Journal of Gerontology: MEDICAL SCIENCES
2002, Vol. 57A, No. 1, M19–M25

Waist Circumference and Weight Change Are Associated With Disability Among Elderly Hispanics

Honglei Chen, Odilia I. Bermúdez, and Katherine L. Tucker

The Jean Mayer USDA Human Nutrition Research Center on Aging, Tufts University, Boston, Massachusetts.

Background. Studies have suggested that both high and low body mass index (BMI) and weight change are related to functional disability in elderly populations. Elderly Hispanics have a high prevalence of both obesity and disability, yet few studies have examined their interrelationship in this population. Therefore, we examined these relationships in a mostly Puerto Rican group of Hispanic elders.

Methods. We investigated associations between a three-level disability score created from responses to a questionnaire on activities of daily living and BMI, waist circumference (WC), and weight change since age 50, using the proportional odds model in a cross-sectional study of 763 elderly Hispanics, aged 60 to 92 years, residing in Massachusetts.

Results. After adjusting for potential confounders, men with a WC ≥109.3 cm (vs <90 cm), or with a reported weight loss of −0.32 to −0.01 kg/year, or a weight gain ≥0.55 kg/year since age 50 (vs relatively stable weight, −0.01 to +0.21 kg/year [y]) were each significantly associated with an approximately threefold higher risk for greater disability. Women with a BMI ≥35 kg/m^2 were almost four times as likely to have higher disability as those with a BMI of 20 to 25 kg/m^2. Compared with women with a WC ≤85.2 cm, those with a WC of 91.5 to 106.6 cm were two times more likely, and those with a WC ≥106.6 cm were five times more likely, to have higher disability scores. Compared with relatively stable weight (−0.05 to +0.23 kg/y), weight gain ≥0.23 kg/year was associated with a twofold higher risk of greater disability among women. When BMI and WC were included in the same model, WC, but not BMI, remained significantly associated with disability.

Conclusions. Abdominal obesity (WC ≥109.3 cm for men, or WC ≥91.5 cm for women) and weight gain ≥0.55 kg/year after age 50 in men or ≥0.23 kg/year in women may increase the risk of disability among elderly Hispanics.

WITH the rapid aging of the U.S. population, functional disability among elderly persons has become an important public health concern. Disability substantially increases the health burden of society and is also related to higher mortality among elderly individuals (1–4). Therefore, it is important to identify potential causal factors in order to better understand how to prevent or delay its occurrence. Major known determinants of disability include advancing age, female gender, low physical activity, and chronic diseases (5–7).

Several studies have suggested that higher body mass index (BMI) or weight loss may relate to greater disability among elderly populations (1,8–17). Recent evidence suggests that abdominal fat accumulation is an independent predictor of morbidity (18,19) and that waist circumference (WC) may be a more relevant measure for abdominal adiposity than waist-to-hip ratio (20). However, few studies (21–23) have evaluated the association between WC and disability and, to our knowledge, none have examined this among Hispanics, a rapidly increasing population segment of the United States (24). Elderly Hispanics have been shown to have a higher prevalence of disability and obesity than non-Hispanic whites (25–28), and Puerto Ricans may have a higher disability prevalence than other Hispanic groups (29,30). In this study, we investigate associations between BMI, WC, and average annual weight change since age 50, and self-reported disability among a representative sample of elderly Hispanics in Massachusetts, which included primarily Puerto Ricans (61.2%) and Dominicans (18.6%).

METHODS

Subjects and Study Design

We obtained a representative sample of elderly Hispanics in Massachusetts through a two-stage sampling approach, using the 1990 census data. Detailed sampling methods and study design have been described previously (30,31). The protocol for this study was approved by the human investigation review board of Tufts/New England Medical Center. A total of 776 of 940 (83%) eligible Hispanics were interviewed from 1993 to 1997. Almost all of them (98%) were interviewed in Spanish. Among these, 763 (98%) subjects, with an average age of 69 years (range, 60–92 years [y]), had complete data on functional limitations and information on at least one of the following variables: BMI, WC, and recalled weight at age 50. Nine (1.2%) and 10 (1.3%) subjects had missing values on BMI and WC, respectively. Twenty-six men (9%) and 95 women (20%) did not recall their weight at age 50. Subjects with missing values were deleted from respective analyses.

