Midlife Hand Grip Strength as a Predictor of Old Age Disability

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In OLD AGE, DECREASED MUSCLE strength predisposes people to functional limitations and disability.\(^1\)\(^-\)\(^3\) Cross-sectionally, muscle strength is significantly, but not linearly, associated with functional limitations such as walking speed.\(^4\)\(^-\)\(^7\) A minimum level of strength is needed to perform tasks. Conversely, when strength is well above the minimum required level, a reserve capacity exists.\(^1\)\(^,\)\(^3\)\(^,\)\(^5\)\(^-\)\(^7\) Reserve capacity serves as a safety margin that helps prevent functional limitations from developing, eg, following inactivity and deconditioning associated with surgery or an acute illness.

The purpose of this research was to study midlife muscle strength as a predictor of late life functional limitations and disability among initially healthy men with an average age of 54.0 years (range, 45-68 years) at baseline. The average follow-up time was 25.3 years.

METHODS

Subjects in these analyses are from the Honolulu Heart Program and the Honolulu-Asia Aging Study.\(^8\) From 1965 through 1968, 8006 men aged 45 to 68 years participated in exam 1. Exam 2 took place 3 years later (1968 through 1970), with 7498 men participating. Exam 4 data were collected from 1991 through 1993 when participants were 71 to 93 years old.

The current analyses were limited to those participants who were healthy at baseline. Persons who had missing data on disease status (n = 37); who had diabetes, gout, arthritis, stroke, heart attack, angina pectoris, or other heart disease at exam 1 or exam 2 (n = 1454); who dropped out or died between exams 1 and 2 (n = 406); or who reported at exam 4 that difficulty in upper extremity, mobility, or self-care tasks had been present for 25 years or more (n = 20) were excluded. All together, 6089 men qualified for the study cohort.

Hand grip strength was measured using a dynamometer (Smedley Hand Dynamometer, Stoelting Co, Wood Dale, Ill) at exams 1 and 2 with midlife strength determined as the average of the best results in these 2 exams.\(^9\) Measures of functional limitations at exam 4 included customary walking speed of 0.4 m/s or slower\(^10\) and inability to rise from a chair. Participants were asked to walk a distance of 3.05 m (10 ft) at their usual pace and time was measured using a stopwatch.

RESULTS

After adjustment for multiple potential confounders, risk of functional limitations and disability 25 years later increased as baseline hand grip strength, divided into tertiles, declined. The odds ratio (OR) of walking speed of 0.4 m/s or slower was 2.87 (95% confidence interval [CI], 1.76-4.67) in those in the lowest third and 1.79 (95% CI, 1.14-2.81) in the middle third of grip strength vs those in the highest third. The risk of self-care disability was more than 2 times greater in the lowest vs the highest grip strength tertile. Adding chronic conditions identified at follow-up to the models predicting disability reduced the ORs related to grip strength only minimally.

CONCLUSIONS

Among healthy 45- to 68-year-old men, hand grip strength was highly predictive of functional limitations and disability 25 years later. Good muscle strength in midlife may protect people from old age disability by providing a greater safety margin above the threshold of disability.

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a stopwatch. Ability to rise from a chair was measured by asking the subject to stand up without using his arms and observing the performance. Disability was ascertained by asking the participants the following question: “Because of health or physical problems, do you have any difficulty . . . ?” Upper extremity disability items were doing heavy household work (washing the car, raking leaves, mowing the lawn, or cleaning up the garage) and lifting something as heavy as 4.5 kg (10 lb). Mobility disability items were walking 0.8 km (½ mile) and walking up 1 flight of stairs. Self-care disability items were dressing, eating, bathing, and toileting.

At exam 4, the presence of chronic conditions was ascertained with ongoing surveillance using hospital records (stroke, coronary heart disease) or laboratory test results (coronary heart disease, diabetes, hypertension), or on the basis of participants’ self-reports (chronic obstructive pulmonary disease, angina, arthritis).

Death ascertainment was based on refusal of newspaper obituaries and listings of death certificates filed with the Hawaii State Department of Health and through a computer linkage to the National Death Index.

Participants were divided into 3 groups based on the baseline hand grip strength tertiles. The relative risks of mortality prior to follow-up tests and functional limitations and disability at follow-up for the hand grip strength groups were estimated using multiple logistic regression models. The models were adjusted for baseline age, socioeconomic status, body weight and height, physical activity and smoking, and chronic conditions ascertained at exam 4.

### RESULTS

At baseline, the average age was 54.0 years (SD, 5.5). The average hand grip strength was 39.2 kg (SD, 6.0), and the cutoff points for grip strength tertiles were 37.0 and 42.0 kg. The mean height was 160.3 cm (SD, 5.7), the mean weight was 63.2 kg (SD, 8.7), and mean body mass index was 23.7 kg/m² (SD, 3.1).

