

ABDOMINAL OBESITY AND MOBILITY DISABILITY IN OLDER ADULTS: A 4-YEAR FOLLOW-UP OF THE INTERNATIONAL MOBILITY IN AGING STUDY

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Abstract: *Background:* Abdominal obesity is related to the disability process in older adults, however, little is known about this relationship when adjusted for important confounders such as depression and physical performance measures in a diverse international aged population. *Objectives:* To explore the longitudinal relationship between abdominal obesity and mobility disability controlling for physical performance and depression. *Design and Setting:* Longitudinal observational study using data from the International Mobility in Aging Study (IMIAS) Study. *Participants:* 1104 out of 2002 older adults aged 64-74 years old free of mobility disability at baseline (2012) and then reassessed in 2016. *Measurements:* Mobility disability was defined as reporting difficulty in walking 400 m or climbing stairs. Activities of daily living (ADL) disability was based on any self-reported difficulty in five mobility-related ADLs. Abdominal obesity was defined as waist circumference ≥ 88 cm for women or ≥ 102 cm for men. Four meters gait speed, handgrip strength and depressive symptoms (CES-D) were assessed. Generalized Estimating Equations (GEE) and multinomial regressions were used to estimate associations between disability and abdominal obesity. *Results:* 1104 free of disability participants were followed over 4 years, the mean age was 68.9 (± 2.9) years among men and 68.7 (± 2.6) years among women. Prevalence and incidence rates of mobility disability varied widely across research site and sex. The longitudinal associations between mobility disability and abdominal obesity remained significant even when adjusted by depressive symptoms, handgrip strength, gait speed, age, sex, education and research site. Participants with abdominal obesity had higher mobility disability (OR=1.68, 95% CI 1.23-1.76, p-value=0.01) and also increased risk for ADL disability (OR: 1.47, 95% CI 1.23-1.76, p-value=0.01). Abdominal obesity in baseline was also predictor of mobility disability in 2016 (OR: 1.93, 95% CI 1.17-3.17, p-value <0.01) but not for ADL disability (OR: 1.59, 95% CI 0.93-2.71, p-value =0.09) with accounting mortality. *Conclusion:* Abdominal obesity is associated longitudinally and predicts mobility disability, even over a short period (4 years) in community-dwelling older adults from different epidemiological contexts.

Key words: Disability, mobility, activities of Daily Living, abdominal obesity, aging.

Introduction

Disability in old age is a major public health concern due to global population aging (1). The current literature provide that higher disability rates among older people reflect an accumulation of health risks across a lifespan of disease, injury, chronic illness, environmental risk, and social and economic adversity (2). Thus, studies that compare populations of older adults with diversity in terms of demographic, economics, social and cultural characteristics, could be helpful to improve the knowledge about disability in the ageing process.

In older adults, important risk factors for disability are depression (3–6), declines in gait speed and muscle strength (7, 8), and obesity (9, 10). Obesity is a contemporary public health problem receiving increasing attention in older adult populations due to its associations with increased risk for comorbidities, cardiovascular disease and earlier death (9). The presence of obesity is linked to an increased risk for disability in older adults (9). In a systematic review, Vincent et al. (2010) reported that obesity was a consistent predictor of mobility

disability in the older population (10).

Waist circumference has emerged as a possible better measure of obesity than BMI in older adults since it is strongly related to visceral fatness, while BMI is considered an inadequate measure particularly in aged subjects due do not reflect the age related changes in body composition (11). Some longitudinal studies have recently shown the predictive value of abdominal obesity (AO) for disability in older adults (12–14). Additionally, the literature from longitudinal studies also demonstrates the strong negative impact of depression on disability health status of older adults' life (3, 4) and its relationship with obesity (15–18). Similarly, physical performance measures (such as gait speed and handgrip strength) are longitudinally associated with both obesity (19, 20) and disability (8, 21–23).

As far as we are aware, there are no longitudinal studies that have focused on the relationship between disability and abdominal obesity adjusting for depression and physical performance, which are considered important confounders of this association (16, 17, 21, 24). For this study, we

hypothesized that the disablement process is influenced by abdominal obesity in its development, even in the presence of other important known risk factors. Moreover, we used data from the International Mobility Aging Study (IMIAS), a multicentre cohort study that provided a good opportunity to study this relationship in older adults aging in different contexts and with very distinct aging profiles. Thus, the current study had two objectives: (a) to estimate the prevalence and 4-year incidence of mobility and mobility-related Activities of Daily Living (ADL) disability in men and women participants in the IMIAS study; and (b) to explore the longitudinal relationship between abdominal obesity with mobility and mobility-related ADL disability controlling for physical performance and depression in older adults who are free from disability.

