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Metabolic Syndrome and Physical Decline in Older Persons: Results from the Health, Aging and Body Composition Study

Brenda W. J. H. Penninx,[1] Barbara J. Nicklas,[2] Anne B. Newman,[3] Tamara B. Harris,[4] Bret H. Goodpaster,[3] Suzanne Satterfield,[5] Nathalie de Rekeneire,[6] Kristine Yaffe,[7] Marco Pahor,[8] and Stephen B. Kritchevsky,[2] for the Health ABC Study

[1]EMGO Institute/Department of Psychiatry, VU University Medical Center, Amsterdam, The Netherlands.
[2]The Sticht Center on Aging, Wake Forest University School of Medicine, Winston-Salem, North Carolina.
[3]University of Pittsburgh, Pennsylvania.
[4]National Institute on Aging, Bethesda, Maryland.
[5]University of Tennessee, Memphis.
[6]Center for Disease Control, Atlanta, Georgia.
[7]University of California, San Francisco.
[8]University of Florida, Gainesville.

Background. The metabolic syndrome includes dyslipidemia, abdominal obesity, insulin resistance, and hypertension and is associated with an increased risk of diabetes and cerebrovascular disease (CVD), but consequences beyond these outcomes have not been examined extensively. We investigated whether metabolic abnormalities have independent consequences on loss of mobility function of older persons.

Methods. Data are from 2,920 men and women, 70–79 years, participating in the Health ABC study without mobility limitations at baseline. Metabolic syndrome was defined as ≥3 of the following: (a) waist circumference >102 (men) or >88 cm (women); (b) triglycerides ≥150 mg/dL; (c) high-density lipoprotein cholesterol <40 mg/dL (men) or <50 mg/dL (women); (d) blood pressure ≥130/85 mm Hg or antihypertensive medication; and (d) fasting glucose ≥110 mg/dL or antidiabetic medication. Mobility limitation was defined as difficulty or inability walking ¼ mile or climbing 10 steps during two consecutive semiannual assessments over 4.5 years.

Results. The prevalence of metabolic syndrome was 38.6%. The metabolic syndrome was associated with an adjusted relative risk (RR) of 1.46 (95% confidence interval [CI] = 1.30–1.63) for developing mobility limitations. The risk increased when more metabolic syndrome components were present (p trend >.001). All metabolic syndrome components were significantly associated with incident mobility limitations with the highest RRs for abdominal obesity (RR = 1.54, 95% CI = 1.35–1.75) and hyperglycemia (RR = 1.44, 95% CI = 1.27–1.63). Findings were unchanged when persons with baseline, or incident, CVD, stroke, or diabetes were excluded.

Conclusions. Metabolic syndrome abnormalities, especially abdominal obesity and hyperglycemia, are predictive of mobility limitations in the elderly, independent of CVD or diabetes.

Key Words: Metabolic syndrome—Obesity—Glucose—Mobility limitation—Older—Diabetes—Cerebrovascular disease.

MAINTENANCE of physical function is a critical factor in the ability of older adults to remain independent. Mobility limitation is of particular interest because it is common, strongly related to health outcomes including major disability or mortality, and represents a stage early enough in the disablement process to be amenable to intervention (1). Better characterization of the relationship between common, preventable conditions and incident mobility limitations is critical to efforts aimed at preventing disability.

The metabolic syndrome, a clustering of traditional cerebrovascular disease (CVD) risk factors, is an example of a prevalent and treatable condition in older people. According to the adult treatment panel (ATP) III (2), the metabolic syndrome is most commonly defined as the presence of three or more of the following five conditions: abdominal obesity, hypertriglyceridemia, low high-density lipoprotein (HDL) cholesterol, hypertension, and hyperglycemia. Using these criteria, the national health and nutrition examination survey study estimated a prevalence of 42% among U.S. adults aged 70+ years (3). Even though there is ongoing dispute about its definition and concept (4), the metabolic syndrome does increase the risk of diabetes and cardiovascular morbidity and mortality (5–7). Unfortunately, there are scant data demonstrating the health consequences of the metabolic syndrome beyond cardiovascular and diabetes outcomes.

