Research Report

Physical Activity, Central Adiposity, and Functional Limitations in Community-Dwelling Older Adults

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ABSTRACT

Background and Purpose: Obesity and physical inactivity are independently associated with declines in physical and functional limitations in older adults. The current study examines the impact of physical activity on odds of physical and functional limitations in older adults with central and general obesity.

Methods: Data from 6279 community-dwelling adults aged 60 years or more from the Health and Retirement Study 2006 and 2008 waves were used to calculate prevalence and odds of physical and functional limitation among obese older adults with high waist circumference (waist circumference ≥88 cm in females and ≥102 cm in males) who were physically active versus inactive (engaging in moderate/vigorous activity less than once per week). Logistic regression models were adjusted for age, sex, race/ethnicity, education, smoking status, body mass index, and number of comorbidities.

Results: Physical activity was associated with lower odds of physical and functional limitations among older adults with high waist circumference (odds ratio [OR], 0.59; confidence interval [CI], 0.52-0.68, for physical limitations; OR, 0.52; CI, 0.44-0.62, for activities of daily living; and OR, 0.44; CI, 0.39-0.50, for instrumental activities of daily living).

Conclusions: Physical activity is associated with significantly lower odds of physical and functional limitations in obese older adults regardless of how obesity is classified. Additional research is needed to determine whether physical activity moderates long-term physical and functional limitations.

Key Words: functional limitations, obesity, older adults, physical activity, prevalence, waist circumference

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The authors declare no conflicts of interest.

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INTRODUCTION

Obesity is associated with a variety of poor health outcomes including cardiovascular disease, increased prevalence of medical comorbidities, and functional disability.[1-3] Approximately 35.5% of adults in the United States are currently obese.[4] This represents an almost 3-fold increase from 1960 to present and continues to rise, even among older adults.[5] Among those aged 60 years and more, the combined prevalence of overweight and obesity, as assessed by body mass index (BMI), is estimated at more than 70%.[6] Concurrently, the prevalence of abdominal adiposity is also rising in the United States across all age groups.[7] This growing trend in central adiposity represents an important public health concern given that excess abdominal fat is independently associated with disability among older adults.[8] Although general adiposity (as measured by BMI) remains the most widely used marker of obesity in clinical settings and epidemiological studies, accumulating evidence suggests that abdominal adiposity may be a more sensitive predictor of obesity-related health problems and functional impairment than BMI.[9,10] Thus, gaining a better understanding of the effects of both general and abdominal obesity on functional outcomes is important for preserving independence in older adults.

Physical activity can help maintain and improve individuals' health by decreasing the risk of disability and delaying the onset of functional impairment.[11,12] At least 150 minutes of moderate physical activity and/or muscle strengthening activities per week is recommended for health maintenance,[13] yet only 24% of adults aged

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65 years and more report engaging in any regular physical activity.[14] Population estimates employing more objective measures of activity suggest even lower rates of engagement in older adults.[15] Both physical inactivity and obesity are independently associated with functional decline and disability in older adults. However, less is known regarding the association between central adiposity, physical activity, and functional outcomes in older adults.[16] Given the heightened risk of disability and potential loss of independence among older adults who are obese, there is an urgent need for effective lifestyle interventions that may aide in the prevention and management of obesity-related limitation and functional disability. The current study examined the impact of physical activity on physical and functional limitations among community-dwelling older adults with central adiposity.

METHODS

Data Source

This is a secondary analysis of existing data. Data were obtained from the 2006 and 2008 waves of the Health and Retirement Study (HRS), enhanced face-to-face interview. The HRS is a nationally representative panel survey of community-dwelling adults aged 50 years and more being conducted by the University of Michigan with support from the National Institute of Aging. The initial HRS sample was drawn in 1992 from a multistage, clustered area probability design of households, targeted individuals born between 1931 and 1941. Follow-up interviews and new cohort additions have occurred at regular intervals and have resulted in a nationally representative sample of American adults older than 50 years. A random one-half of the larger HRS sample was preselected to complete an enhanced face-to-face interview in 2006, which included physical and biomarker measurements. The second half of the HRS sample received the enhanced face-to-face interview in 2008. Inclusion of both 2006 and 2008 waves ensures that all HRS respondents who were eligible for and consented to the enhanced face-to-face interviews are included in the analyses. Additional descriptions of sampling procedures and study design are available online at: http://hrsonline.isr.umich.edu.