Measurements

We measured functional status with a 12-item activities-of-daily-living (ADL) questionnaire, adapted from the Katz scale (32). These items include the following: (i) walking

for a quarter of a mile (two or three blocks); (ii) walking up 10 steps without resting; (iii) getting outside; (iv) walking from one room to another on the same level; (v) getting out of bed or chair; (vi) eating, including holding a fork, cutting food, or drinking from a glass; (vii) dressing, including tying shoes, working zippers, and buttoning; (viii) bathing or showering; (ix) using the toilet, including getting to the toilet; (x) using a manual can opener; (xi) opening a frozen food package; and (xii) opening a milk carton (30). Each item had four levels of severity: "no difficulty" (0), "some difficulty" (1), "much difficulty" (2), or "can't do" (3). We calculated an ADL summary score by summing the scores for all 12 items. Subjects with a score of 0 were defined as having "no disability." We grouped the subjects with a summary score greater than 0 into two categories: 1 to 5 as "some disability" and 6 to 36 as "considerable disability." With this definition, 12% of the elderly Hispanics categorized with "some difficulty" reported "can't do" on one ADL item; the majority reported only "some difficulty" on one or more ADL items. Of those categorized with "considerable disability," 97% reported "much difficulty" or "can't do" on two or more ADL items.

Anthropometric measurements were taken in duplicate by trained interviewers, and the average of the two measures was used. Height and knee height were measured to the nearest 0.1 cm with a Harpenden pocket stadiometer (Holtain Ltd, Crosswell, UK). For subjects unable to stand, or with stooped posture, height was further corrected by knee height with published equations developed for elderly Hispanics (31). WC was measured with a nonstretchable measuring tape at the level of the smallest area of the waist and recorded to the nearest 0.1 cm. Weight was measured to the nearest pound with a Seca balance scale (Seca Corporation, Columbia, MD) and was later translated into kilograms. Subjects were also asked to recall their weights at the age of 50. Weight change was calculated by subtracting weight at 50 years from current weight. Because the length of time of measurement varied considerably, we used the average annual weight change (absolute weight change divided by time frame) rather than the absolute value in the analysis.

To allow for nonlinear relationships between anthropometric variables and disability score, we categorized these anthropometric variables before data analysis. BMI was categorized as <20, 20 to 25, 25 to 30, 30 to 35, and ≥ 35 kg/m^2, with 20 to 25 kg/m^2 as the reference group. WC was defined by quintile categories within each gender, with the first quintile (67.1–89.8 cm for men and 56.0–85.2 cm for women) as the reference group. We also grouped annual weight change into quintile categories, and used the third quintiles (-0.01 to $+0.21$ kg/y for men and -0.05 to $+0.23$ kg/y for women), which represented the most stable weight over time, as the reference group.

In most analyses, we adjusted for age, physical activity, ethnicity, educational level, smoking status, alcohol use, living alone, and self-reported chronic conditions. Information regarding these variables was collected by questionnaire, and their definitions are presented in Table 1. Physical activity was estimated with a modified version of the Harvard Alumni Physical Activity Questionnaire (33), and a score lower than 29 was considered as sedentary activity, assuming 8 hours of sleep, 8 hours of sitting, and 8 hours of light activity. Subjects were asked to report whether they had ever been told by a physician that they had specific conditions, including arthritis, respiratory diseases, hip fracture, cataract, stroke, cancer, diabetes, heart attack, other heart diseases, depression, or hypertension. Because of the high prevalence of arthritis and hypertension in this population, we created three variables: arthritis (yes/no), hypertension (yes/no), and other chronic conditions (yes/no, from the previous list) for inclusion in regression models.

Table 1. Characteristics of the Study Sample

	Men		Women	
Variable	*n*	Mean/Proportion	*n*	Mean/Proportion
Age, y	295	69.1 ± 7.4	468	69.4 ± 7.2
Physical Activity Score	282	29.8 ± 3.4	449	29.0 ± 3.0
Ethnicity, %				
Puerto Rican	196	66.4	271	57.9
Dominican	43	14.6	99	21.2
Other Hispanic	56	19.0	98	20.9
Education, (y), %				
0	32	11.0	77	16.7
1–6	150	51.4	275	59.5
7–12	62	21.2	60	13.0
>12	48	16.4	50	10.8
Smoking Status, %				
Nonsmokers	80	27.1	292	62.4
Past smokers	156	52.9	129	27.6
Current smokers	59	20.0	47	10.0
Alcohol Use, %				
Non- and former moderate drinkers	96	35.4	384	83.8
Former heavy drinkers[†]	82	30.3	—	—
Current drinkers	93	34.3	74	16.2
Chronic Conditions, %				
Arthritis	132	44.8	293	62.6
Hypertension	180	61.0	335	71.6
Others	204	69.2	367	78.4
Living Alone, %				
Yes	94	31.9	159	34.0
No	201	68.1	309	66.0

Note: Means and standard deviations are presented for continuous variables and proportions are presented for categorical variables.

[†]For women, former heavy drinkers ($n = 11$) were combined with non- and former moderate drinkers because of the small sample size.

Statistical Analysis

All statistical analyses were completed with the SAS System for Windows (version 7, SAS Institute, Inc, Cary, NC). We did not find significant interactions between ethnicity and any of the independent variables; therefore, results were presented for all Hispanics combined. We calculated the age-adjusted ADL summary scores by anthropometric variable categories. To further adjust for potential confounders, we used the proportional odds model to calculate the odds ratios (OR) for higher disability score separately for men and women. This model is a natural extension of logistic regression, with consideration of the ordinal nature of the outcome variable (34). The OR for each independent variable reflects the relative odds of having higher levels of the out-

come for the exposure group, compared with the reference group. In this case, this represents the likelihood of having "considerable disability" versus "moderate or no disability" and "considerable or moderate disability" versus "no disability" for the exposure group compared with the control group.