Systematic evaluation of the consequences of the metabolic syndrome, and its individual components, on aging-related physical function decline is scarce. To prevent or slow the decline in physical function with aging, it is important to know whether, and which, metabolic syndrome

abnormalities independently contribute to functional loss. The metabolic syndrome could cause subsequent physical decline not only indirectly through its cardiovascular and diabetes consequences but also more directly through its association with subclinical cardiovascular health indicators (8), increased inflammation and oxidative stress (9–11), or through sedentary behavior, frailty and low muscle strength (12–15).

This study examines the contribution of the metabolic syndrome and its individual components to incident development of persistent mobility limitations in older adults.

Methods

Study Population

Participants were part of the Health, Aging, and Body Composition study, a prospective cohort study of 3,075 well-functioning white and black elders, aged 70–79 years. Participants were recruited in 1997 and 1998, drawn from a sample of Medicare-eligible beneficiaries residing in the areas surrounding Pittsburgh, PA, and Memphis, TN. Participants were excluded if they (a) were incapable of communicating with the interviewer; (b) reported difficulty with walking for a quarter of a mile, walking up 10 steps, or performing activities of daily living; (c) had active cancer treatment in the past 3 years, or (d) had plans to move out of the area in the next 3 years. Of the 3,075 participants, we excluded those with missing data on metabolic syndrome ($n = 40$) or incident mobility limitations ($n = 82$), or those who died before the first follow-up ($n = 33$), leaving 2,920 participants for the present analysis. All participants provided written informed consent, approved by the institutional review boards of the clinical sites.

Measurements

Metabolic abnormalities and syndrome.—The metabolic syndrome was defined, following the national cholesterol education program ATP III guidelines (2), as meeting at least three of the following five criteria: (a) abdominal obesity (waist circumference >102 cm in men, >88 cm in women), (b) triglyceride level ≥150 mg/dL, (c) low HDL cholesterol (<40 mg/dL in men, <50 mg/dL in women), (d) systolic blood pressure ≥130 mm Hg and/or diastolic blood pressure ≥85 mm Hg or using antihypertensive medication, and (e) high fasting glucose (≥110 mg/dL or using antidiabetic medication). Waist circumference and blood pressure were both averaged over two measurements. Lipid and blood glucose levels were measured after an overnight fast. In addition to presence of metabolic syndrome, the number of metabolic abnormalities was used as an index of severity of metabolic syndrome.

Mobility limitations.—The occurrence of mobility limitation for a period of 4.5 years of study follow-up was determined semiannually, at the annual study assessment visits and during the in-between telephone follow-up assessments. Because of the study eligibility criteria, all participants had no self-reported mobility limitations at baseline. During all assessments, participants were asked whether they experience difficulty (no, a little, some, a lot, or inability) in walking ¼ mile or in climbing 10 steps. Incident mobility limitation was considered to be present if a person reported difficulty or inability to walk ¼ mile and/or climb 10 steps at two consecutive semiannual follow-up assessments. The requirement that limitations needed to be present at two consecutive assessments selects more chronic functional limitation and, therefore, this outcome is a more reliable indicator of a clinically relevant change in functional status.

Covariates.—Analyses will be adjusted for sociodemographics, lifestyle (smoking and alcohol use), chronic diseases, and cognitive impairment because these variables have been associated with the metabolic syndrome as well as with functional decline over time. Sociodemographics included age, race, sex, site, and education. Smoking status (yes/no) and alcohol use (none, <1 drink/d, ≥1 drink/d) were assessed in the baseline interview. Cognitive impairment was considered present when the Teng 3MS score was below 80 (16). The baseline presence of lung disease, cancer, and osteoarthritis was adjudicated using standardized algorithms considering self-report and medication use. Baseline diabetes mellitus was based on self-reported diagnosis of diabetes and medication use or a fasting glucose concentration ≥126 mg/dL. Baseline CVD considered the presence of coronary heart disease, peripheral arterial disease, congestive heart failure angina pectoris, or previous percutaneous transluminal coronary angioplasty or coronary artery bypass grafting, whereas CVD included self-reported history of stroke, transient ischemic attack, or carotid endarterectomy. Incident CVD, stroke, and diabetes events over the entire follow-up were defined by conclusive evidence for myocardial infarction, congestive heart failure, angina, stroke, or diabetes from hospitalization and/or death records, which were adjudicated according to criteria decided on by the Health ABC death and disease adjudication committee. Body mass index (BMI), calculated as weight in kilograms divided by the square of height in meters, was considered in additional analyses to adjust for presence of total obesity (BMI >30 kg/m^2).