Sample

A total of 14 724 eligible HRS respondents consented to physical assessments in 2006 and 2008. Of these, 10 419 were aged 60 years and more. After eliminating respondents with missing waist circumference (WC), BMI, out of range values, and duplicate observations, there were 6279 subjects remaining for analyses. Subjects of all races/ethnicity were included in the sample. The study was exempt from Institutional Review Board approval at all respective institutions because of the deidentified nature of the data used.

Measures

Adiposity

Waist circumference was used as a proxy for abdominal adiposity.[17] Waist circumference was assessed in person, using a nonelastic tape measure over a thin layer of clothing at the level of the respondents' navel while standing. The respondent was instructed to inhale and slowly exhale, holding their breath at the end of the exhale. Waist circumference was measured and recorded while holding the exhale. Individuals were categorized as having high abdominal adiposity in accordance with WC cut points established by the National Institutes of Health.[18] Women with a WC of 88 cm or more and men with a WC of 102 cm or more were classified as having high abdominal adiposity; individuals with values below cut points were categorized as having low abdominal adiposity. Body mass index was also calculated where available for all respondents who consented to physical measures. In the HRS, weight was measured using a Healthometer 830KL (Medstock, Australia) scale and rounded to the nearest half pound. Weight for individuals more than 300 lb was not recorded in the HRS as this was beyond the capacity of the measurement device. Height was measured by having the respondent stand barefoot with their heels and shoulders touching the wall. Individuals with a BMI between 18.5 and 24.9 kg/m^2 were classified as normal weight, 24.9 and 29.9 kg/m^2 as overweight, and 30 kg/m^2 or more as obese.[18] Individuals who were underweight (n = 61) were excluded from the analyses as this population is known to be at higher risk of frailty and disability.[19]

Physical Activity

Physical activity was assessed using a self-report physical health questionnaire as part of the HRS interview. Respondents were asked: "How often do you take part in sports or activities that are *vigorous*, such as running or jogging, swimming, cycling, aerobics or gym, workout, tennis, or digging with a spade or shovel: more than once a week, once a week, 1 to 3 times a month, or hardly ever or never?" and "How often do you take part in sports or activities that are moderately energetic, such as gardening, cleaning the car, walking at a moderate pace, dancing, floor, or stretching exercises: more than once a week, once a week, 1 to 3 times a month, or hardly ever or never?" For purposes of analyses, respondents reporting that they engaged in moderate or vigorous physical activity "once per week" or "more than once per week" were classified as active; those reporting activity less than once per week were classified as inactive (ref = 0).

Outcome Measures

Physical limitations in the HRS was assessed using self-report. Respondents were asked to report whether "they had difficulties (yes, no) in performing the following tasks

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because of a health or physical problem": walking several blocks, walking 1 block, sitting 2 hours, getting up from chair, climbing 1 flight of stairs, stooping, reaching arms, pulling/pushing large objects, lifting weights, and picking up a dime. All *yes* responses were compiled into a summary score in the HRS database ranging from 0 to 10. Univariate analyses revealed that 67% of our sample reported at least 1 limitation. Thus, we chose a conservative cut point. For purposes of these analyses, respondents who reporting *difficulty* with performing 2 or more of the above tasks were classified as having physical limitations (0 = no limitation; 1 = limitation).

Functional limitations

Activities of daily living (ADLs) and instrumental activities of daily living (IADLs) were used to assess functional limitations.[20] Respondents were classified as having ADL limitations if they reported difficulty or inability with one or more of the following: bathing, dressing, eating, toileting, or getting out of bed. Respondents were classified as having IADL limitations if they reported difficulty with at least one of the following IADLs: preparing meals, managing money or needing help with house or yard work, using the phone, or taking medications All limitations reported in this article were measured in the HRS using self-report. Respondents were instructed to *exclude* any difficulties that were expected to last less than 3 months. For all outcomes, responses were dichotomized (0 = no limitation; 1 = limitation).

Covariates

Race and ethnicity (white, black, other) were entered as a categorical variable into the model. Age at the time of physical assessment, years of education completed, and the number of medical comorbidities were entered as continuous variables in the model. The comorbidity index ranged from 0 to 8 to reflect the number of diagnosed health conditions that the respondent self-reports. Conditions include diabetes, hypertension, lung disease, stroke, any cancer, arthritis, myocardial infarction, and chronic heart failure coded (0 = no history; 1 = positive history). Sex (male = 0; female = 1) and current smoking status were entered as dichotomous variables into the model.