Methods

Study design and participants

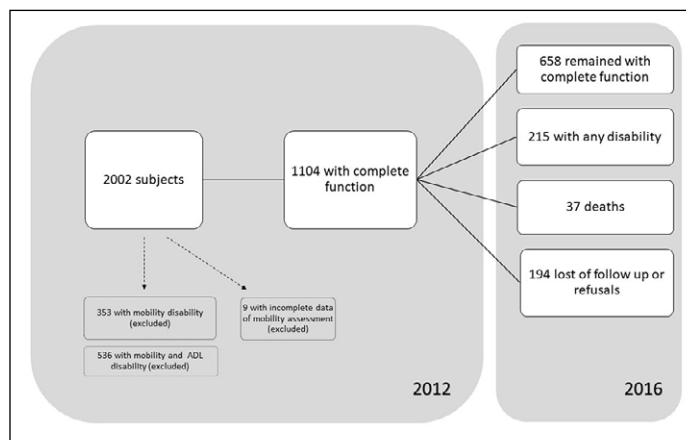
IMIAS is a population-based longitudinal study that involved five sites with different epidemiological contexts: Kingston (Ontario, Canada) and Saint-Hyacinthe (Quebec, Canada), Tirana (Albania), Manizales (Colombia) and Natal (Brazil). IMIAS' main purpose was understanding the differences in mobility disability among older adults from diverse settings, that differed in social, cultural, socioeconomic aspects and of health care systems (25). For instance, these countries had different demographic aging with percentage population over 65 years ranging from 7 in Colombia to 16 in Canada, also show disparities in term of gender inequalities, where Canada have a better position in Gender Inequality Index Rank (18) than their counterparts from Albania (51), Colombia (89) and Brazil (92) (25). The study design and data collection methods have been described earlier (25, 26).

IMIAS participants were community-dwelling men and women aged 64–74 years old at the time of the first assessment wave. Older adults from Tirana, Manizales, and Natal were randomly recruited through neighborhood primary care centers. Canadian participants were invited to participate in the study by an invitation letter from their primary care physicians (26). Briefly, only older adults without severe cognitive decline were included (defined as four or more errors in the orientation scale of the Leganes Cognitive Test) (25, 27). The assessments were performed by health professionals in Latin America cities and Tirana, and by teachers and other lay professionals in Canada (25).

In 2012, 2002 participants were recruited and followed for four years, with reassessments in 2014 and 2016. In 2016, 1527 of the 1891 subjects known to have not died participated in the follow-up assessment (81%). For this data analysis, we included only participants without any disability at baseline ($n=1104$).

Figure 1 describes the sampling strategy of this study.

Figure 1



Measurements

Disability Status

Disability status was defined by self-reported difficulties in mobility tasks and also in difficulties in performing ADL related to mobility following definitions used by Guralnik et al. (1995) (28). Mobility disability was defined as self-reported difficulty in walking 400 m or climbing a flight of stairs without resting (26, 29, 30); ADL disability was defined by reporting difficulties in performing at least one of five mobility-related activities of daily living (ADL): going to the bathroom, bathing, dressing, getting out of bed, walking across a small room (26, 30, 31). Furthermore, we used a three-level hierarchical variable for disability status definition as follows: complete function (those individuals without disability); mobility disability (have difficulty walking 400 m or climbing a flight of stairs); and mobility-related ADL disability (including those with mobility disability plus difficulty to perform one or more mobility-related ADL) (31, 32).

Abdominal obesity

Waist circumference (cm) was assessed using a non-elastic tape at the midpoint between the lower edge of the rib cage and the iliac crest. Abdominal obesity was considered when waist circumference was ≥ 88 cm for women or ≥ 102 cm for men (33, 34).

Covariates

Physical performance

For gait speed assessment the participant was requested to walk at their usual-pace in a distance of four meters, or three meters if four meters of space was unavailable in the home (31). The gait speed was defined by the distance (in meters) divided by time (in seconds). Two measurements were performed and the fastest value was used for analysis. Handgrip strength was measured using a handheld dynamometer (Jamar Hydraulic Hand Dynamometer®). Participants were instructed

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Table 1

Absolute and relative frequencies in each categories of disability (in 2016) across research site and sex among those with complete function in 2012 (n=1104)

