Published in final edited form as:
J Am Geriatr Soc. 2015 February ; 63(2): 222–232. doi:10.1111/jgs.13205.

Prevalence of Metabolic Syndrome and Its Association with Physical Capacity, Disability, and Self-Rated Health among Lifestyle Interventions and Independence for Elders (LIFE) Study Participants

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Conflict of Interest: The editor in chief has reviewed the conflict of interest checklist provided by the authors and has determined that the authors have no financial or any other kind of personal conflicts with this paper.

Authors' Contributions:
All authors meet the criteria for authorship stated in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals.
Botoseneanu, Gill: concept and design.
Ambrosius, Beavers: statistical analyses.
Botoseneanu, Gill, Ambrosius: interpretation of results.
Botoseneanu, Ambrosius, Gill: drafting the manuscript.
Gill, de Rekeneire, Anton, Church, Folta, Goodpaster, King, Spring: acquisition of data.
Botoseneanu, Gill, Ambrosius, Beavers, de Rekeneire, Anton, Church, Folta, Goodpaster, King, Nicklas, Spring, Wang: critical revision and finalizing of manuscript. All authors have approved the advanced version for publication.

Sponsor's Role: None

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Abstract

Objectives—To evaluate the prevalence of metabolic syndrome (MetS) and its association with physical capacity, disability, and self-rated health among older adults at high risk for mobility disability, including those with and without diabetes.

Design—Cross-sectional analysis.

Setting—Lifestyle Interventions and Independence for Elders (LIFE) Study.

Participants—1,535 community-dwelling sedentary adults aged 70–89 years old at high risk for mobility disability [short physical performance battery (SPPB) score ≤ 9; mean (SD) = 7.4 (1.6)].

Measurements—MetS was defined according to the 2009 multi-agency harmonized criteria; outcomes were physical capacity (400m walk time, grip strength, and SPPB score), disability (composite 19-item score), and self-rated health (5-point scale ranging from “excellent” to “poor”).

Results—The prevalence of MetS was 49.8% in the overall sample, and 83.2% and 38.1% among diabetics and non-diabetics, respectively. MetS was associated with greater grip strength [mean difference (kilograms) $\Delta = 1.2$, $p = .01$] in the overall sample and among participants without diabetes, and with poorer self-rated health ($\Delta = 0.1$, $p < .001$) in the overall sample only. No significant differences were found in the 400m walk time, SPPB score, and disability score between participants with and without MetS, in either the overall sample or diabetes subgroups.

Conclusion—Metabolic dysfunction is highly prevalent among older adults at risk for mobility disability, yet consistent associations were not observed between MetS and walking speed, lower extremity function, and self-reported disability after adjusting for known and potential confounders. Longitudinal studies are needed to investigate whether MetS accelerates declines in functional status in high-risk older adults and to inform clinical and public health interventions aimed at preventing or delaying disability in this group.

Keywords

metabolic syndrome; mobility disability; grip strength; short physical performance battery; self-rated health

INTRODUCTION

Preserving physical capacity and reducing disability are essential for maintaining independent living among older adults. Impairments in physical capacity have been linked with subsequent disability, hospitalization, nursing home admission, and mortality,[1–5] yet they represent an early enough stage in the disablement process to be amenable to restorative interventions. [6,7] Consequently, better identification of treatable risk factors for age-related loss in physical capacity, especially in older adults at high-risk for disability, is critical to efforts aimed at preventing disability.

Metabolic syndrome (MetS), defined as a clustering of risk factors for cardiovascular disease and type-2 diabetes, including abdominal obesity, dyslipidemia, hypertension, and impaired glucose tolerance, is increasingly prevalent among US adults ages 70 years and older.[8,9] Despite the ongoing controversy over the concept of MetS and questions about whether its components are additive,[10] several existing studies suggest an association between MetS and poorer self-reported and objectively-measured functional status in the general population of older adults.[11–14] However, the link between MetS and functional status, either self-reported or objectively measured, in older adults at high-risk for disability has not yet been assessed. Given the high prevalence of MetS in older adults and its potential treatability,[15] it is important to examine whether this clustering of risk factors may be associated with reduced physical capacity and increased disability in individuals at high-risk for disability.