Because BMI and WC were strongly correlated (Pearson correlation coefficients = 0.89 for men and 0.86 for women), we further calculated the ORs with both variables in the same models to evaluate their independent associations with disability score. All statistical tests were two-sided, and p values less than .05 were considered statistically significant.

Results

The characteristics of this sample of elderly Hispanics residing in Massachusetts are presented in Table 1. Their ages varied from 60 to 92 years of age (mean, 69 y), and they were generally inactive. The majority of the participants were Puerto Rican (61.2%) and Dominican (18.6%). Only 16% of these Hispanic men and 11% of these Hispanic women had attained more than 12 years of education. Men were more likely to be cigarette smokers or alcohol drinkers than women. However, more women than men reported chronic conditions. Approximately one third of these elderly Hispanics lived alone at the time of this investigation.

Table 2 shows the definitions of anthropometric and functional disability variables. Hispanic women had a higher average disability score (5.1 vs 3.4, $p < .0001$) than did men. Based on our definition, approximately 70% of women and 50% of men reported either some or considerable disability in their ADLs. According to the current definitions of overweight and obesity (19), a similar percentage of women and men were overweight (BMI, 25–29.9 kg/m^2; 35% vs 39%), but a much higher proportion of women than men were obese (BMI, ≥30 kg/m^2; 41% vs 24%). However, men had greater average WC than women (mean, 99.6 vs 95.8 cm). Women reported greater average weight change since age 50 than did men (mean, +0.14 vs +0.11 kg/y) and a larger range of weight change (−4.0 to +4.1 vs −2.3 to +2.8 kg/y).

Associations between age-adjusted ADL summary scores (mean ± *SE*) and BMI categories, WC, and annual weight change quintiles are illustrated in Figures 1, 2, and 3. Both men and women with a BMI greater than 35 kg/m^2 had significantly greater ADL scores than those in the groups with BMIs of 20 to 35 kg/m^2 (Figure 1). The lowest age-adjusted disability score was observed for men with a BMI of 25 to 30 kg/m^2, whereas the curve tended to be flat below a BMI of 35 kg/m^2 in women. There was a linear association between WC and ADL score among elderly Hispanic women, but not men, where those with WC of 102.6 to 109.3 cm had the lowest average ADL scores (Figure 2). However, for both men and women, those with the highest WC (>109.3 cm and 106.6 cm, respectively) had the highest ADL scores. Figure 3 suggests a U-shaped curve between weight change and ADL score in these elderly Hispanics, particularly for women. The groups with the smallest weight changes since age 50 (−0.01 to +0.21 kg/y for men or −0.05 to +0.23 kg/y for women) had the lowest average ADL scores. Compared with relatively stable weight, women with both the greatest weight gain (≥0.71 kg/y) or weight loss (≤0.44 kg/y) reported significantly more disability. In men, only moderate weight loss (−0.32 to −0.01 kg/y) differed significantly from the relatively stable weight category.

Table 2. Definitions of Anthropometric and Disability Variables

	Men (n = 295)		Women (n = 468)	
Variable	%	Range	%	Range
Disability Score (ADL Categories)				
No disability	49.8	0	29.9	0
Some disability	28.5	1–5	36.8	1–5
Considerable disability	21.7	6–31	33.3	6–29
BMI, kg/m^2				
<20	4.5	16.4–19.9	3.7	13.4–19.9
20–25	32.9	20.0–25.0	20.4	20.2–25.0
25–30	38.8	25.2–29.9	35.1	25.1–30.0
30–35	20.1	30.0–34.8	23.9	30.0–35.0
≥35	3.8	35.1–45.1	17.0	35.1–53.5
Waist Circumference				
1st quintile		67.1–89.8		56.0–85.2
2nd quintile		90.1–96.3		85.3–91.4
3rd quintile		96.3–102.5		91.5–97.6
4th quintile		102.6–109.3		97.6–106.6
5th quintile		109.3–143.5		106.6–139.6
Annual Weight Change				
1st quintile†		−2.25 to −0.32 (−29.2 to −3.80)		−4.00 to −0.44 (−55.9 to −4.48)
2nd quintile		−0.32 to −0.01 (−11.3 to –0.2)		−0.44 to −0.06 (−17.2 to −0.6)
3rd quintile		−0.01 to +0.21 (−0.2 to +6.9)		−0.05 to +0.23 (−1.3 to +7.6)
4th quintile		+0.21 to +0.55 (+2.3 to +19.8)		+0.23 to +0.70 (+2.6 to +17.5)
5th quintile		+0.55 to +2.78 (+6.7 to +47.3)		+0.71 to +4.07 (+7.6 to +52.9)

Notes: Missing values as follows: body mass index (BMI) for 6 men, 3 women; waist circumference for 6 men, 4 women; and annual weight change for 26 men, 95 women. ADL = activity of daily living.