	Kingston		Saint - Hyacinthe		Tirana		Manizales		Natal		Total		TOTAL
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	
Complete function	88 (84.6)	85 (74.6)	104 (88.9)	91 (83.5)	49 (55.1)	16 (5.7)	77 (70.0)	52 (74.3)	60 (66.7)	36 (69.2)	378 (74.1)	280 (70.0)	658 (72.3)
Mobility disability	5 (4.8)	13 (11.4)	7 (6.0)	12 (11.0)	16 (18.0)	7 (13.5)	16 (14.5)	11 (15.7)	11 (12.2)	9 (17.3)	55(10.8)	52 (13.0)	107 (11.8)
Mobility-related ADL disability	7 (6.7)	16 (14.0)	5 (4.3)	4 (3.7)	19 (21.3)	30 (50.0)	8 (7.3)	7 (10.0)	8 (10.0)	3 (5.8)	48 (9.4)	60 (15.0)	108 (11.9)
Deaths	4 (3.8)	-	1 (0.9)	2 (1.8)	5 (5.6)	2 (25.0)	9 (8.2)	-	10 (11.1)	4 (7.7)	29 (5.7)	8 (2.0)	37 (4.1)

by the interviewer and verbally encouraged to grip the handle as hard as possible using their dominant hand. The measurement protocol for handgrip strength followed the recommendations of The American Society of Hand Therapists (35). Three measurements were performed, and the highest value was used in the analyses.

Depressive symptoms

Depressive symptoms were reported as the score on the Center for Epidemiologic Studies Depression Scale (CESD), which is a widely used 20-item test with scores from 0 to 60 (highest possible burden of depressive symptomatology). Scores ≥ 16 were used as indicative of clinically relevant depression (36).

Sociodemographic information obtained at baseline during the structured interview included age, sex, education (years) and income sufficiency. Income sufficiency was recorded by the answer to the question: To what extent is your income sufficient to make ends meet? Possible responses were: very sufficient, suitable, and insufficient (37). Chronic conditions were assessed as self-report of having been diagnosed by a medical doctor with any of the following conditions: hypertension, heart diseases, diabetes, cancer, chronic respiratory disease, arthritis or osteoporosis. As an indicator of comorbidity, we used the sum of all chronic conditions and then we categorized in 0-1, 2-3 and 4 or more chronic conditions (38, 39). Height (cm) was measured to the nearest 0.1 cm with a stadiometer. Body weight (kg) was assessed using a digital scale with participants wearing light indoor clothes and no shoes. Body mass index was calculated using weight and height² (kg/m²). Finally, physical activity was self-reported using total walking time per week obtained from the Mobility Assessment tool for Walking (MAT-W) (40). Smoking was classified into three categories: never smoked, ex-smoker and smoker.

Statistical analysis

Descriptive statistics were used to summarize the data. Continuous variables were presented by mean values and standard deviations, while categorical variables were presented by proportions. Sex-specific results are shown according to disability status only for descriptive purposes. Differences

between mobility disability, ADL disability, and complete function groups were compared using ANOVA and Chi-square test. The incidence of mobility and ADL disability in 2014 were calculated considering the participants who were free of disability at baseline. 2016 disability incidence was only considered for those participants without disability (mobility and ADL) in 2014.

We used Generalized Estimating Equations (GEE) to model the longitudinal associations between mobility disability and ADL disability with abdominal obesity, adjusting for depressive symptoms and physical performance measures and remaining covariates. GEE is an extension of the generalized linear model that accounts for the within-subject correlation across repeated measurements, allows for within-subject missing data, and is appropriate to estimate population-averaged effects over time. We used an unstructured correlation structure for GEE analysis for which we built two models; one model with mobility disability as the dependent variable, and the other model with mobility-related ADL disability as the dependent variable. Both models were adjusted by the following baseline variables: age, sex, years of education, income sufficiency, research site, number of chronic conditions, and height; and by the following time-varying variables: abdominal obesity, depression, handgrip strength, gait speed and time of follow up (representing the 3 waves of data collection). Sex interactions for abdominal obesity, depressive symptomatology and physical performance measures were tested in both models. Since these interactions were not significant, sex was included as a covariate.

Finally, we performed a multinomial regression to assess the predictive value of baseline abdominal obesity, depressive symptomatology, handgrip strength, and gait speed for 2016 mobility disability. Participants were classified into four categories according to disability in 2016: complete function, mobility disability, mobility-related ADL disability, and death (the distribution of this outcome is shown in Table 1). All analyses were controlled by disability status in 2012, age, sex, education, income sufficiency, research site, number of chronic conditions and height. Sex interactions were also tested using product terms for abdominal obesity, depressive symptomatology and physical performance measures, however they were non-significant. Comparative analyses between the subjects who remained in the study and those who dropped out

Table 2
Sex-specific distributions of general characteristics according to disability status at baseline (n=2002)