In addition, numerous studies have documented the value of self-rated health (SRH), a subjective global assessment of an individual's own health status, as a predictor of future disability and loss of independent living among older adults. [16,17] SRH has been shown to capture a wide-range of health-related phenomena, including chronic diseases, perceived functional status, and metabolic and inflammatory abnormalities,[18–20] and to be a critical contributor to one's overall quality of life. Yet, few published studies have examined the association between MetS and SRH in the general population,[21] and no study (to our knowledge) has evaluated older persons at high-risk for disability; such studies are needed as a first step towards understanding whether the treatment of MetS components might improve SRH and quality of life in older adults.

The present study has two aims: (a) to ascertain the prevalence of MetS and its components in older adults at high-risk for disability, in the overall sample and separately in subgroups defined by age, gender, race, education, BMI category, and diabetes status; and (b) to evaluate the cross-sectional associations between MetS and physical capacity (walking speed, grip strength, and lower extremity function), disability, and SRH, in older adults at high-risk for disability. For the second aim, we hypothesized that participants with MetS would score more poorly on all outcomes (physical capacity, disability, and SRH) compared with participants without MetS. Describing the demographic distribution of MetS and its components and identifying the associations between MetS and precursors of disability among high-risk older adults may inform clinical and public health interventions aimed at maintaining functional status and reducing disability rates among older adults.

METHODS

Study Design and Participants

We used baseline data from the Lifestyle Interventions and Independence for Elders (LIFE) Study, a Phase 3 multi-center randomized controlled trial of 1,635 community-dwelling sedentary older adults at high-risk for mobility disability.[22] The primary goal of the LIFE Study was to compare the effects of a moderate-intensity physical activity (PA) program with a successful aging health education program on the incidence of major mobility disability (i.e., inability to walk 400 meters) in this vulnerable population of older adults.

Potential participants, aged 70 to 89 years old, were deemed eligible if they were (a) sedentary (i.e., defined as <20 minutes/week of structured physical activity in the past month and ≤125 minutes/week of moderate physical activity based on 18 items from the Community Healthy Activities Model Program for Seniors (CHAMPS) physical activity questionnaire);[23] (b) at high-risk for mobility disability based on objectively-assessed lower-extremity function (i.e., Short Physical Performance Battery (SPPB) score of 9 or less);[24] and (c) able to walk 400m in <15 min, unassisted, without sitting or leaning. The exclusion criteria were designed to identify persons who were likely incapable of fully-participating in the interventions because of comorbid conditions or cognitive impairment and those for whom PA would be unsafe. The study design, protocol, and inclusion/exclusion criteria have been described in detail elsewhere.[22]

For the present study, we excluded 100 participants for whom we could not ascertain MetS status because of missing data, resulting in an analytic sample of 1535 participants.

Measures

Physical Capacity, Disability, and SRH—Three measures of physical capacity were evaluated: 400m walk time, grip strength, and the SPPB score.

400m walk time represented the time (in seconds) that each participant needed to complete a 400m course, while walking at usual speed, without sitting, leaning, or the assistance of another person or a walker. In older adults, the 400m walk time has been associated with greater risk of mobility limitation, disability, and mortality,[25] serves as a proxy indicator for ability to walk within the community, and thus has emerged as an important health outcome.[26]

Grip strength, a commonly used measure of upper-body strength with predictive value for mortality and disability,[4,27] was measured in kilograms (kg) as the average of two maximal trials of the dominant hand (to the nearest 2 kg) with a JAMAR hand dynamometer (Lafayette Instrument Company, USA).

The *SPPB score*,[24] a highly reliable and responsive summary measure of lower-extremity function,[28] is comprised of three hierarchical timed tests of balance, 4-m usual pace walking, and repeated chair stands. For each test, a five-level summary scale from 0 (unable to perform the task) to 4 (best performance) was created according to established procedure.[24] An overall SPPB score (range: 0–12) was calculated for each participant by summing the scores on the three tests; higher scores indicate better performance. Individuals with SPPB scores greater than 9 were excluded from the study.