†Numbers in parentheses are absolute weight changes (kg).

In Table 3, we present the ORs and their 95% confidence intervals for higher disability score by BMI category. After adjusting for potential confounders, elderly Hispanic women with a BMI greater than 35 kg/m^2 had a 3.9-fold higher risk for greater disability score compared with women with BMIs between 20 and 25 kg/m^2. A nonsignificant 3.5-fold increased risk was also observed for men. However, these associations were diminished once WC was further adjusted.

The results for WC and functional disability are presented in Table 4. After adjusting for potential confounders, men with a WC greater than 109.3 cm were three times as likely to have higher disability as those with a WC smaller than 90 cm. The OR increased to 7.9 once BMI was further adjusted. For women, a linear relationship ($p_{\text{for trend}} < .0001$) was seen between WC and functional disability. Compared with women whose WCs were smaller than 85.2 cm, the ORs ranged from 1.5 for those with a WC between 85.3 and 91.4 cm to 5.2 for those with a WC greater than 106.6 cm. These associations persisted after further adjustment for BMI.

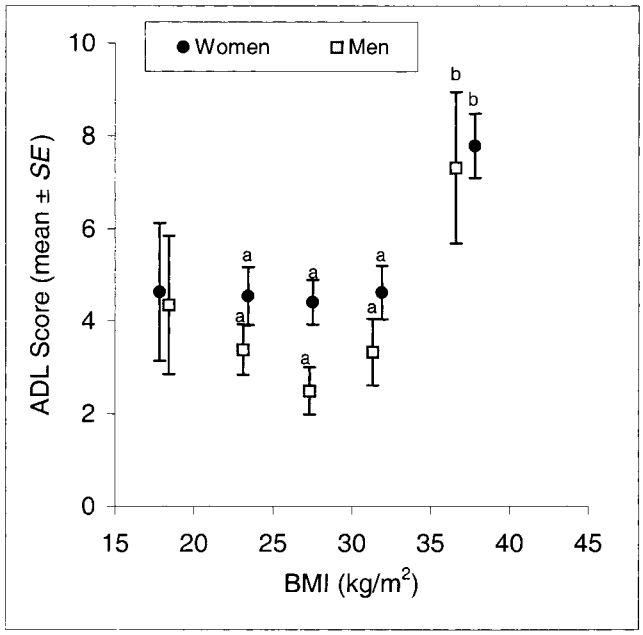

Figure 1. Age-adjusted activities-of-daily-living (ADL) summary scores (mean ± *SE*) in relation to body-mass-index (BMI) categories among elderly Hispanic men and women. Means with different letters within each gender differ significantly from each other; $p < .05$.

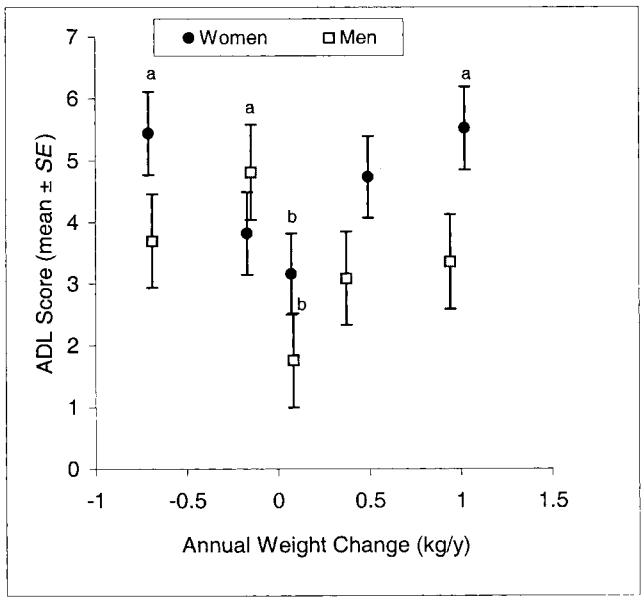

Figure 3. Age-adjusted activities-of-daily-living (ADL) summary scores (mean ± *SE*) in relation to annual weight change quintiles among elderly Hispanic men and women. Means with different letters within each gender differ significantly from each other; $p < .05$.

As seen in Figure 3, results shown in Table 5 show that the lowest risk of disability was found for men or women who had relatively stable weight since age 50 (−0.01 to +0.21 kg/y for men and −0.05 to +0.23 kg/y for women). Compared with men with stable weight, men who lost an average of between −0.32 and −0.01 kg/year or who gained more than 0.55 kg/year were approximately three times more likely to have higher disability. Women with annual weight gain greater than 0.23 kg/year had an approximately twofold higher likelihood of having greater disability than those with relatively stable weight.