Variables	MEN			p-value
	Complete function (n=620)	Mobility Disability (n=125)	ADL Disability (n=205)	
<i>Sociodemographic characteristics</i>				
Age, years; mean (s.d.)	68.9 (2.9)	69.7 (3.0)	69.3 (2.9)	0,01
Education, years; mean (s.d.)	11.0 (6.0)	8.1 (5.2)	9.4 (6.2)	<0.01
Research Site, (%)				
Kingston, Canada	132 (72.1)	12 (6.6)	39 (21.3)	<0.01
Saint-Hyacinthe, Canada	155 (81.6)	14 (7.4)	21 (11.1)	
Tirana, Albania	99 (53.5)	34 (18.4)	52 (28.1)	
Manizales, Colombia	118 (58.4)	36 (17.8)	48 (23.8)	
Natal, Brazil	116 (61.1)	29 (15.3)	45 (23.7)	
Income Sufficiency, n (%)				
Very well	194 (81.2)	9 (3.8)	36 (15.1)	<0.01
Suitably	212 (67.1)	45(14.2)	59 (18.7)	
Not very well	213 (54.5)	71 (18.2)	107 (27.4)	
Smoke history, n (%)				
Never smoked	215 (69.6)	38 (12.3)	56 (18.1)	0,06
Ex-smoker	335 (65.2)	65 (12.6)	114 (22.2)	
Current smoker	70 (55.1)	22 (17.3)	35 (27.6)	
Total walking time per week; minutes/week; mean (s.d.)	274.3 (271.7)	175.1 (159.4)	155.5 (236.8)	<0.01
<i>Clinical characteristics</i>				
Chronic Conditions, n (%)				
Hypertension	287 (56.6)	81 (16.0)	139 (27.4)	<0.01
Diabetes	107 (55.4)	30 (15.5)	56 (29.0)	0,004
Cancer	56 (65.9)	13 (15.3)	16 (18.8)	0,71
Heart diseases	116 (49.8)	47 (20.2)	70 (30.0)	<0.01
Lung diseases	49 (52.7)	18 (19.4)	26 (28.0)	0,02
Stroke	15 (35.7)	4 (9.5)	23 (54.8)	<0.01
Osteoarthritis	166 (55.5)	39 (13.0)	94 (31.4)	<0.01
Osteoporosis	28 (54.9)	6 (11.8)	17 (33.3)	0.10
Presence of Depressive Symptoms, n (%)				
No	564 (70.1)	99 (12.3)	141 (17.5)	<0.01
Yes	45 (33.8)	25 (18.8)	63 (47.4)	
<i>Antropometric Variables</i>				
BMI, kg/m ² , mean (s.d.)	26.9 (3.9)	27.3 (4.5)	28.1 (5.0)	0,003
Weight, kg, mean (s.d.)	76.5 (13.2)	75.7 (15.3)	79.4 (16.6)	0,02
Height, cm, mean (s.d.)	168.4 (7.6)	166.1 (7.9)	167.8 (8.1)	0,01
Abdominal Obesity, n (%)				
No	465 (69.5)	84 (12.6)	119 (17.8)	<0.01
Yes	155 (55.0)	41 (14.5)	86 (30.5)	
<i>Physical performance measures</i>				
Handgrip Strength, kg, mean (s.d.) ^a	37.6 (8.7)	33.8 (9.2)	33.4 (9.5)	<0.01
Gait Speed, m/s, mean (s.d.) ^b	1.04 (0.22)	0.87 (0.18)	0.81 (0.22)	<0.01

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Table 2 (continued)
Sex-specific distributions of general characteristics according to disability status at baseline (n=2002)