Among the 6089 men who qualified for the study, 2259 (37%) died before exam 4. Of the 3830 survivors, 3218 (84.0%) participated in the follow-up tests. Baseline grip strength did not predict participation among the survivors.

Of these 3218 initially healthy men, 72 (2.2%) became unable to rise from a chair without using their arms, and 201 (6.2%) had a walking speed of 0.4 m/s or slower at follow-up. The numbers with self-reported disability were difficulty walking 0.8 kg (½ mile) (n = 598 [18.6%]; walking up a flight of stairs (n = 451 [14.1%]); lifting 4.5 kg (10 lb) (n = 247 [7.7%]); doing heavy household work (n = 586 [18.2%]); dressing (n = 169 [5.3%]); bathing (n = 165 [5.2%]); eating (n = 72 [2.2%]); and toileting (n = 110 [3.4%]). There was a clear gradient of increasing risk for all functional limitations and disability outcomes according to weaker baseline hand grip strength tertiles (Figure). This gradient persisted after adjustment for multiple baseline confounders (Table). Finally, after adjusting for chronic conditions ascertained at exam 4, the risks of functional limitations and disability in the lowest and middle baseline grip strength tertiles decreased moderately after these adjustments, but remained statistically significant in most cases (Table).

### COMMENT

Our study provides strong evidence that hand grip strength predicts functional limitations and disability 25 years later in an initially healthy cohort of 45- to 68-year-old men. Those in the lowest grip strength tertile had the greatest risk and those in the middle tertile had intermediate risk compared with those in the highest tertile. Muscle strength is found to track over the lifespan: those who had higher grip strength during midlife remained stronger than others in old age. People with greater muscle strength during midlife are at a lower risk of becoming disabled because of their greater reserve of strength regardless of chronic conditions that may develop.

Hand grip strength has been found to correlate with strength of other muscle groups and is thus a good indicator of overall strength. Consequently, grip strength measurements could be used for early screening of populations to identify those at higher risk of physical disability related to low muscle strength. In these persons, exercise interventions aimed at improving strength in all muscle groups could potentially lower the risk of subsequent physical disability. Muscle strength can be increased substantially by physical exercise at all ages.

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**Figure.** Functional Limitations 25 Years After Assessing Grip Strength

<table>
<thead>
<tr>
<th>Self-reported Difficulty</th>
<th>Grip Strength Tertiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doing Heavy Household Work</td>
<td>Highest</td>
</tr>
<tr>
<td>Walking 0.8 km (1/2 mile)</td>
<td>Middle</td>
</tr>
<tr>
<td>Walking Up 10 Steps</td>
<td>Lowest</td>
</tr>
<tr>
<td>Lifting 4.5 kg (10 lb)</td>
<td></td>
</tr>
<tr>
<td>Dressing</td>
<td></td>
</tr>
<tr>
<td>Bathing</td>
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<tr>
<td>Toileting</td>
<td></td>
</tr>
<tr>
<td>Eating</td>
<td></td>
</tr>
<tr>
<td>Functional Limitations</td>
<td></td>
</tr>
<tr>
<td>Walking Speed ≤0.4 m/s</td>
<td></td>
</tr>
<tr>
<td>Unable to Rise From a Chair</td>
<td></td>
</tr>
</tbody>
</table>

There are also other potential explanations for our results. Grip strength may be a marker of physical activity, which itself preserves function and prevents disability. Low grip strength may indicate subclinical disease, which later develops into clinical disease and disability. Finally, good grip strength may mark some general intrinsic midlife vitality or motivation that tracks into good functional ability in old age.

The Japanese-American men studied here are not representative of all older people. However, it is unlikely that major racial or sex differences in the strength-disability relationship would be found, as the biomechanical principles of human movement are universal. Also, data were not available at baseline to allow for the exclusion of all participants with functional limitations and disability. However, activities of daily living disability is rare among middle-aged men: the prevalence is 0.9% among 45- to 54-year-old men and 1.8% among 55- to 64-year-old men and disability is usually related to a disease. After people with documented chronic conditions at baseline were excluded, it is likely that the baseline cohort contained very few disabled individuals.

Overall, there are very few long-term prospective studies on risk factors for disability and mortality in old age. Cigarette smoking, deviations from normal weight, and a low level of physical activity have been shown to be long-term predictors of self-reported disability and mortality in studies with 17 to 27 years of follow-up. This is the first study to show that muscle strength is a powerful predictor of physical disability as long as 25 years later. This study suggests that hand grip strength could be used for early screening of people at increased risk of physical disability in old age.

REFERENCES


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