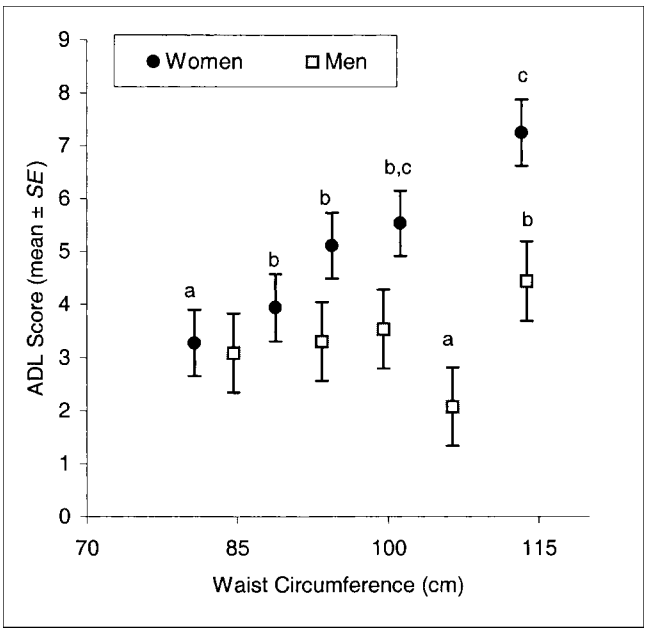

Figure 2. Age-adjusted activities-of-daily-living (ADL) summary scores (mean ± *SE*) in relation to waist circumference quintiles among elderly Hispanic men and women. Means with different letters within each gender differ significantly from each other; $p < .05$.

Discussion

In this representative sample of elderly Hispanics in Massachusetts, we found that WC greater than 109.3 cm (vs ≤89.8 cm) in men, or 91.5 cm (vs ≤85.2 cm) in women,

Table 3. Odds Ratios and Their 95% Confidence Intervals for BMI Categories on Functional Disability From the Proportional Odds Model

	Men		Women	
BMI, kg/m²	Model 1 (n = 254)	Model 2 (n = 253)	Model 1 (n = 434)	Model 2 (n = 432)
<20	1.3 (0.3–4.7)	1.6 (0.3–7.4)	1.3 (0.4–3.6)	1.4 (0.5–4.2)
20–25	1.0	1.0	1.0	1.0
25–30	0.6 (0.3–1.2)	0.4 (0.2–1.1)	1.4 (0.8–2.4)	1.0 (0.5–1.8)
30–35	1.1 (0.5–2.2)	0.3 (0.1–1.2)	1.6 (0.9–2.9)	0.7 (0.3–1.6)
≥35	3.5 (0.9–14.0)	0.6 (0.1–3.5)	3.9**** (2.0–7.6)	1.1 (0.4–3.0)

Notes: Model 1 was adjusted for age, physical activity score, smoking status, alcohol use, education level, ethnicity, living alone, arthritis, hypertension, and other chronic conditions. Model 2 was further adjusted for waist circumference. BMI = body mass index.

****$p < .0001$.

Table 4. Odds Ratios and Their 95% Confidence Intervals for Waist Circumference (WC) Quintile Categories on Functional Disability From the Proportional Odds Model

	Men			Women	
WC Quintiles, cm	Model 1 (n = 255)	Model 2 (n = 253)	WC Quintiles, cm	Model 1 (n = 433)	Model 2 (n = 432)
≤89.8	1.0	1.0	≤85.2	1.0	1.0
90.1–96.3	1.3 (0.6–3.0)	1.8 (0.7–4.6)	85.3–91.4	1.5 (0.8–2.7)	1.5 (0.8–3.0)
96.3–102.5	0.9 (0.4–2.2)	1.7 (0.5–5.2)	91.5–97.6	2.1* (1.1–3.9)	2.4* (1.2–5.0)
102.6–109.3	0.5 (0.2–1.2)	1.2 (0.3–4.2)	97.6–106.6	1.9* (1.0–3.6)	2.4* (1.0–5.5)
≥109.3	3.0* (1.3–7.0)	7.9** (1.9–33.1)	≥106.6	5.2**** (2.7–9.9)	5.5*** (2.0–15.1)

Notes: Model 1 was adjusted for age, physical activity score, smoking status, alcohol use, education level, ethnicity, living alone, arthritis, hypertension, and other chronic conditions. Model 2 was further adjusted for body mass index.
*$p < .05$; **$p < .01$; ***$p < .001$; ****$p < .0001$.

and late-adult weight gain after age 50 of more than 0.55 kg/year (vs −0.01 to +0.21 kg/y) in men, or 0.23 kg/year (vs −0.05 to +0.23 kg/y) in women, were associated with greater disability. A BMI greater than 35 kg/m^2 (vs 20–25 kg/m^2) was associated with significantly higher disability in women and a 3.5-fold, but nonsignificant, greater disability score in men. However, the significance of BMI was diminished after adjusting for WC.