Analyses

The prevalence and odds of physical and functional limitations were examined within each WC category using chi-square and multivariate logistic regression. Unadjusted models were used to examine the impact of physical activity on functional limitations *within* each WC category

Table 1. Differences in Sample Characteristics by Waist Circumference Category

Characteristic	Total Sample N = 6279 Mean (SD)	Low WC N = 2353 Mean (SD)	High WC N = 3926 Mean (SD)	*P* Value[a]
Age, y	68.9 (6.09)	69.2 (6.17)	68.7 (6.03)	.0004
Education, y	12.3 (3.30)	12.4 (3.39)	12.2 (3.26)	.0022
Comorbidities	2.7 (1.22)	2.6 (1.23)	2.8 (1.21)	.0001
Waist circumference, cm	100.1 (14.69)	87.3 (8.88)	107.8 (11.86)	.0001
	n (%)	**n (%)**	**n (%)**	
Sex				<.0001
Male	2875 (45.8)	1666 (70.8)	1209 (30.8)	
Female	3404 (54.2)	687 (29.2)	2717 (69.2)	
Race[b]				.05
White	5106 (81.3)	1947 (82.7)	3159 (80.5)	
Black	1015 (16.2)	352 (15.0)	663 (16.9)	
Other	158 (2.5)	54 (2.3)	104 (2.7)	
Current smoker	1517 (24.2)	615 (26.1)	902 (23.0)	.006
Active	3429 (54.6)	1392 (59.2)	2037 (51.9)	<.0001
Body mass index[b]				<.0001
Normal	1523 (24.5)	1156 (50.4)	367 (9.4)	
Overweight	2310 (37.2)	910 (39.7)	1400 (35.7)	
Obese	2385 (38.4)	229 (10.0)	2156 (55.0)	

Abbreviations: SD, standard deviation; WC, waist circumference.

[a]Chi-square for categorical variables and *t* test for continuous variables used to determine *P* values.

[b]Totals may not add up to 100% because of rounding.

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as well as within each BMI category. Adjusted, multivariable models were adjusted for age, years of education, ethnicity, sex, smoking status, BMI, and the number of medical comorbidities. Waist circumference was used as a covariate in models stratified by BMI. All data were examined using SAS software version 9.3 (SAS Institute Cary, North Carolina) and weighted using the HRS respondent-level weights for physical measures, which includes adjustments for sample selection probability and nonresponse. Detailed documentation regarding HRS sample weight calculations is available at http://hrsonline.isr.umich.edu/sitedocs/wghtdoc.pdf. Statistical tests were 2-sided with *P* values less than or equal to 0.05. Confidence intervals excluding 1.0 were considered statistically significant.

RESULTS

Respondent demographics are presented in Table 1 by WC category. Over half of the sample was classified as having high abdominal adiposity (as measured by WC). Those in the high WC category were less educated, slightly younger, less active, and had a higher number of medical comorbidities than those in the low circumference category and were predominately female. Prevalence of physical and IADL limitations was notably higher among those with high WC than among those with low WC, but there were no significant differences in the prevalence of ADL limitation between low- and high-WC groups. Prevalence of physical, ADL, and IADL limitations is reported in Table 2 by WC. We also report prevalence by BMI for purposes of comparison.

Odds ratios and confidence intervals for functional limitations among physically active older adults as compared with older adults who report low or no activity are presented in Table 3. A total of 1503 of the sample had nonpositive weights and were automatically excluded from the analyses (they did not contribute statistically to the analyses). Both unweighted (n = 6279) and weighted (n =

Table 2. Prevalence of Physical and Functional Limitations in Physically Active, Community-Dwelling Older Adults by Waist Circumference and Body Mass Index

Obesity Category	Physical Limitations n (%)[a]	ADL n (%)[a]	IADL n (%)[a]
Waist circumference			
Low	11 091 (46.4)	595 (49.8)	1 011 (43.9)
High	2 163 (55.1)	1 144 (50.0)	1 823 (47.3)
Body mass index			
Normal	721 (47.3)	417 (53.1)	702 (46.8)
Overweight	1 137 (49.2)	592 (47.0)	997 (44.1)
Obese	1 356 (56.9)	710 (50.5)	1 100 (47.0)

Abbreviations: ADL, activities of daily living; IADL, instrumental activities of daily living.
[a]Totals may not add up to 100% because of rounding.