Disability was assessed with the previously validated Pepper Assessment Tool for Disability questionnaire.[29] The items covered 3 domains: (a) basic activities of daily living (ADL; moving in and out of a chair, moving in and out of a bed, gripping with hands, using toilet, dressing, getting in and out of a car, walking across a small room, and bathing); (b) mobility (walking several blocks, lifting heavy objects, walking one block, lifting or carrying 10 lbs, climbing several flights of stairs, climbing one flight of stairs, and walking a quarter of a mile); and (c) instrumental activities of daily living (IADL; light housework, participating in

community activities, managing money, visiting with relatives or friends, using the telephone, and taking care of a family member). Respondents were asked to report the level of difficulty with each item during the past month; responses were coded on a 5-point Likert scale, ranging from 1 (usually no difficulty) to 5 (unable to do), and the scores were averaged to generate a summary score, with higher mean scores denoting greater disability.

Self-rated health (SRH) was measured using the participants' ratings of their general health status,[30] as indicated by their response to the question: "Would you say your general health is…?"; the ratings ranged from 1 (excellent) to 5 (poor).

Metabolic Syndrome (MetS)—MetS was defined in accordance with the harmonized criteria recommended in the 2009 Joint Interim Statement from multiple scientific associations,[31] as the presence of 3 or more components from the following: (a) abdominal obesity (waist circumference ≥ 102 cm in men and ≥ 88 cm in women; waist circumference was measured at the midpoint between highest point of the iliac crest and lowest part of the costal margin in the mid-axillary line); (b) low HDL-cholesterol (< 40 mg/dl for men and < 50 mg/dl for women or drug treatment for low HDL); (c) elevated triglycerides (TG) (≥ 150 mg/dl or drug treatment for elevated TG); (d) hypertension (elevated blood pressure) (systolic pressure ≥ 130 and/or diastolic pressure ≥ 85 mm Hg or antihypertensive drug treatment with a history of physician-diagnosed elevated blood pressure); and (e) elevated fasting plasma glucose (≥ 100 mg/dl or drug treatment for diabetes). MetS was coded as a binary variable (absent/present).

Blood samples were collected after a 12-hour fast. All samples were tested in a single laboratory; prior to testing, all samples were stored and transferred according to protocol. Participants were asked to bring all current medications with them and a medication review was done at the phlebotomy visit.

Covariates

Comorbidities: Self-reported, physician-diagnosed diabetes (absent/present) was recorded for stratified analyses. A comorbidity index (range: 0–5) for other conditions was created by summing participants' reports of physician-diagnosed angina/myocardial infarction, congestive heart failure, stroke, and cancer (no/yes for all4 conditions), and peripheral arterial disease, as determined through measurement of ankle-brachial index (ABI). Peripheral arterial disease was coded as absent if ABI ≥ 0.9 and present if ABI < 0.9.[32]

Cognitive status was assessed with the Modified Mini-Mental State (3MS) examination,[33] with scores ranging from 0 to 100; higher scores indicate better cognitive function.

Health risk factors: Body-mass index (BMI) was calculated from measured weight and height [weight(kg)/height^2(m)]; physical activity level was assessed using the CHAMPS score (range:0–120);[23] smoking status (non-smoker vs. current smoker) and alcohol use (non-drinker, < 1 drink/day, or ≥1 drink/day) were also recorded at baseline.

Statistical Analysis

Descriptive statistics were calculated for all variables. The Cochran-Armitage trend tests and Chi-Square tests were used to compare proportions of MetS (and each component of MetS) between baseline subgroups. Linear models were used to compare participants with and without MetS in both unadjusted and adjusted models. The following covariates were used in the adjusted models: demographics (gender, race, education, age, field site), health status (comorbidity index, 3MSE), health risk factors (BMI category, CHAMPS score, smoking status, alcohol use), and diabetes (only for the overall sample models). Differences of adjusted means and confidence intervals were also calculated. These analyses were completed for the overall sample, as well as for subgroups defined on the basis of diabetes status. No explicit adjustment was made for multiple comparisons.

Because of earlier reports showing associations between either the severity of MetS or individual MetS components and several of the outcomes investigated here,[34–37] we performed additional analyses with MetS as an ordinal variable (to capture the severity of metabolic dysfunction as indicated by the number of MetS components identified in each participant) and separately with each MetS component. All secondary analyses were adjusted for the same set of covariates previously described for the main analyses.