Our study sample, with subjects of primarily Puerto Rican and Dominican origin, had high prevalences of obesity and functional disability. Mean BMIs were 26.8 kg/m^2 and 29.4 kg/m^2 for men and women, respectively, higher than those reported in similar ADL studies among primarily white elderly persons (10,12–14), but similar to the Hispanic Health and Nutrition Examination Survey data reported for Puerto Ricans (35,36).

Studies have suggested associations between BMI and disability as linear (9), as J or U shaped (12,37,38), or at a threshold (1,17). These studies are not quantitatively comparable due to the lack of uniformity in study populations, variable definitions, and statistical methods. Most of these studies were done with non-Hispanic white populations, although two included Mexican Americans (38,39). Unlike those study populations, most of our subjects were Puerto Rican or Dominican, with few Mexican Americans. In this population, we saw that only severe obesity (BMI ≥35 kg/m^2) was associated with significantly increased risk for disability in women and a nonsignificantly increased risk in men, while no increased risk was observed for leanness in either men and women.

Larger WC has been shown to be associated with greater risk for some chronic diseases (40–43), which may further be associated with disability. However, few studies have examined the relationship between WC and disability directly. Visser and colleagues (21) did not find any significant association between WC and disability among elderly persons participating in the Framingham Heart Study, but they did not report their results in detail. In contrast, Lean and colleagues (22) and Han and colleagues (23) showed that large WC represented greater risk for overall and individual functional limitations in a relatively young population (20–59 y) in The Netherlands. We observed similar results among elderly Hispanic women, where there was a clear dose-response relationship between WC and risk for greater disability. Among men, only subjects with the largest WC had higher risk of greater functional disability.

Recent studies have suggested that greater body fat is positively associated with disability among elderly individuals (21,44,45). We found that WC, but not BMI, remained significantly associated with disability score when both variables were in the same model, suggesting that abdominal fat accumulation is more important than overall obesity for disability in these elderly Hispanics.

Average annual weight change was associated with a U-shaped disability score, suggesting adverse effects for both weight gain and weight loss. Studies (14,15) have suggested that weight loss is associated with greater disability, probably due to an association between weight loss and worsening health status. We also found that weight gain was strongly associated with greater disability among these elderly Hispanics. We may have been more able to detect the effects of weight gain than other studies because 58% of this population had reported weight gain since age 50, and 36.5% gained more than 5 kg.

Compared with relatively stable weight, weight losses also tended to be associated with greater disability among our sample of elderly Hispanics, although some comparisons were not statistically significant. Among men, the associations were stronger for moderate weight loss of −0.32 to −0.01 kg/year than for larger weight loss of more than −0.32 kg/year. Further analysis showed that men with weight loss of more than −0.32 kg/year were younger and less likely to have other chronic conditions. Therefore, it is possible that residual confounding contributes to this difference. Because weight at age 50 was subject to recall bias, and because we did not have detailed information about whether the weight loss was intentional, we were unable to further explore this question.

It has been suggested that obesity and weight change could contribute to disability through their associations with chronic conditions or physical activity. Though we have

Table 5. The Odds Ratios (OR) and Their 95% Confidence Intervals (CI) for Quintile Categories of Annual Weight Change Since Age 50 on Functional Disability From the Proportional Odds Model

Annual Weight Change Quintiles, kg/y	Men (n = 237)		Annual Weight Change Quintiles, kg/y	Women (n = 349)	
	OR	95% CI		OR	95% CI
≤−0.32	1.8	0.7–4.4	≤−0.44	1.4	0.7–2.8
−0.32 to −0.01	2.7*	1.1–6.3	−0.44 to −0.06	1.6	0.8–3.1
−0.01 to +0.21	1.0	—	−0.05 to +0.23	1.0	—
+0.21 to +0.55	1.1	0.5–2.6	+0.23 to +0.70	2.0*	1.0–3.9
≥+0.55	3.3**	1.4–7.8	≥+0.71	2.1*	1.0–4.2

Note: Values are adjusted for age, physical activity score, smoking status, alcohol use, education level, ethnicity, living alone, arthritis, hypertension, and other chronic conditions.
*$p < .05$; **$p < .01$.

shown that these chronic conditions and physical activity were significantly related to functional disability in this population (30), these potential confounders failed to explain the associations observed in this study. Our results suggest that other pathways also operate between obesity and disability.

The cross-sectional nature of the study makes it impossible for us to make causal inference, which needs to be further investigated in future prospective studies. However, it is likely that central obesity and late-adult weight change may both increase disability incidence and contribute to difficulty in disability rehabilitation. These results suggest that obesity, particularly abdominal fat accumulation as indicated by larger WC, and late-adult weight change may contribute to the high prevalence of disability seen among elderly Hispanics of Caribbean origin.