	WOMEN			p-value
	Complete function (n=484)	Mobility Disability (n=228)	ADL Disability (n=331)	
<i>Sociodemographic Variables</i>				
Age, years; mean (s.d.)	68.7 (2.6)	69.4 (2.8)	69.3 (2.88)	0,005
Education, years; mean (s.d.)	10.7 (5.3)	7.3 (5.0)	7.9 (5.21)	<0.01
<i>Research Site, n (%)</i>				
Kingston, Canada	145 (68.4)	16 (7.5)	51 (24.1)	<0.01
Saint-Hyacinthe, Canada	132 (62.9)	35 (16.7)	43 (20.5)	
Tirana, Albania	63 (30.6)	52 (25.2)	91 (44.2)	
Manizales, Colombia	75 (36.9)	62 (30.5)	66 (32.5)	
Natal, Brazil	69 (32.5)	63 (29.7)	80 (37.7)	
<i>Income Sufficiency, n (%)</i>				
Very well	160 (70.8)	27 (11.9)	39 (17.3)	<0.01
Suitably	169 (51.2)	71 (21.5)	90 (27.3)	
Not very well	152 (31.7)	126 (26.2)	202 (42.1)	
<i>Smoke history, n (%)</i>				
Never smoked	493 (52.4)	183 (19.4)	265 (28.2)	0,29
Ex-smoker	501 (59.8)	127 (15.2)	210 (25.1)	
Current smoker	110 (51.4)	43 (20.1)	61 (28.5)	
Total walking time per week; minutes/week; mean (s.d.)	242.3 (299.4)	125.4 (140.8)	130.0 (176.5)	<0.01
<i>Clinical characteristics</i>				
<i>Chronic Conditions, n (%)</i>				
Hypertension	223 (35.9)	164 (26.4)	234 (37.7)	<0.01
Diabetes	70 (31.8)	53 (24.1)	97 (44.1)	<0.01
Cancer	46 (52.3)	14 (15.9)	28 (31.8)	0,32
Heart diseases	48 (24.4)	57 (28.9)	92 (46.7)	<0.01
Lung diseases	38 (27.3)	34 (24.5)	67 (48.2)	<0.01
Stroke	16 (28.6)	9 (16.1)	31 (55.4)	<0.01
Osteoarthritis	210 (37.0)	36 (22.1)	93 (57.1)	<0.01
Osteoporosis	137 (40.9)	61 (18.2)	137 (40.9)	<0.01
<i>Presence of Depressive Symptoms, n (%)</i>				
No	413 (55.7)	160 (21.6)	168 (22.7)	<0.01
Yes	67 (22.6)	67 (22.6)	163 (54.9)	
<i>Antropometric Variables</i>				
BMI, kg/m ² , mean (s.d.)	26.5 (4.5)	28.9 (4.9)	30.1 (6.1)	<0.01
Weight, kg, mean (s.d.)	65.1 (12.0)	67.2 (14.2)	71.2 (0.8)	<0.01
Height, cm, mean (s.d.)	156.5 (6.7)	151.8 (6.5)	153.6 (6.9)	<0.01
<i>Abdominal Obesity, n (%)</i>				
No	217 (63.8)	55 (16.2)	68 (20.0)	<0.01
Yes	267 (38.0)	173 (24.6)	263 (37.4)	
<i>Physical performance measures</i>				
Handgrip Strength, kg, mean (s.d.) ^c	22.8 (5.1)	20.6 (4.9)	19.5 (5.5)	<0.01
Gait Speed, m/s, mean (s.d.) ^d	1.03 (0.22)	0.85 (0.20)	0.75 (0.25)	<0.01

a. 20 missings values ; b. 22 missings values; c. 22 missings values; d. 18 missings values; *p-values from Chi square test for categorical variables and by ANOVA test for continuous variables.

Table 3
Baseline prevalence and incidence of mobility and mobility-related ADL disability in 2014 and 2016, stratified by sex

	MEN							
	2012 Prevalence (95% CI)		Two year incidence 2012-2014 (95% CI) ^a		Two year incidence 2014-2016 (95% CI) ^b		Four year incidence 2012-2016 (95% CI) ^b	
	Mobility Disability	ADL Disability	Mobility Disability	ADL Disability	Mobility Disability	ADL Disability	Mobility Disability	ADL Disability
Kingston	16.9 (12.2-23.0)	21.2 (15.9-27.6)	4.6 (2.0-10.4)	6.4 (3.1-12.7)	4.6 (1.8-11.2)	4.6 (1.8-11.2)	8.0 (4.1-15.0)	7.0 (3.4-13.7)
Saint-Hyacinthe	12.1 (8.2-17.5)	10.9 (7.3-16.2)	8.2 (4.6-14.1)	5.97 (3.1-11.3)	2.9 (1.0-8.3)	2.9 (1.0-8.3)	6.9 (3.5-13.0)	4.3 (1.8-9.7)
Tirana	38.3 (31.6-45.5)	27.8 (21.9-34.6)	67.4 (57.2-76.1)	41.3 (31.7-51.5)	9.5 (2.6-28.9)	9.5 (2.6-28.9)	39.3 (29.5-50.0)	22.6 (15.0-32.6)
Manizales	36.6 (30.3-43.4)	23.6 (18.3-30.0)	15.2 (9.7-23.0)	7.1 (3.6-13.4)	14.8 (8.6-24.1)	6.1 (2.6-13.6)	18.8 (12.4-27.5)	7.9 (4.0-14.8)
Natal	27.8 (22.0-34.6)	23.6 (18.2-30.2)	13.8 (8.2-22.2)	5.3 (2.3-11.8)	10.9 (5.4-20.9)	6.2 (2.4-15.0)	20.0 (12.7-30.0)	11.2 (6.0-20.0)
	WOMEN							
Kingston	21.7 (16.6-27.7)	23.8 (18.6-30.0)	7.2 (3.8-13.1)	8.8 (5.0-15.1)	17.0 (10.9-25.5)	11.0 (6.2-18.6)	19.3 (13.1-27.5)	14.0 (8.8-21.6)
Saint-Hyacinthe	30.9 (25.1-37.5)	20.4 (15.7-26.4)	17.1 (11.3-24.9)	6.8 (3.5-12.9)	6.9 (5.78-17.32)	2.33 (0.6-8.1)	13.08 (7.9-20.7)	3.7 (1.4-9.2)
Tirana	66.0 (59.3-72.1)	43.9 (37.3-50.7)	76.6 (64.5-85.5)	45.0 (33.1-57.5)	16.6 (4.7-44.8)	8.3 (1.5-35.3)	64.1 (50.7-75.7)	56.6 (43.2-69.0)
Manizales	56.6 (49.7-63.2)	32.3 (26.3-39.0)	21.1 (13.2-31.9)	8.4 (3.9-17.2)	14.8 (7.7-26.6)	7.4 (2.9-17.5)	22.8 (14.6-33.9)	9.8 (4.8-19.0)
Natal	63.2 (56.5-69.4)	37.7 (31.4-44.4)	19.3 (11.1-31.3)	14.0 (7.3-25.3)	14.2 (6.2-29.3)	2.8 (0.05-14.5)	20.8 (11.7-34.2)	6.2 (2.1-16.8)