Statistical Analyses.—Differences in proportions and means of covariates between persons with and without metabolic syndrome were assessed using χ^2 and *t*-test statistics, respectively. For the study outcome, person-time for each participant was calculated from the date of the baseline examination to the date of the first of the two consecutive self-reports of mobility limitations, date of death, or date of the last study contact, whichever came first. Cox proportional hazards regression models were used to evaluate the association of the metabolic syndrome and its individual components

Table 1. Baseline Characteristics for Study Sample and According to Metabolic Syndrome Status

	Total Study Sample (N=2,920)	No Metabolic Syndrome (N=1,792)	Metabolic Syndrome (N=1,128)	p^*
Age (mean years ± *SD*)	73.6 ± 2.9	73.7 ± 2.9	73.5 ± 2.8	.13
Sex, % female	52.2	48.9	57.4	<.001
Race, % black	41.3	42.7	39.0	.05
Site, % Memphis	49.8	50.0	50.5	.78
Education, % >high school	42.2	43.3	40.3	.11
Current smoker, %	10.0	11.8	7.1	<.001
Alcohol use, % none	50.2	47.2	55.5	
% <1 drink/d	42.1	44.7	38.5	<.001
% ≥1 drink/d	7.3	8.1	6.0	
CVD, %	19.1	16.0	24.2	<.001
Stroke, %	7.1	6.6	7.9	.20
Diabetes, %	14.9	5.4	30.1	<.001
Cancer, %	18.7	17.9	20.0	.15
Lung disease, %	11.5	10.4	13.1	.03
Arthritis, %	14.2	12.8	16.5	.005
Metabolic syndrome criteria				
Abdominal obesity, %	61.4	45.7	86.3	<.001
Hyperglycemia, %	23.8	7.9	49.0	<.001
Low HDL, %	29.4	8.9	62.0	<.001
High triglycerides, %	30.8	9.4	64.7	<.001
High blood pressure, %	78.7	70.3	92.2	<.001
Metabolic syndrome, %	38.6	0.0	100.0	—
No. of metabolic abnormalities, %				
0	6.1	9.9	—	
1	23.3	38.0	—	—
2	32.0	52.1	—	—
3	21.7	—	56.2	—
4	13.0	—	33.6	—
5	3.9	—	10.2	—

Notes: HDL = high-density lipoprotein; *SD* = standard deviation CVD = cerebrovascular disease.
$^*p$ value for comparison of person without and with the metabolic syndrome, based on t test for continuous variables and χ^2 tests for categorical variables.

on time to incident mobility limitation. Relative risks (RRs) and 95% confidence intervals (CIs) were adjusted for selected covariates. Potential interaction between metabolic syndrome components and race or sex was investigated using the Metabolic Abnormalities × Race or Sex product terms in adjusted models. In addition, because it is known that total obesity has a strong effect on physical decline, we conducted additional analyses considering overall obesity status (BMI >30 kg/m^2) as a covariate.

To establish whether the effect of metabolic syndrome (components) on mobility risk is independent of baseline CVD, stroke, and/or diabetes, we conducted analyses stratified by baseline CVD, stroke, and diabetes status. Finally, we checked whether study associations could be explained by *incident* disease events, by repeating analyses after additional exclusion of persons with any evidence of incident CVD, stroke, and/or diabetes during study follow-up.

Results

The mean age of the study sample was 73.6 years, and 52.2% were women and 41.3% were black. Of the initial 2,920 participants, 1,128 (38.6%) met the criteria for metabolic syndrome. The most prevalent metabolic syndrome component was high blood pressure (78.7%), and the least prevalent was hyperglycemia (23.8%). Persons with the metabolic syndrome were less likely to be a current smoker or alcohol drinker and were more likely to be female, white, or have CVD, diabetes, lung disease or arthritis (Table 1).