Acknowledgments

This work was funded, in part, by the National Institute on Aging (Grant R01 AG10425) and by the U.S. Department of Agriculture, Agricultural Research Service (Agreement 58-1950-9-001).

Address correspondence to Katherine L. Tucker, PhD, Jean Mayer USDA Human Nutrition Research Center on Aging, Tufts University, 711 Washington Avenue, Boston, MA 02111. E-mail: tucker@hnrc.tufts.edu

References

1. Harris T, Kovar MG, Suzman R, Kleinman JC, Feldman JJ. Longitudinal study of physical ability in the oldest-old. *Am J Public Health.* 1989;79:698–702.
2. Rice DP, LaPlante MP. Medical expenditures for disability and disabling comorbidity. *Am J Public Health.* 1992;82:739–741.
3. Reuben DB, Rubenstein LV, Hirsch SH, Hays RD. Value of functional status as a predictor of mortality: results of a prospective study. *Am J Med.* 1992;93:663–669.
4. Scott WK, Macera CA, Cornman CB, Sharpe PA. Functional health status as a predictor of mortality in men and women over 65. *J Clin Epidemiol.* 1997;50:291–296.
5. Ahacic K, Parker MG, Thorslund M. Mobility limitations in the Swedish population from 1968 to 1992: age, gender and social class differences. *Aging.* 2000;12:190–198.
6. Fried L, Guralnik J. Disability in older adults: evidence regarding significance, etiology, and risk. *J Am Geriatr Soc.* 1997;45:92–100.
7. Ostir GV, Carlson JE, Black SA, Rudkin L, Goodwin JS, Markides KS. Disability in older adults. 1: Prevalence, causes, and consequences. *Behav Med.* 1999;24:147–156.
8. Pinsky JL, Branch LG, Jette AM, et al. Framingham Disability Study: relationship of disability to cardiovascular risk factors among persons free of diagnosed cardiovascular disease. *Am J Epidemiol.* 1985;122: 644–656.
9. Rissanen A, Heliovaara M, Knekt P, Reunanen A, Aromaa A, Maatela J. Risk of disability and mortality due to overweight in a Finnish population. *Br Med J.* 1990;301:835–837.
10. Hubert HB, Bloch DA, Fries JF. Risk factors for physical disability in an aging cohort: the NHANES I Epidemiologic Followup Study. *J Rheumatol.* 1993;20:480–488.
11. Makela M, Heliovaara M, Sievers K, Knekt P, Maatela J, Aromaa A. Musculoskeletal disorders as determinants of disability in Finns aged 30 years or more. *J Clin Epidemiol.* 1993;46:549–559.
12. Galanos A, Pieper C, Cornoni-Huntley J, Bales C, Fillenbaum G. Nutrition and function: is there a relationship between body mass index and the functional capabilities of community-dwelling elderly? *J Am Geriatr Soc.* 1994;42:368–373.
13. Hubert H, Fries J. Predictors of physical disability after age 50. Six-year longitudinal study in a runners club and a university population. *Ann Epidemiol.* 1994;4:285–294.
14. Launer LJ, Harris T, Rumpel C, Madans J. Body mass index, weight change, and risk of mobility disability in middle-aged and older women. The epidemiologic follow-up study of NHANES I. *JAMA.* 1994;271:1093–1098.
15. Tully CL, Snowdon DA. Weight change and physical function in older women: findings from the Nun Study. *J Am Geriatr Soc.* 1995;43: 1394–1397.
16. Davis JW, Ross PD, Preston SD, Nevitt MC, Wasnich RD. Strength, physical activity, and body mass index: relationship to performance-based measures and activities of daily living among older Japanese women in Hawaii. *J Am Geriatr Soc.* 1998;46:274–279.
17. Ebrahim S, Wannamethee SG, Whincup P, Walker M, Shaper AG. Locomotor disability in a cohort of British men: the impact of lifestyle and disease. *Int J Epidemiol.* 2000;29:478–486.
18. Expert Panel on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults. Executive summary of the clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. *Arch Intern Med.* 1998;158:1855–1867.
19. Expert Panel on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: executive summary. *Am J Clin Nutr.* 1998;68:899–917.
20. Taylor RW, Keil D, Gold EJ, Williams SM, Goulding A. Body mass index, waist girth, and waist-to-hip ratio as indexes of total and regional adiposity in women: evaluation using receiver operating characteristic curves. *Am J Clin Nutr.* 1998;67:44–49.
21. Visser M, Harris TB, Langlois J, et al. Body fat and skeletal muscle mass in relation to physical disability in very old men and women of the Framingham Heart Study. *J Gerontol Med Sci.* 1998;53A:M214–M221.
22. Lean ME, Han TS, Seidell JC. Impairment of health and quality of life in people with large waist circumference. *Lancet.* 1998;351:853–856.
23. Han TS, Tijhuis MA, Lean ME, Seidell JC. Quality of life in relation to overweight and body fat distribution. *Am J Public Health.* 1998;88: 1814–1820.
24. Day J. *Population Projections of The U.S. by Age, Sex, and Hispanic Origin, 1993–2050. U.S. Bureau of Census Current Population Reports*. Washington, DC: U.S. Government Printing Office; 1993.
25. O'Donnell R. Functional disability among Puerto Rican elderly. *J Aging Health.* 1989;1:244–264.
26. Jette A, Crawford S, Tennstedt S. Toward understanding ethnic differences in late-life disability. *Res Aging.* 1996;18:292–309.
27. Haan MN, Weldon M. The influence of diabetes, hypertension, and stroke on ethnic differences in physical and cognitive functioning in an ethnically diverse older population. *Ann Epidemiol.* 1996;6:392–398.
28. Ostchega Y, Harris TB, Hirsch R, Parsons VL, Kington R. The prevalence of functional limitations and disability in older persons in the U.S.: data from the National Health and Nutrition Examination Survey III. *J Am Geriatr Soc.* 2000;48:1132–1135.
29. Tran T, Williams L. Poverty and impairment in activities of living among elderly Hispanics. *Soc Work Health Care.* 1998;26:59–78.
30. Tucker KL, Falcon LM, Bianchi LA, Cacho E, Bermúdez OI. Self-reported prevalence and health correlates of functional limitation among Massachusetts elderly Puerto Ricans, Dominicans, and non-Hispanic white neighborhood comparison group. *J Gerontol Med Sci.* 2000;55A:M90–M97.
31. Bermúdez OI, Becker EK, Tucker KL. Development of sex-specific equations for estimating stature of frail elderly Hispanics living in the northeastern United States. *Am J Clin Nutr.* 1999;69:992–998.
32. Katz S, Ford A, Moskowitz R, Jackson B, Jaffe M. Studies of illness in the aged. The index of ADL: a standardized measure of biological and psychosocial function. *JAMA.* 1963;185:914–919.
33. Paffenbarger RS Jr, Wing A, Hyde R. Physical activity as an index of heart attack risk in college alumni. *Am J Epidemiol.* 1978;108:161–175.
34. Armstrong BG, Sloan M. Ordinal regression models for epidemiologic data. *Am J Epidemiol.* 1989;129:191–204.
35. Najjar M, Kuczmarski R. Anthropometric Data and Prevalence of Overweight for Hispanics: 1982–1984. Hyattsville, MD: National Center for Health Statistics; 1989.
36. Tucker K, Falcon L, Bermúdez O. Nutrition among Hispanic elders in the United States. In: Markides KS, Miranda MR, eds. *Minorities, Aging and Health.* Thousand Oaks, CA: Sage Publications; 1997:235–267.
37. Mansson NO, Eriksson KF, Israelsson B, Ranstam J, Melander A,