Incidence = new cases/participants at risk; a Only those who completed the 2014 questionnaire were included in the calculation of incidence in 2014; bOnly those who completed the 2016 questionnaire were included in the calculation of incidence in 2016.

Table 4
Generalized Estimating Equations models estimating the effect of obesity, handgrip strength, gait speed and depression on the risk of mobility disability and mobility-related ADL disability

	Mobility disability			Mobility-related ADL disability		
	OR	95% CI	p-value	OR	95% CI	p-value
Abdominal Obesity						
Yes	1.68	1.23-1.76	0.01	1.47	1.23-1.76	0.01
No	Referent			Referent		
Depressive Sintomatology						
Yes	1.93	1.82-2.63	<0.01	2.19	1.82-2.63	<0.01
No	Referent			Referent		
Handgrip Strength (kg)	0.96	0.94-0.97	<0.01	0.96	0.95-0.98	<0.01
Gait Speed (m/s)	0.02	0.01-0.04	<0.01	0.04	0.02-0.07	<0.01

Models adjusted for age, sex, research site, income, education, height, chronic conditions, total walking time per week, tobacco use and time of follow up.

of follow-up assessment in 2016 were performed considering socio-demographic factors and variables of interest. No differences in sex, age, abdominal obesity or depression were observed; however, those lost to follow up had lower education.

Results

Sex-specific characteristics according to disability status are shown in Table 2. Disability was more frequent among those with insufficient income, higher comorbidity, those with depression and those with abdominal obesity. Both men and women with mobility disability in 2012 had fewer years of

schooling, handgrip strength, and gait speed values. Moreover, both men and women who had ADL disability showed significant lower baseline values in gait speed and handgrip strength compared to those participants without disabilities.

Sex-specific baseline prevalence, two years and four years incidence of mobility and ADL disability in both sexes and across research sites are shown in Table 3. Generally, participants from Latin American cities and Tirana presented more disability rates than Canadian participants. Among men, the baseline prevalence of mobility disability varied from 12.1% to 38.3%, and from 10.9% to 27.8% for ADL disability among research sites. At baseline, prevalence rates were higher

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Table 5

Multinomial regression of associations of baseline abdominal obesity, gait speed, grip strength and depression with disability in 2016

	Mobility disability			Mobility-related ADL disability			Death		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Abdominal Obesity									
Yes	1.93	1.17-3.17	0.009	1.59	0.93-2.71	0.09	1.64	0.68-3.92	0.26
No	Referent			Referent			Referent		
Depressive Sintomatology									
Yes	1.16	0.60-2.24	0.65	0.91	0.44-1.86	0.80	1.27	0.38-4.22	0.69
No	Referent			Referent			Referent		
Handgrip Strength (kg)	0.95	0.92-0.99	0.02	0.88	0.96-1.00	0.09	0.97	0.91-1.04	0.45
Gait Speed (m/s)	0.34	0.10-1.07	0.06	0.44	0.14-1.38	0.16	0.11	0.01-0.89	0.03

Models adjusted for age, sex, research site, income, education, height, chronic conditions, total walking time per week, tobacco use and time of follow up.

in women than men for both mobility, ranging from 21.7% to 66.0% and 20.4% to 43.9% for ADL disability. Similar patterns of women presenting higher values of disability incidence were observed in 2014 and 2016 (Table 3).

