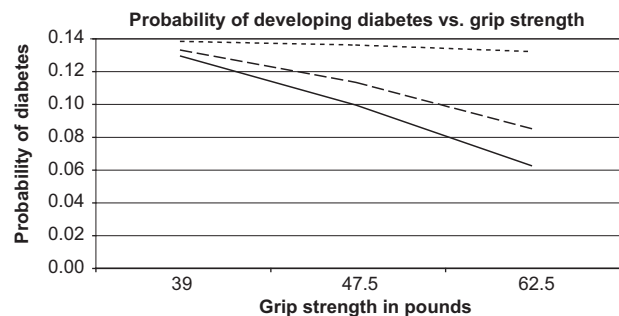


Fig. 1 – Probability of 10-year incident type 2 diabetes by baseline hand-grip strength (continuous measurement). Probabilities are shown for persons with BMI set to the 25th percentile (solid line), median (long-dashed line), or 75th percentile (short-dashed line) and average age, sex and family history for this cohort.

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