Rastam L. Body mass index and disability pension in middle-aged men—non-linear relations. *Int J Epidemiol.* 1996;25:80–85.
38. Ma J, Markides KS, Perkowski LP, Stroup-Benham CA, Lichtenstein M, Goodwin JS. Impact of selected medical conditions on self-reported lower-extremity function in Mexican-American elderly. *Ethn Dis.* 1998;8:52–59.
39. Mitchell BD, Stern MP, Haffner SM, Hazuda HP, Patterson JK. Functional impairment in Mexican Americans and non-Hispanic whites with diabetes. *J Clin Epidemiol.* 1990;43:319–327.
40. Weidner MD, Gavigan KE, Tyndall GL, Hickey MS, McCammon MR, Houmard JA. Which anthropometric indices of regional adiposity are related to the insulin resistance of aging? *Int J Obes Relat Metab Disord.* 1995;19:325–330.
41. Carey VJ, Walters EE, Colditz GA, et al. Body fat distribution and risk of non-insulin-dependent diabetes mellitus in women. The Nurses' Health Study. *Am J Epidemiol.* 1997;145:614–619.
42. Wei M, Gaskill SP, Haffner SM, Stern MP. Waist circumference as the best predictor of noninsulin dependent diabetes mellitus (NIDDM) compared to body mass index, waist/hip ratio and other anthropometric measurements in Mexican Americans—a 7-year prospective study. *Obes Res.* 1997;5:16–23.
43. Rexrode KM, Carey VJ, Hennekens CH, et al. Abdominal adiposity and coronary heart disease in women. *JAMA.* 1998;280:1843–1848.
44. Visser M, Langlois J, Guralnik JM, et al. High body fatness, but not low fat-free mass, predicts disability in older men and women: the Cardiovascular Health Study. *Am J Clin Nutr.* 1998;68:584–590.
45. Baumgartner RN. Body composition in healthy aging. *Ann NY Acad Sci.* 2000;904:437–448.

Received December 15, 2000
Accepted February 14, 2001
Decision Editor: John E. Morley, MB, BCh