

## BRIEF REPORT

# Low Grip Strength and Prediabetes in Normal-Weight Adults

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**Introduction:** Detection of prediabetes is an important step in diabetes prevention in primary care. Risk stratification of healthy-weight individuals for detection of prediabetes is necessary to avoid missed opportunities for diabetes prevention.

**Methods:** Using data from the 2011 to 2012 National Health and Nutrition Examination Survey, we studied the relationship between combined handgrip strength, a proxy for lean muscle mass, and prediabetes among adults aged  $\geq 20$  years without diagnosed or undiagnosed diabetes who had a healthy body mass index (18.5–24.9 kg/m<sup>2</sup>; unweighted n = 1340, weighted n = 58,360,690). Prediabetes was defined as having a glycohemoglobin level between 5.7% and 6.4%.

**Results:** Of the healthy-weight adults, 20.5% had prediabetes. Combined mean grip strength was lower for individuals with prediabetes than those with normoglycemia in the full sample (63.8 vs 70.9 kg;  $P = .004$ ). Similar results were seen among both men (87.9 vs 82.1 kg;  $P = .03$ ) and women (51.8 vs 56.5 kg;  $P = .001$ ) in subgroup analysis.

**Conclusions:** Grip strength is associated with prediabetes among healthy-weight US adults. Grip strength may have utility as an indicator for screening healthy-weight individuals for prediabetes. (J Am Board Fam Med 2016;29:280–282.)

**Keywords:** Hand Strength, Prediabetes

Prediabetes is a high-risk state for the development of diabetes.<sup>1</sup> Over one third of adults in the United States have prediabetes, but the majority of these individuals are unaware of it.<sup>2</sup> Treatment of prediabetes has been associated with the delayed onset of diabetes.<sup>3</sup> Detection of prediabetes is a fundamental strategy in preventing the transition to diabetes.<sup>1</sup>

American Diabetes Association recommendations for screening for prediabetes focus on adults who are overweight or obese, and may miss individuals of a healthy weight with “normal-weight obesity,” a condition characterized by high body fat and lower lean muscle mass at a healthy body mass index (BMI).<sup>1,4</sup> Grip strength, a proxy for lean muscle mass, is predictive of undiagnosed diabetes among patients with a healthy BMI.<sup>5</sup> The objective of this study was to examine the relationship between grip strength and prediabetes among healthy-weight adults.

## Methods

We analyzed 2011 to 2012 data from the National Health and Nutrition Examination Survey (NHANES). The NHANES is a nationally representative survey for the noninstitutionalized civilian US population that includes a physical examination, an interview covering a broad range of health-related topics, and a variety of laboratory tests. The data are publicly available for secondary analysis from the Centers for Disease Control and Preven-

This article was externally peer reviewed.

Submitted 18 August 2015; revised 23 September 2015; accepted 25 September 2015.

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**Funding:** The project was funded in part by National Institutes of Health/National Institute on Aging grant no. P30AG028740 through the Claude D. Pepper Older American's Independence Center.

**Conflict of interest:** none declared.

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tion. All the analyses were conducted using the de-identified data supplied by the National Center for Health Statistics. This study focused on adults aged 20 years and older who had a BMI 18.5 to <25 kg/m<sup>2</sup>, with no reported diagnosis of diabetes, and an HbA<sub>1c</sub> measurement <6.5% (47.5 mmol/mol) on examination. A total of 1340 adults were analyzed, representing 58,360,690 Americans.

Handgrip strength was measured using a digital grip strength dynamometer (Takei Scientific Instruments Co., Ltd, Tokyo, Japan). Grip strength was measured 3 times using both hands in a standing position. This analysis utilized combined grip strength (in kilograms), calculated as the sum of the highest reading from each hand. Individuals were considered to have prediabetes if they reported a diagnosis by a physician of “borderline diabetes” or prediabetes, or if upon examination their HbA<sub>1c</sub> level was between 5.7% (38.8 mmol/mol) and 6.4% (46.4 mmol/mol).

To account for the design of the NHANES, we used SUDAAN 11 software (Research Triangle Institute, Research Triangle Park, NC) for all analyses. The survey design and weighting variables allowed us to account for survey design in univariate analyses and 2-sample *t* tests, to make population estimates for the noninstitutionalized civilian US population.