The 2,920 participants contributed 9,574 person-years during the 4.5-year follow-up. In this period, a total of 1,247 (42.7%) had incident mobility limitations, and the event rate was 13.0 per 100 person-years. Cox regression analyses, adjusted for age, sex, race, site, education, smoking, alcohol use, lung disease, heart disease, stroke, cancer, and arthritis, showed that all five individual metabolic syndrome components were associated with an increased incidence of mobility limitations (Table 2). Adjusted RRs were especially high for abdominal obesity (RR = 1.54) and hyperglycemia (RR = 1.44). In adjusted analyses, the metabolic syndrome itself was associated with a 1.46-fold increased risk of incident mobility limitations. Figure 1 shows the strong association ($p < .001$) between adjusted risk for incident mobility limitations and severity of metabolic syndrome as indicated by the number of metabolic syndrome components. Compared with persons with no components, those with two, three, four, or five components had a RR of 1.53 (95% CI = 1.12–2.09), 1.91 (95% CI = 1.39–2.63), 2.13 (95% CI = 1.53–2.96), and 2.48 (95% CI = 1.69–3.64), respectively.

To investigate which metabolic syndrome components were independently associated with incident mobility limitations, we ran a Cox regression analysis including all components

Table 2. Risk of Incident Mobility Limitations According to Metabolic Syndrome Status

		Incident Mobility Limitations		
		Incidence Rate/100 Person-Years	Unadjusted Risk, RR (95% CI)	Adjusted* Risk, RR (95% CI)
Abdominal obesity	No	8.8	Ref	Ref
	Yes	15.7	1.71 (1.52–1.93)	1.54 (1.35–1.75)
Hyperglycemia	No	11.2	Ref	Ref
	Yes	18.1	1.60 (1.41–1.80)	1.44 (1.27–1.63)
Low HDL	No	12.1	Ref	Ref
	Yes	14.0	1.15 (1.02–1.30)	1.20 (1.06–1.36)
High triglycerides	No	12.5	Ref	Ref
	Yes	13.2	1.05 (0.94–1.19)	1.17 (1.04–1.33)
High blood pressure	No	8.7	Ref	Ref
	Yes	14.0	1.60 (1.38–1.87)	1.24 (1.06–1.45)
Metabolic syndrome	No	10.5	Ref	Ref
	Yes	16.7	1.55 (1.39–1.73)	1.46 (1.30–1.63)

Notes: HDL = high-density lipoprotein; CI = confidence interval; RR = relative risk.
*Adjusted for age, sex, race, site, education, smoking, alcohol use, lung disease, heart disease, stroke, cancer, and arthritis.

together. In this model, abdominal obesity (RR = 1.46, 95% CI = 1.27–1.66), hyperglycemia (RR = 1.32, 95% CI = 1.16–1.50), and hypertension (RR = 1.20, 95% CI = 1.02–1.41) remained significantly associated with incident mobility limitations, but low HDL and high triglycerides were not (RR = 1.07, 95% CI = 0.94–1.22, and RR = 1.03, 95% CI = 0.90–1.18, respectively).

To explore whether findings could be due to an effect of total obesity on incident mobility limitation, additional adjustment for total obesity (BMI >30 kg/m^2) was included. As expected, total obesity was associated with incident mobility limitations (adjusted RR = 1.74, 95% CI = 1.54–1.97). Although risks for incident mobility limitations reduced after adjustment for total obesity, metabolic syndrome components remained significantly associated with incident mobility limitations—abdominal obesity: RR = 1.27, 95% CI = 1.10–1.47; hyperglycemia: RR = 1.30, 95% CI = 1.14–1.47; high triglycerides: RR = 1.12, 95% CI = 0.99–1.27; and hypertension: RR = 1.19, 95% CI = 1.01–1.38. For low HDL, the p value dropped to $p = .18$ (RR = 1.09, 95% CI = 0.96–1.23). The overall effect of metabolic syndrome remained significant (RR = 1.29, 95% CI = 1.15–1.45), suggesting that higher risk of incident mobility limitations for metabolic syndrome is not completely due to concomitant total obesity.