Table 3. Odds of Physical and Functional Limitation for Physically Active, Community-Dwelling Older Adults

Obesity Category	Physical Limitations OR (95% CI)			ADL OR (95% CI)			IADL OR (95% CI)		
	Unadjusted	Adjusted	Adjusted Weight	Unadjusted	Adjusted	Adjusted Weight	Unadjusted	Adjusted	Adjusted Weight
Waist circumference									
Low-	0.48 (0.41-0.57)[a]	0.56 (0.47-0.66)[a]	0.56 (0.45-0.71)[a]	0.49 (0.39-0.62)[a]	0.51 (0.40-0.64)[a]	0.58 (0.42-0.79)[b]	0.35 (0.29-0.41)[a]	0.39 (0.32-0.46)[a]	0.34 (0.27-0.44)[a]
High-	0.52 (0.44-0.59)[a]	0.59 (0.52-0.68)[a]	0.66 (0.56-0.68)[a]	0.50 (0.42-0.59)[a]	0.52 (0.44-0.62)[a]	0.45 (0.36-0.57)[a]	0.40 (0.35-0.45)[a]	0.44 (0.39-0.50)[a]	0.48 (0.40-0.58)[a]
Body mass index									
Normal	0.47 (0.38-0.58)[a]	0.54 (0.44-0.67)[a]	0.48 (0.36-0.64)[a]	0.49 (0.37-0.65)[a]	0.51 (0.38-0.69)[a]	0.60 (0.41-0.88)[c]	0.37 (0.30-0.45)[a]	0.41 (0.33-0.51)[a]	0.43 (0.32-0.57)[a]
Overweight	0.48 (0.41-0.57)[a]	0.56 (0.47-0.67)[a]	0.62 (0.49-0.79)[a]	0.52 (0.42-0.65)[a]	0.55 (0.44-0.69)[a]	0.49 (0.36-0.66)[a]	0.36 (0.30-0.43)[a]	0.41 (0.34-0.48)[a]	0.39 (0.30-0.49)[a]
Obese	0.56 (0.48-0.66)[a]	0.64 (0.54-0.76)[a]	0.74 (0.59-0.93)[d]	0.48 (0.39-0.60)[a]	0.51 (0.39-0.60)[a]	0.44 (0.33-0.59)[a]	0.41 (0.35-0.49)[a]	0.47 (0.39-0.55)[a]	0.50 (0.39-0.63)[a]

Abbreviations: ADL, activities of daily living; CI, confidence interval; IADL, instrumental activities of daily living; OR, odds ratios; WC, waist circumference.
Note. Adjusted weight models are reported for n = 4776 of the sample.
[a]$P = .0001$; [b]$P < .0006$; [c]$P = .008$; [d]$P = .01$.

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4776) adjusted models are reported in Table 3. However, a comparison of weighted and unweighted models revealed no meaningful differences in the results. Results discussed in text are unweighted. In the high-WC group, physical activity was associated with significantly lower odds of physical, ADL, and IADL limitations. The association remained after adjusting for age, sex, race/ethnicity, education, smoking status, BMI, and the number of comorbidities. Physical activity was also associated with lower odds of physical and functional limitation among those with low WC. Consistent with existing literature,[2] having a higher number of comorbidities was associated with higher odds of limitation in all functional domains among older adults with high and low WC. Similar results were obtained using BMI categories (Table 4). Sex and ethnicity were also found to be differentially associated with odds of physical and functional impairment among older adults with low WC. Nonwhite status was marginally associated with lower odds of physical limitation (odds ratio, 0.82 [0.67-01.00]), but not ADL or IADL limitation; being female was associated with higher odds of ADL limitation (odds ratio, 1.52 [1.16-1.99]).