RESULTS

Participants' demographic and health characteristics are described in Table 1, for the full sample, as well as separately for participants with and without MetS. As shown, 764 (49.8%) participants had 3 or more MetS components, thus fulfilling the requirements for MetS (i.e., MetS subgroup), while 771 (50.2%) had 2 or fewer components (i.e., non-MetS subgroup). The MetS and non-MetS subgroups were generally comparable on all characteristics except diabetes and obese BMI, both of which were substantially more common in the MetS subgroup.

Hypertension was the most common component among the MetS (93.2%) and the non-MetS (63.8%) subgroups, followed by abdominal obesity (92.7% and 52.8%); low HDL was the least common component in both subgroups: 42.8% and 2.2%. The majority (54.3%) of MetS participants met 3 metabolic criteria and 54.1% of non-MetS participants met 2 metabolic criteria.

Prevalence of Metabolic Syndrome and Individual Components

Table 2 presents the prevalence of MetS and individual MetS components according to selected participant characteristics.

MetS Prevalence: The prevalence of MetS was similar among men and women, as well as among Whites and non-Whites. Higher age and education were associated with progressively lower rates of MetS. As expected, the prevalence of MetS increased with higher BMI category and was substantially higher among participants with diabetes as compared with those without diabetes.

Individual MetS Components—Fasting glucose was the only metabolic risk factor that differed between men and women (more prevalent among men). Racial differences were identified only in the prevalence of elevated TG (higher among Whites) and hypertension (higher among non-Whites). Older age was associated with lower rates of all metabolic abnormalities except hypertension, while higher education was associated with lower rates of all criteria except high fasting glucose. The prevalence of each metabolic component increased as BMI increased and was higher among participants with diabetes compared with those without diabetes.

Associations between MetS and Physical Capacity, Disability, and SRH

The results from unadjusted analyses (shown in Table 3, for the full sample and separately according to MetS status) indicate that participants with MetS walked more slowly on the 400m walk test, and had higher disability scores and worse SRH than those without MetS. Grip strength, however, was significantly higher among participants with MetS compared with those without MetS. SPPB scores were similar in the two subgroups.

The mean estimated differences in all outcome scores from the unadjusted and adjusted models are presented in Table 4.

In the overall sample, MetS was associated with stronger grip strength, though the mean difference was diminished in the adjusted model (1.2, p= .01 adjusted vs. 1.6, p= .001 unadjusted). After adjustment for all covariates (listed in the footnote to Table 4), the associations of MetS with 400m walking speed and with the disability score were not statistically significant. MetS was not associated with the SPPB scores in the unadjusted or adjusted models. However, in both sets of models, the SRH scores were significantly worse (higher) in the presence of MetS.

Among participants with diabetes, there was no significant association between MetS and any of the physical capacity measures in either the unadjusted or adjusted analyses. The differences in disability and SRH scores observed among MetS diabetics compared with non-MetS diabetics became statistically non-significant after adjustment for the demographic and health covariates. Among participants without diabetes, MetS was associated with higher grip strength in both the unadjusted and adjusted models, but no association was observed between MetS and the remaining 4 outcomes in the adjusted models.

Secondary analyses (*data available upon request*) with MetS as an ordinal variable showed that SRH progressively worsened as the number of MetS components increased (b=0.04, p= .014), but the severity of MetS was not significantly associated with any of the other outcomes. Finally, separate analyses with each MetS component yielded only non-significant results for walking speed, grip strength, SPPB, and disability score. In the overall sample, all components with the exception of abdominal obesity (p= .86) were associated with worse SRH (p= .02 for TG, p= .02 for HDL, p= .01 for BP, and p < .001 for glucose); in analyses stratified by diabetes status, the only association that remained statistically significant was between low HDL and worse SRH among non-diabetics (p=.04).

DISCUSSION

This study offers three main findings. First, MetS was highly prevalent in this sample of adults aged 70 years or older who were at high risk for disability, being identified in one out of every two participants. Second, the prevalence of MetS and its components differed according to the participants' age, education, BMI, and diabetes status. Third, after adjustment for known and potential confounders, MetS was associated with better grip strength (in the overall sample and among participants without diabetes) and worse SRH (in the overall sample only), but not with walking speed, SPPB score, or self-reported disability.