## Results

Among healthy-weight adults, 20.5% had HbA<sub>1c</sub> levels consistent with prediabetes. Grip strength in individuals with prediabetes was significantly lower than in individuals without prediabetes, both among the full sample as well as among men and women (Table 1). Among whites, grip strength was significantly lower among individuals with prediabetes (62.2 kg) than among individuals without prediabetes (71.4 kg; *P* = .004). Mean grip strength among nonwhites with prediabetes was 68.9 kg, and grip strength among nonwhites without prediabetes was 70.6 kg (*P* = .39). Among individuals aged 45 years and older, individuals with prediabetes had a mean grip strength of 59.9 kg, and those without prediabetes had a mean grip strength of 65.16 (*P* = .07). The difference in means was significant among women aged 45 years and older. Women aged ≥45 years with prediabetes had a mean grip strength of 49.7 kg; those without prediabetes

**Table 1. Comparison of Mean Combined Grip Strength by Prediabetes Status Using *t* Tests for Statistical Significance**

	Combined Grip Strength (kg), Mean (Standard Error)	<i>P</i> Value
Full Sample		
No prediabetes	70.9 (1.01)	.004
Prediabetes	63.8 (1.43)	
Men		
No prediabetes	87.9 (1.41)	.03
Prediabetes	82.1 (1.76)	
Women		
No prediabetes	56.5 (0.79)	.001
Prediabetes	51.8 (1.03)	

had a mean grip strength of 52.8 kg (*P* = .05). Men aged ≥45 years with prediabetes had a mean grip strength of 79.7 kg, whereas those without prediabetes had a mean grip strength of 81.7 kg (*P* = .39).

## Discussion

These results show grip strength is a marker for prediabetes in US healthy-weight adults. The findings are particularly important because 20.5% of healthy-weight adults had prediabetes, and these individuals are not typically screened for prediabetes because of their healthy weight. The association of grip strength with prediabetes among healthy-weight individuals indicates the potential utility of grip strength as a prescreening measure to determine whether an individual should be screened. Interestingly, decreased grip strength was present among whites with prediabetes but not nonwhites with prediabetes. Minorities are known to be at increased risk for diabetes; it may be that grip strength is unrelated to prediabetes in individuals who are already at increased risk.

This is, to our knowledge, the first study to evaluate the relationship between grip strength and prediabetes in healthy-weight individuals. As such, the results showing the relationship between lower grip strength and prediabetes in this presumed healthy population are intriguing but are currently just a first step. Grip strength has the potential to be a marker of prediabetes among certain populations. However, the use of grip strength needs further research to determine clinical cutoff values for screening, especially given known differences in grip strength between men and women and among

individuals of different ages. Further study can identify the cutoff points that might contribute to the utility of implementing grip strength measures in primary care practice to heighten suspicion of prediabetes. This study might contribute to a more sophisticated, but inexpensive and easily implemented, adjunct measure of body composition that seems to be missing when using BMI alone to classify the healthy-weight population at risk for prediabetes. Consequently, this strategy could identify more patients with prediabetes who would not have been identified, and thereby contribute to preventing prediabetes.

This study has several limitations to the generalizability and interpretation of the results. First, although the data are nationally representative, the data are cross-sectional, which means we can show only an association between grip strength and prediabetes, not a causal relationship. However, the utility of grip strength as a potential cue to screen for prediabetes relies only on the association of grip strength with prediabetes, and does not require causal inference as to whether prediabetes causes decreased grip strength or whether decreased muscle mass led to prediabetes. Second, there might be a potential confounder, such as physical activity, that is associated with grip strength. While some physical activity can influence the strength of the forearm (which may be related to grip strength), the NHANES data are limited regarding the type of leisure time and work-related physical activity, so we cannot examine differences in activities that may account for differences in grip strength. In any event, grip strength seems to distinguish individuals with prediabetes at a healthy weight—a group that would not incur heightened suspicion for prediabetes. Third, a review of the literature on the use of dynamometers in epidemiologic studies found

that there is evidence that variation in how a dynamometer is used can affect the values recorded<sup>6</sup> and has implications for the potential need for standardized protocols for the assessment of grip strength in a primary care setting.

## Conclusion

Considering the substantial proportion of healthy-weight adults with prediabetes, strategies for diabetes prevention may benefit from additional risk stratification of these patients. Decreased grip strength may have future utility in increasing suspicion for prediabetes and potentially guiding screening for prediabetes among healthy-weight adults.

## References

1. American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care*. 2012; 35(Suppl 1):S64–71.
2. Centers for Disease Control and Prevention (CDC). Awareness of prediabetes—United States, 2005–2010. *MMWR Morb Mortal Wkly Rep* 2013;62: 209–12.
3. Selph S, Dana T, Blazina I, Bougatsos C, Patel H, Chou R. Screening for type 2 diabetes mellitus: a systematic review for the U.S. Preventive Services Task Force. *Ann Intern Med* 2015;162:765–76.
4. Romero-Corral A, Somers VK, Sierra-Johnson J, et al. Normal weight obesity: a risk factor for cardiometabolic dysregulation and cardiovascular mortality. *Eur Heart J* 2010;31:737–46.
5. Mainous AG 3rd, Tanner RJ, Anton SD, Jo A. Grip strength as a marker of hypertension and diabetes in healthy weight adults. *Am J Prev Med* 2015;49: 850–8.
6. Roberts HC, Denison HJ, Martin HJ, et al. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. *Age Ageing* 2011;40:423–9.