The longitudinal association between mobility disability and obesity is shown in Table 4. The generalized estimation equation model showed that the association between mobility disability and abdominal obesity remained statistically significant even after adjustment by depressive symptoms, handgrip strength and gait speed. Those participants with abdominal obesity had an odds ratio of 1.68 (95% CI 1.23-1.76) for developing mobility disability in 4 years compared to the reference group without abdominal obesity. Stronger associations were also found with depressive symptomatology (OR: 1.93, 95% CI 1.82-2.63), while higher values in the physical performance measures were protective factors for mobility disability (Table 4).

In the fully adjusted model, we found higher odds of ADL disability among those with abdominal obesity (OR: 1.47, CI 95% 1.23-1.76). Again, we observed a strong longitudinal association between depressive symptoms and ADL disability (OR: 2.19, CI 95% 1.89-2.63). Higher values of handgrip strength and gait speed were associated with lower risk of ADL disability (Table 4).

In our analyses of baseline predictors for 2016 disability controlling for mortality, abdominal obesity (OR: 1.93; CI 95% 1.17-3.17) was a predictor of mobility disability in 2016, also gait speed (OR: 0.34; CI 95% 0.10-1.07) and handgrip strength (OR: 0.95; CI 95% 0.92-0.99) were protective factors for mobility disability (Table 5). Nevertheless, abdominal obesity was not a predictor of ADL disability (OR: 1.59; CI 95% 0.93-2.71) or death (OR: 1.64; CI 95% 0.68-3.92). Also, in relation to death gait speed was protective (OR: 0.11; CI 95% 0.01-0.89).

Discussion

In this study we aimed to describe the prevalence and incidence of mobility and mobility-related ADL disability in an international, multisite study of community-dwelling older adults. Moreover, we also examined the longitudinal relationship between mobility and mobility-related ADL disability with abdominal obesity, controlling for depression and physical performance measures in older adults from different epidemiologic contexts. We observed that the prevalence and incidence of mobility and mobility-related ADL disability varied across research sites and between sexes. In general, higher prevalence and incidence of disability were found in those participants from Latin America and Tirana and among women compared to men. Previous cross-sectional analyses based on data from the first wave of the IMIAS showed that women were more likely to report having difficulties in mobility and in performing ADLs (26). Also, the high load of prevalence and incidence of disability in older adults from Latin America has support in previous studies conducted in Latin America (1, 41).

The longitudinal relationship between abdominal obesity and mobility disability remained statistically significant even after controlling for depressive symptomatology, physical performance measures, health behaviors, comorbidity, socioeconomic variables and research site. Those participants with waist circumference higher than 102 cm (men) or 88 cm (women), respectively had a higher risk of mobility disability in 4 years of follow-up (OR 1.47). Similar results were found by Koster et al. (2008) using data from the Health ABC study, in which older adults who had higher values of waist circumference had a higher risk for developing mobility disability after 6.5 years of follow-up (42). Guallar-Castillón et al. (2007) also found that waist circumference was associated with mobility disability after two years of follow-up in older

Spanish adults (43). Same pattern was seen abdominal obesity and mobility-related ADL did not reach statistical significance. Corona et al. (2016) found that abdominal obesity was a strong predictor of ADL disability over five years of followup in Brazilian older adults (participants in the SABE study) controlling for handgrip strength, age, sex, education, physical activity level, cognitive function and chronic conditions (14). A prospective study of preretirement age adults from England also found that waist circumference was the best predictor for the risk of developing disability among the five anthropometric measures of obesity after five years, even adjusting for age, height, smoking, social class and education corroborant with our findings (12).

Consistent with results from the GEE models, we found that baseline abdominal obesity was an important predictor of mobility disability development after four years in the multinomial regression model. However, it did not predict more severe disability (ADL disability) and mortality. Perhaps the lack of association was influenced by the relatively small number of incident cases of ADL disability, since our sample is composed of younger older subjects, where this type of disability is uncommon. Furthermore, a previous study showed that obese older adults can use compensatory strategies in order to facilitate the successful completion of physical tasks as older adults who report no signs of difficulty (44). Additionally, this discrepancy may reflect that abdominal obesity could bring greater difficulties experienced in walking intermediate distances compared to the difficulties posed by shorter walking in everyday activities (12). Despite this, Guallar-Castillon et al. (2007) also did not find an association between high quintile of waist circumference and ADL disability in Spanish older adults, which corroborates with our findings (13). Nevertheless, the relationship between central obesity and mortality is still contradicted in older populations (45).