Understanding the current demographic distribution of MetS and its components among older adults at risk for disability may help to tailor clinical and public health initiatives aimed at reducing old-age disability. In contrast to previous findings showing a higher prevalence of MetS and abdominal obesity among women (compared with men),[8,38–40] we found only a higher rate of glucose intolerance among men. The cardiometabolic profiles were otherwise comparable between men and women. Higher educational achievement was correlated with lower rates of MetS and all its components except elevated blood glucose. We also found an age-related decrease in the prevalence of MetS after age 70, from about 60% among participants younger than 75 years to about 30% among the oldest group (>85 years), with a decreasing prevalence of all MetS components with advancing age except for hypertension. The cross-sectional nature of our data precluded us from further investigating whether the observed association between older age and "better" metabolic profiles is due to true age differences (i.e., improvement in levels of metabolic markers with age), to differences between older and younger cohorts (i.e., worse metabolic profiles in younger cohorts), or to a healthy-survivor effect (i.e., "resilient" individuals with better metabolic profiles surviving longer than those with worse metabolic profiles). Although these findings on educational and age differences in the rates of MetS and its components are generally consistent with nationally-representative estimates from the National Health and Nutrition Examination Survey using the new harmonized MetS definition,[8] as well as with other studies that have investigated socio-demographic determinants of metabolic dysfunction,[41,42] more research, particularly using longitudinal data, is needed to better understand the mechanisms underlying such differences.

Previous investigations of the relationship between MetS and various objective indicators of physical capacity have focused on the general population of older adults, rather than on those at high risk for disability, with mixed results: while several studies have found poorer grip strength, walking speed, and balance among participants with MetS compared with those without MetS,[12–14] others have found no such associations.[35] The results from our sample of high-risk older adults show that the association with MetS varies across the three measures of physical capacity. First, walking speed was comparable among MetS and non-MetS participants in the adjusted model and separately in participants with and without diabetes, indicating that the difference in walking speed observed in the unadjusted model was due to other demographic and health differences between the MetS subgroups. Further, walking speed showed no associations with individual MetS components or with the severity of MetS. The relation between metabolic profiles and walking speed has been previously evaluated in women[43] or menonly[12] or in general-risk populations.[35] Because

these studies have reported conflicting results, further research is needed to substantiate our findings.

Second, in contradiction to our hypothesis and to results from several previous studies,[14,44] grip strength was higher in the overall MetS subgroup and among non-diabetic MetS participants. While we cannot fully explain this seemingly paradoxical finding, it is possible that the higher BMI in MetS participants (compared with non-MetS participants) was a reflection of not only a higher fat-mass (as indicated by the higher rates of abdominal obesity in the MetS group), but also of higher muscle mass compared with the non-MetS group, thus resulting in better grip strength. Although body-composition measures were not available for further analysis, this explanation is indirectly supported by a prior study showing that across all BMI categories, older persons with MetS had higher muscle mass compared with those who had similar BMI but no MetS.[45] Additional studies are warranted to confirm our finding and to investigate potential mechanisms linking MetS to upper-extremity muscle mass and grip strength.

Third, lower-extremity function as measured by the SPPB score was not associated with MetS across any of the models or subgroups. While these results may reflect a true lack of association between lower-extremity function and MetS, they may also represent a statistical artifact. Based on the eligibility criteria, LIFE participants were required to walk unassisted at a speed compatible with independent living (thus excluding those at the very low end of SPPB scores) and to also be at high risk for mobility disability as indicated by an SPPB score of 9 or less. By reducing variability across subgroups, the truncated range of SPPB scores in the resulting sample may have limited the ability to detect differences.

After adjustment for demographic and health characteristics, we found no differences in disability scores, which combined self-reports of mobility abilities and basic and instrumental activities of daily living, according to MetS status, in the full sample or among the diabetic or non-diabetic subgroups. The existing literature is also conflicting regarding the relation between MetS and self-reported functional status in the general older population: while some studies have shown an increased burden of mobility and IADL disability in the setting of MetS,[34,46] others have found no association[47] and even a protective effect of MetS on ADL disability.[44] Due to differences in the initial risk profile (i.e., high disability risk vs. general population) and disability assessment between our sample and samples from prior studies, our results cannot lend support to either side. Additional research is needed to further evaluate the cross-sectional and longitudinal association between potentially treatable metabolic abnormalities and various domains of disability in older adults.