DISCUSSION

The current study examined the impact of physical activity on prevalence and odds of physical and functional limitations in obese older adults. Obesity was categorized using both WC and BMI criteria. Our results indicate that regardless of the obesity criteria used (WC or BMI), physical activity is significantly associated with lower odds of physical and functional limitations in older adults who are obese. Obese older adults in the current sample who reported engaging in moderate/vigorous physical activity at least once per week were significantly less likely to report physical and functional limitations than those who reported low/no physical activity. The finding suggests that the benefits of physical activity are not limited to normal-weight older adults, but may moderate the negative impact of carrying excess weight on physical and functional limitations among those who are obese. Our results are also encouraging in that the deleterious effects of increasing comorbidities did not negate the positive impact of physical activity on physical and functional limitations in the current study. This is a particularly important consideration among obese elders who are more likely to present with multiple health conditions and suggests that even minimal engagement in moderate/vigorous physical activity is associated with reduced odds of impairment *in spite of* multiple health conditions.

Our findings also suggest that there are important sex and ethnic differences in the association between weight and physical and functional outcomes. Consistent with observations from studies of obese older persons and recently published trends,[4] there was a higher proportion of women classified as obese than men. This was particularly true when using WC guidelines and confirms recent reports that abdominal weight gain among women is occurring at a much greater rate than among men.[7] However, normal and overweight women in this sample tended to be at higher odds of ADL limitation than men, but the odds of ADL limitation did not differ between men and women among the obese as might be expected. This may in part be due to biological differences in body composition between men and women.[21] We also found that nonwhite status was associated with *lower* odds of physical limitations in higher weight categories in spite of reports consistently placing minorities at higher ends of the weight spectrum. These findings suggests that the relationship between excess weight and functional outcomes in both minorities/nonwhites and older women is complex and merits further investigation.[22] Current research is underway by our group to further examine the nature of these ethnic and sex differences.

Primary strengths of the current study include analyses of data based in a large, well-characterized, nationally representative community-dwelling sample, and the availability of 2 objective measures of adiposity. Although the current results are based on a nationally representative

Table 4. Independent Impact of Increasing Comorbidities on Physical and Functional Limitations in Physically Active, Community-Dwelling Older Adults

Obesity Category	Physical Limitations OR (95% CI)		ADL OR (95% CI)		IADL OR (95% CI)	
Waist circumference						
Low	1.48 (1.37-1.59)[a]	1.46 (1.32-1.61)[a]	1.13 (1.02-1.25)[a]	1.21 (1.05-1.39)[a]	1.54 (1.43-1.67)[a]	1.67 (1.50-1.86)[a]
High	1.48 (1.40-1.6)[a]	1.54 (1.42-1.67)[a]	1.23 (1.15-1.33)[a]	1.21 (1.09-1.34)[a]	1.00 (0.85-1.17)[a]	1.65 (1.52-1.79)[a]
Body mass index						
Normal	1.45 (1.32-1.58)[a]	1.41 (1.25-1.58)[a]	1.09 (0.96-1.24)	1.09 (0.92-1.29)	1.55 (1.41-1.71)[a]	1.73 (1.52-1.97)[a]
Overweight	1.50 (1.39-1.62)[a]	1.54 (1.38-1.71)[a]	1.21 (1.10-1.34)[a]	1.22 (1.07-1.38)[b]	1.52 (1.41-1.65)[a]	1.56 (1.40-1.73)[a]
Obese	1.45 (1.34-1.57)[a]	1.53 (1.37-1.70)[a]	1.25 (1.14-1.38)[a]	1.28 (1.11-1.46)[c]	1.63 (1.50-1.77)[a]	1.72 (1.55-1.91)[a]

Abbreviations: ADL, activities of daily living; CI, confidence intervals; IADL, instrumental activities of daily living; OR, odds ratios.
Note. Adjusted weight models are reported for n = 4776 of the sample.
[a]$P = .0001$; [b]$P < .003$; [c]$P = .0004$.

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population, the results are limited in generalizability in that they are cross-sectional in nature. Examination of longitudinal data is needed to understand the differential impact of changes in physical activity and changes in weight on physical and functional limitations over time, particularly in women and minorities. Additional limitations include that there were no objective measures of physical activity used in the survey and the simple count measure of comorbidity used for analyses does not take disease severity into account.[23] Imprecise measurements of physical activity may have affected study results including prevalence estimates reported here.

CONCLUSIONS

Engagement in moderate/vigorous intensity exercise at least once per week is associated with lower odds of physical and functional impairment in obese older adults. Encouraging physical activity in normal weight and obese older adults may help to lower the odds of physical and functional impairment. Additional research is needed to examine the long-term benefits of physical activity in older adults who remain obese.

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