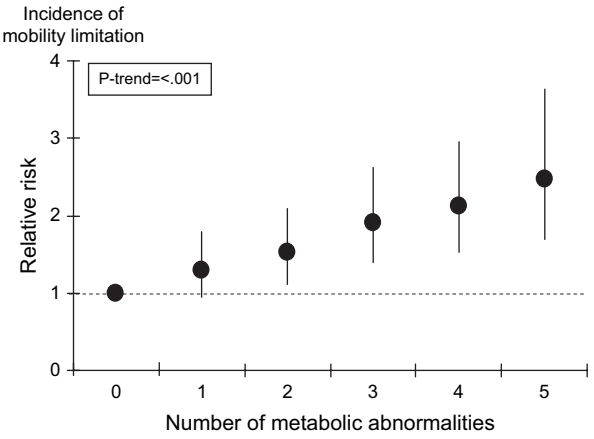

Figure 1. Adjusted* risk for incidence of mobility limitation according to number of metabolic components. *Adjusted for age, sex, race, site, education, smoking, alcohol use, lung disease, heart disease, stroke, cancer, and arthritis.

We tested the consistency of the association between metabolic syndrome and incident mobility limitations across race and sex strata using interaction terms. For race, no significant interaction with metabolic syndrome or its individual components was observed (all $p > .30$). Table 3 confirms that although high triglycerides and HDL levels were more common in whites and hypertension and hyperglycemia were more common in blacks, the associations between individual metabolic syndrome components with incident mobility limitations were similar across race groups. However, several metabolic syndrome components showed a trend for an interaction by sex. Table 3 shows that for all metabolic syndrome components, except for hyperglycemia, the associations appeared to be stronger for older women compared with men (p for sex interaction ranged between .06 for low HDL and .15 for abdominal obesity). Also, for metabolic syndrome and for the number of individual components, associations appear to be stronger for women (p for sex interaction = .14 and .05, respectively), although RRs were significant in both sexes.

Because it is unknown whether the prognostic importance of the metabolic syndrome for loss of physical function is equally important among persons with and without CVD or diabetes, we conducted analyses according to baseline disease status (Table 4). Among the 1,928 persons without baseline CVD, stroke, or diabetes, the incident mobility limitations risk of the individual metabolic syndrome components remained high (RRs ranged between 1.11 for high triglycerides and 1.63 for abdominal obesity). Among these disease-free participants, 30.1% had the metabolic syndrome, which was associated with a 1.44-fold increased risk of incident mobility limitations (95% CI = 1.22–1.68). As expected, the prevalence of metabolic syndrome is much

Table 3. Risk of Incident Mobility Limitations According to Metabolic Syndrome Status for Blacks and Whites and Men and Women Separately

	Black (N=1,206)		Whites (N=1,714)		p for Race Interaction	Men (N=1,397)		Women (N=1,523)		p for Sex Interaction
	%	RR* (95% CI)	%	RR* (95% CI)		%	RR* (95% CI)	%	RR* (95% CI)	
Abdominal obesity	64.4	1.45 (1.20–1.76)	59.1	1.59 (1.33–1.91)	.74	44.0	1.40 (1.18–1.68)	77.3	1.74 (1.42–2.13)	.15
Hyperglycemia	30.7	1.36 (1.16–1.61)	19.0	1.53 (1.27–1.85)	.32	28.1	1.53 (1.27–1.83)	19.9	1.42 (1.20–1.69)	.90
Low HDL	23.1	1.20 (1.00–1.44)	33.8	1.22 (1.03–1.44)	.99	30.6	1.02 (0.84–1.24)	28.3	1.33 (1.14–1.56)	.06
High triglycerides	19.2	1.20 (0.99–1.45)	38.9	1.17 (1.00–1.38)	.92	29.1	1.01 (0.82–1.23)	32.2	1.30 (1.11–1.52)	.07
High blood pressure	85.1	1.21 (0.95–1.54)	74.3	1.28 (1.04–1.58)	.56	77.0	1.07 (0.85–1.35)	80.3	1.41 (1.14–1.75)	.12
Metabolic syndrome	36.5	1.40 (1.19–1.65)	40.1	1.52 (1.29–1.79)	.42	34.4	1.30 (1.09–1.57)	42.5	1.57 (1.36–1.82)	.14
No. of abnormalities	—	—	—	—	.94	—	—	—	—	.05
0	4.6	Ref	7.1	Ref	—	7.4	Ref	4.8	Ref	—
1	22.8	1.46 (0.89–2.41)	23.7	1.21 (0.79–1.87)	—	29.4	1.10 (0.73–1.66)	17.7	1.60 (0.94–2.72)	—
2	36.2	1.70 (1.04–2.75)	29.1	1.43 (0.94–2.18)	—	28.7	1.22 (0.81–1.84)	35.0	2.07 (1.24–3.44)	—
3	21.6	2.10 (1.28–3.44)	21.8	1.83 (1.20–2.79)	—	19.1	1.36 (0.90–2.08)	24.1	2.73 (1.64–4.57)	—
4	11.8	2.22 (1.33–3.71)	13.8	2.13 (1.37–3.29)	—	12.0	1.61 (1.04–2.50)	13.9	3.03 (1.79–5.13)	—
5	3.2	2.84 (1.56–5.20)	4.5	2.29 (1.39–3.79)	—	3.3	1.90 (1.09–3.30)	4.5	3.50 (1.96–6.24)	—