In the overall sample, participants with MetS had marginally worse self-assessments of health compared with their non-MetS counterparts. This association also showed a gradient according to MetS severity and was independently associated with several MetS components in the overall sample and with low HDL among participants without diabetes. However, the clinical significance of these differences (the largest difference between MetS and non-MetS participants was 0.2 in the overall sample) is uncertain since the minimum and/or meaningful clinically important difference[48] in SRH has not been clearly established.

The value of MetS, above and beyond that of its individual components, as an independent predictor of other important health outcomes has been called into question.[10] Our study found non-significant associations between the MetS composite and walking speed, lower-extremity function, and self-reported disability, and between both individual MetS components and MetS severity and most outcomes (all except SRH). Although these results may reflect a true lack of association, two alternate explanations need to be considered. First, it is possible that the LIFE recruitment strategy, which excluded individuals at the high- and low-end of functional status, may have restricted the range of variation in these outcomes and thus reduced the power to detect statistically significant differences. Second, the non-significant effect of MetS on these and other outcomes may be due to selective survival; specifically, members of the cohort who were "susceptible" to the negative influence of MetS may have already died, thus resulting in a study population comprised of "MetS-resistant" individuals. The cross-sectional nature of our data prevented us from investigating the possibility of selection or survival bias. Longitudinal analyses are warranted to determine whether MetS is associated with reductions in physical capacity and increases in disability in later life. A third limitation of this study includes the use of a summary disability score: while the disability assessment instrument has been shown to be valid, reliable, and sensitive to change,[29] it may have obscured more subtle associations between MetS and selected functional domains (i.e., mobility, ADL, IADL) or tasks. Fourth, because the participants were enrolled in the LIFE Study, a randomized-controlled trial aimed at preventing mobility decline among older, sedentary men and women with an SPPB score of 9 or less, the results may not be generalizable to individuals who do not meet these criteria. Nonetheless, given that many older adults in the US are sedentary and have functional limitations, our results are likely to be representative of a substantial proportion of community-living older men and women.

In conclusion, although about half of older adults at risk for mobility disability participating in the LIFE trial have metabolic profiles consistent with MetS, an association between MetS and walking speed, lower extremity function, and self-reported disability remains to be established. Longitudinal studies are needed to investigate whether the metabolic dysregulation characterized by MetS accelerates declines in functional status over time. This knowledge may in turn inform clinical and public health interventions aimed at preventing or delaying disability in older adults.

Acknowledgments

Funding: The LIFE Study is funded by a National Institutes of Health/National Institute on Aging Cooperative Agreement # U01AG22376 and a supplement from the National Heart, Lung and Blood Institute (3U01AG022376). It is sponsored in part by the Intramural Research Program, National Institute on Aging, National Institutes of Health. Complete acknowledgments and funding information are shown in Appendix1 and are available at: https://www.thelifestudy.org/docs/LIFE-AcknowledgementList11_2014-02-17_Full%20List_clean.pdf

Dr. Botoseneanu was funded by grant # T32AG19134 from the National Institute on Aging.

Dr. Anton is supported by a K23AT004251, the Florida Claude D. Pepper Older Americans Independence Center (P30AG028740), and the Thomas H. Maren Foundation.

Dr. Spring was funded by grants HL075451 from the National Heart, Lung and Blood Institute and DK087126 from the National Institute of Diabetes, Digestive, and Kidney Disease.

Dr. Gill is the recipient of an Academic Leadership Award (K07AG043587) from the National Institute on Aging and is supported by the Yale Claude D. Pepper Older Americans Independence Center (P30AG21342).

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The Lifestyle Interventions and Independence for Elders Study is funded by a National Institutes of Health/National Institute on Aging Cooperative Agreement #U01AG22376 and a supplement from the National Heart, Lung and Blood Institute #U01AG022376-05A2S, and sponsored in part by the Intramural Research Program, National Institute on Aging, NIH.

The research is partially supported by the Claude D. Pepper Older Americans Independence Centers at the University of Florida (1P30AG028740), Tufts University (1P30AG031679), University of Pittsburgh (P30AG024827), and Yale University (P30AG021342), and the NIH/NCRRCTSA at Stanford University (UL1RR025744).

LIFE investigators are also partially supported by the following:

Dr. Thomas Gill (Yale University) is the recipient of an Academic Leadership Award (K07AG3587) from the National Institute on Aging.