Despite this, the literature does provide explanations for the association between central obesity and disability. The presence of abdominal obesity can be linked to physical inactivity, which in turn could lead to disability (43). Another possibility is that the presence of abdominal obesity could represent a burden for the osteomuscular system, thus limiting mobility (43). Finally, other authors have suggested that the increase in the amount of adipose tissue can be related to an up-regulation of systemic inflammation, thus leading to a disability process (46, 47).

Our analyses found that the presence of depressive symptoms was strongly associated to mobility and mobility-related ADL in both sexes and these findings are in line with results from previous studies (3–6). However, the presence of depressive symptoms at baseline did not predict the disability status after 4 years. Absence of predictive power of depression for disability was also seen in other studies (48, 49). Perhaps this lack of prediction could be a side effect of the exclusion of those who were already disabled at baseline; thus, we may have excluded some participants with both disability and depression, and this might have reduced the

number of depressed participants, influencing the prediction power 4 years later. We also found that physical performance measures (handgrip strength and gait speed) were longitudinally associated to mobility and mobility-related ADL. Also, these measures showed association with the mobility disability status in 2016. These findings are in line with previous studies (8, 24, 50, 51). Moreover, gait speed was an important protective factor for mortality, which is line with previous studies (52).

Limitations and strengths

This study has some strengths. First, we used waist circumference to measure obesity, which is a better predictor of body fat amount in older adults compared to body mass index (12). In a recent study, Batis et al. (2016) found that diagnostic accuracy of BMI was poor in both sexes with advanced age, and for this population the use of centrally adiposity measures were recommended (53). Furthermore, we used the same standardized assessment protocols over the four years in four international research sites. Additionally, this is the first study to date which examined the relationship between obesity and disability status controlling for important confounders such as physical performance and depression in diverse populations of older adults with distinct ways of living.

Despite this, some limitations should be considered. The study sample was relatively small to do site-specific analyses, with inclusion of quartiles or quintiles distribution for abdominal obesity. However, in bivariate analyses for increased disability risk in the lowest and the highest quintiles of BMI and we did not find significant differences in these extreme categories. Due to our limited sample size, other important confounders could not be included such as life space mobility, social participation or individual's medical conditions. Also, our outcomes were self-reported, which may be influenced by culture or education (54). However, self-reported measures are considered valid and cost-effective measures of disability assessment in older adult populations (55). Another possible limitation is that our sample is composed of the young-old (aged 65-74 years) added to the short time of follow up, could be related to the small number of incident cases of ADL disability and may result in lack of statistical power to detect the association between abdominal obesity and ADL disability. However, we have verified that in bivariate analyses the associations between abdominal obesity and mobility and ADL disability yielded high statistical power (97% and 93%, respectively).

In this study abdominal obesity was defined according to NIH recommendations (> 88 cm for women and >102 cm for men) (34), despite of previous discussion about ethnic-based cut offs for abdominal obesity to increase the accuracy for screening metabolic and cardiovascular diseases (56, 57), recent finding have been showing that obesity can be also related to socioeconomic disparities than only genetic influence (58). Moreover the cut off adopted in this study was associated to disability in prior studies from diverse countries (14, 23, 59,

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60). Finally, in order to avoid overload in statistical analysis comorbidity was used as the sum of eight chronic conditions. Despite of some previous work argued that this approach does not consider the disease severity, using comorbidity in this way we could provide a global measure of the overall impact of disease burden on disability process (38, 39).

Relevant clinical implications

We observed that abdominal obesity has an important role in the development of mobility disability in a short period of time (4 years) in community-dwelling older adults from different epidemiological contexts. The presence of abdominal obesity remained an important risk factor for disability independent of sex, country, or other significant factors, demonstrating that it is urgent to implement health promotion policies to reduce obesity in adult populations in order to prevent mobility disability in later life.

Conclusion

In summary, our results showed that the presence of abdominal obesity has a central role in the mobility disability process. Future intervention studies and health policies are needed to reduce obesity in order to interrupt the progression from functional limitation to disability sooner in older populations.

Conflicts of interest: The authors declare no conflict of interest.

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Ethical standard: The Research Ethics Committees at the Universidad de Caldas, Universidade Federal do Rio Grande do Norte, Albanian Institute of Public Health, Queens University and Centre de Recherche du Centre Hospitaliere de l'Université de Montréal approved the study, and written informed consent was obtained from all subjects prior to study participation.

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