Notes: HDL, high-density lipoprotein; CI = confidence interval.
*Adjusted for age, sex, race, site, education, smoking, alcohol use, lung disease, heart disease, stroke, cancer, and arthritis.

higher among persons with baseline CVD or stroke (46.7% of the 696) and among diabetics (78.0% of the 436). Nevertheless, the presence of metabolic syndrome was also associated with incident mobility limitations in CVD/stroke patients (RR = 1.24, 95% CI = 1.01–1.52) and in diabetics (RR = 1.36, 95% CI = 0.96–1.93). Finally, we ran analyses after exclusion of the 1,598 persons with any evidence of *baseline or incident* CVD, stroke, or diabetes. In the remaining 1,322 persons, the metabolic syndrome still predicted the incidence of mobility limitations (RR = 1.39, 95% CI = 1.13–1.72), and the limitations risk for individual metabolic syndrome components remained significant and were very similar to those of the overall sample (data not shown).

Discussion

This study examined whether the metabolic syndrome is associated with 4-year physical decline. Older persons with the metabolic syndrome had 50% more chance to develop mobility limitations compared with those without the metabolic syndrome. An increased functional risk was consistently confirmed for all five metabolic syndrome components, although associations with abdominal obesity and hyperglycemia appeared to be the strongest. We observed a strong, linear association ($p < .001$) between the number of metabolic syndrome components and incident mobility limitation. The effect of metabolic syndrome on physical decline was independent of overall obesity and of cardiovascular and diabetic consequences.

As previously published (17) and in line with other studies (3), our study confirms the high prevalence of metabolic syndrome in an older population (39%). The scientific concept of the metabolic syndrome remains controversial, because studies have indicated that there is not just one, but multiple, underlying pathophysiological mechanisms involved (including obesity-related, blood pressure-related, and insulin resistance-related mechanisms). Nevertheless, for incident mobility limitation in our study, all five metabolic syndrome components showed significant and consistent associations. When all five metabolic syndrome components were simultaneously entered in analyses, abdominal obesity, hyperglycemia, and hypertension remained independently associated. This indicates that the adverse functional consequences of metabolic syndrome are not driven by one single factor, but appear consistent for different

Table 4. Adjusted* Risk of Incident Mobility Limitation for Metabolic Syndrome Criteria According to Baseline CVD, Stroke, and Diabetes Status

	Persons Without Baseline CVD, Stroke or Diabetes (N=1,928)	Persons With Baseline CVD or Stroke (N=696)	Persons With Baseline Diabetes (N=436)
	RR* (95% CI)	RR* (95% CI)	RR* (95% CI)
Abdominal obesity	1.63 (1.37–1.95)	1.29 (1.04–1.61)	1.30 (0.93–1.80)
Hyperglycemia	1.28 (1.01–1.63)	1.35 (1.09–1.66)	—
Low HDL	1.30 (1.10–1.54)	0.97 (0.78–1.20)	1.03 (0.79–1.34)
High triglycerides	1.11 (0.94–1.32)	1.18 (0.95–1.47)	0.98 (0.74–1.30)
High blood pressure	1.17 (0.99–1.41)	1.21 (0.79–1.87)	1.41 (0.89–2.22)
Metabolic syndrome	1.44 (1.22–1.68)	1.24 (1.01–1.52)	1.36 (0.96–1.93)