Dr. Carlos Fragoso (Spirometry Reading Center, Yale University) is the recipient of a Career Development Award from the Department of Veterans Affairs.

Dr. Roger Fielding (Tufts University) is partially supported by the U. S. Department of Agriculture, under agreement No. 58-1950-7-707. Any opinions, findings, conclusion, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U. S. Dept of Agriculture.

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Table 1

Characteristics of Study Participants According to Metabolic Syndrome.

	Overall Sample N=1535	With Metabolic Syndrome N=764	Without Metabolic Syndrome N=771
Demographics			
Age in years, mean (SD)	78.9 (5.2)	77.9 (5.0)	79.8 (5.3)
Female, n (%)	1022 (66.6)	506 (66.2)	516 (66.9)
Non-White, n (%)	311 (20.3)	160 (21.0)	151 (19.7)
Education in years, n (%)			
Less than high-school (0–8 years)	41 (2.7)	26 (3.4)	15 (2.0)
High-school/equivalent (9–12 years)	455 (29.7)	261 (34.2)	194 (25.3)
College (13–16 years)	607 (39.6)	290 (38)	317 (41.3)
Post-graduate/Other (> 16 years)	428 (28.0)	187 (24.5)	241 (31.4)
Health Characteristics			
Diabetes diagnosis, n (%)	399 (26.1)	332 (43.6)	67 (8.7)
Body-mass index (BMI), mean (SD)	30.2 (6.1)	32.4 (5.9)	28.1 (5.5)
BMI category, n (%)			
< 18.5	7 (0.5)	1 (0.1)	6 (0.8)
18.5 to <25.0	278 (18.1)	46 (6.0)	232 (30.1)
25.0 to <30.0	542 (35.3)	239 (31.3)	303 (39.3)
≥ 30.0	708 (46.1)	478 (62.6)	230 (29.8)
Co-morbidities, mean (SD)	0.6 (0.8)	0.6 (0.8)	0.5 (0.7)
3MSE score, mean (SD)	91.7 (5.4)	91.6 (5.4)	91.7 (5.3)
CHAMPS score, mean (SD)	17.3 (33.2)	16.7 (33.1)	17.8 (33.3)
Current smoker, n (%)	46 (3.1)	16 (2.1)	30 (4.0)
Alcohol use, n (%)			
Non-user	932 (61.0)	509 (66.7)	423 (55.3)
< 1 drink/day	418 (27.4)	183 (24.0)	235 (30.7)
≥ 1 drink/day	178 (11.6)	71 (9.3)	107 (14.0)
Metabolic Syndrome Criteria[*], n (%)			
Abdominal Obesity	1109 (72.8)	707 (92.7)	402 (52.8)
Low HDL-C	338 (22.2)	321 (42.8)	17 (2.2)
High triglycerides	448 (29.5)	400 (53.5)	48 (6.2)
Hypertension	1204 (78.4)	712 (93.2)	492 (63.8)
High fasting glucose	775 (50.6)	634 (83.2)	141 (18.3)
Number of metabolic abnormalities			
Mean (SD)	2.5 (1.3)	3.6 (0.8)	1.4 (0.7)
Count, n (%)			
0	88 (5.7)		88 (11.4)
1	266 (17.3)		266 (34.5)
2	417 (27.2)		417 (54.1)
3	415 (27.0)	415 (54.3)	

	Overall Sample N=1535	With Metabolic Syndrome N=764	Without Metabolic Syndrome N=771
4	216 (14.1)	216 (28.3)	
5	133 (8.7)	133 (17.4)	

BMI = Body-Mass Index; 3MSE = Modified Mini-Mental Examination score (range 0–100; higher score indicates better cognitive function); CHAMPS = Community Healthy Activities Model Program for Seniors physical activity score (range 0–120; higher score indicates higher levels of physical activity); HDL-C = High-Density Lipoprotein Cholesterol.

Missing values account for the small discrepancies between total *n* (in each column) and the values listed under each descriptive characteristic.