Notes: HDL = high-density lipoprotein; CI = confidence interval; RR = relative risk.
*Adjusted for age, sex, race, site, education, smoking, alcohol use, lung disease, heart disease, stroke, cancer, and arthritis.

underlying components. However, from our results we should also conclude that individuals with the metabolic syndrome have no appreciably higher mobility risk than would be expected from the presence of the individual metabolic risk factors.

The highest risk for incident mobility limitation was observed for abdominal obesity. This effect remained significant after adjustment for total obesity (BMI >30 kg/m^2), which adds evidence to the suggestion that central fat is at least as important as BMI in determining the health risk associated with obesity in old age (18). For heart disease, diabetes, hypertension, and dyslipedemia, indicators of visceral fat appeared to be more important predictors than overall fat indicators (19,20). Abdominal obesity still predicted mobility limitations after adjustment for other metabolic components and after excluding cardiovascular and diabetic patients. This suggests that there are additional pathways—for instance, through osteoarthritis, lower physical activity levels, reduced ventilatory function, chronic inflammation, and frailty (12,21–23)—that may cause physical decline among those with abdominal obesity.

Although diabetes has shown to increase subsequent functional decline (24), there have not been many studies that examined whether detrimental health effects already exist for persons with high glucose levels below the diabetes threshold. Our study indicates that (also among persons who are not having diabetes) hyperglycemia increases incident mobility limitation, independent of cardiovascular disease. This could be due to underlying subclinical coronary and peripheral vascular disease (25), renal impairment, or peripheral or autonomic neuropathy not assessed by our study. However, effects could also be due to other direct effects of hyperglycemia, such as fatigue, blurred vision, headaches, inflammation, and oxidative stress (10,26,27). Furthermore, because the metabolic syndrome may be an indication of underlying insulin resistance, we conducted additional analyses in which we also included fasting insulin level as a covariate. These analyses showed that the metabolic syndrome was still predictive of incident functional limitations in the total sample (hazard ratio [HR] = 1.29, 95% CI = 1.13–1.47) as well as in the diabetes and CVD-free sample (HR = 1.31, 95% CI = 1.10–1.55), suggesting that the association of metabolic syndrome with physical decline goes beyond its link with insulin resistance.

Our study points out that persons with hypertension are more likely to develop functional decline even apart from cardiovascular events. Other functional consequences of hypertension could be through subclinical cerebrovascular dysfunction (27,28) or through direct unfavorable effects at the tissue level, specifically the skeletal muscle myocytes (29). Finally, also dyslipidemia is associated with incident mobility limitations. However, in multivariate analyses including all metabolic syndrome components, these associations reduced and lost significance.

The prevalence and incidence of functional limitation is generally higher in older women than in older men (30). In addition, as confirmed in our study, women more often have the metabolic syndrome than men. The higher occurrences of both metabolic syndrome and functional limitation could explain why we found more pronounced effects of metabolic abnormalities among women. Also, because men have a lower life expectancy, selective attrition could have affected the males more and therefore the functional decline risk of the metabolic syndrome could be relatively smaller. Finally, it could simply be that certain metabolic abnormalities put older women more at risk for functional decline than older men. Our findings indicate that this may be especially true for the obesity-associated components because sex interaction effects were most strong for those components.

Our prospective study provides convincing evidence that the metabolic syndrome has adverse health consequences beyond those of cardiovascular or diabetes outcomes. Because mobility limitation represents a stage early enough in the disablement process to be amenable to intervention, our findings raise the question whether intervening on the metabolic syndrome, especially its abdominal obesity and hyperglycemia components, prevents functional decline.

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Correspondence

Address correspondence to Brenda W. Penninx, PhD, EMGO Institute/Department of Psychiatry, VU University Medical Center, AJ Ernststraat 887, 1081 HL Amsterdam, The Netherlands. Email: b.penninx@vumc.nl

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