* Abdominal obesity: waist circumference ≥ 102 cm in men and ≥ 88 cm in women; low HDL-C: < 40 mg/dl for men and < 50 mg/dl for women or drug treatment for low HDL; elevated triglycerides: ≥ 150 mg/dl or drug treatment for elevated triglycerides; hypertension: systolic pressure ≥ 130 and/or diastolic pressure ≥ 85 mm Hg or antihypertensive drug treatment with a history of physician-diagnosed hypertension; and elevated fasting plasma glucose: ≥ 100 mg/dl or drug treatment for diabetes. MetS defined as the presence of 3 or more criteria.

J Am Geriatr Soc. Author manuscript; available in PMC 2016 February 01.

Table 2

Prevalence of Metabolic Syndrome and Individual Components According to Selected Sample Characteristics (N=1535)*

	MetS (≥3 criteria) (%)	Abdominal Obesity (%)	Low HDL-C (%)	Elevated TG (%)	Hypertension (%)	High Fasting Glucose (%)
Age						
70 to <75 years	59.2	85.6	25.7	33.5	77.9	56.2
75 to <80 years	54.1	75.5	23.7	30.5	79.9	53.6
80 to <85 years	45.2	67.2	21.8	29.9	78.4	48.0
85 to ≤90 years	32.4	53.8	13.9	19.7	76.9	39.2
P-value	*<.001*	*<.001*	*.001*	*.001*	*.76*	*<.001*
Gender						
Female	49.5	74.3	22.1	29.5	79.1	47.3
Male	50.3	69.8	22.5	29.5	77.2	57.2
P-value	*.77*	*.07*	*.87*	*.97*	*.40*	*<.001*
Race						
Non-white	51.4	77.0	18.3	19.4	86.5	53.7
White	49.4	71.7	23.3	32.1	76.3	49.8
P-value	*.52*	*.06*	*.06*	*<.001*	*<.001*	*.22*
Education						
Less than high-school (0–8 years)	63.4	78.0	41.5	43.9	80.5	61.0
High-school/equivalent (9–12 years)	57.4	76.9	24.3	30.9	84.6	53.7
College (13–16 years)	47.8	70.9	21.1	30.2	76.6	48.6
Post-graduate/Other (> 16 years)	43.7	70.5	20.0	25.9	74.5	49.5
P-value	*<.001*	*.02*	*.01*	*.02*	*<.001*	*.09*
BMI category						
<18.5	14.3	0.0	14.3	14.3	85.7	28.6
18.5 to <25	16.5	14.5	13.7	17.4	64.4	29.2
25 to <30	44.1	69.3	20.4	27.8	78.4	47.6
≥30	67.5	98.7	27.1	35.7	83.9	61.4
P-value	*<.001*	*<.001*	*<.001*	*<.001*	*<.001*	*<.001*
Diabetes diagnosis						
No	38.1	68.8	18.2	26.4	76.2	35.2

	MetS (≥3 criteria) (%)	Abdominal Obesity (%)	Low HDL-C (%)	Elevated TG (%)	Hypertension (%)	High Fasting Glucose (%)
Yes	83.2	84.1	34.1	38.8	85.0	94.5
P-value	*<.001*	*<.001*	*<.001*	*<.001*	*<.001*	*<.001*

BMI = Body-Mass Index; HDL-C = High-Density Lipoprotein Cholesterol; TG = Triglycerides.

Chi-square tests were used when comparing two subgroups and the Cochran-Armitage trend tests were used for more than 2 subgroups.

* Abdominal obesity: waist circumference ≥ 102 cm in men and ≥ 88 cm in women; low HDL-C: < 40 mg/dl for men and < 50 mg/dl for women or drug treatment for low HDL; elevated triglycerides: ≥ 150 mg/dl or drug treatment for elevated triglycerides; hypertension: systolic pressure ≥ 130 and/or diastolic pressure ≥ 85 mm Hg or antihypertensive drug treatment with a history of physician-diagnosed hypertension; and elevated fasting plasma glucose: ≥ 100 mg/dl or drug treatment for diabetes.

Table 3

Physical Capacity, Disability Score, and Self-Rated Health According to Metabolic Syndrome.

	Overall Sample (N=1535)	With Metabolic Syndrome (N=764)	Without Metabolic Syndrome (N=771)	P-value*
Physical Capacity		Mean (standard deviation)		
400m walk time (sec.)	508.5 (113.7)	518.4 (115.8)	498.7 (110.8)	.001
Grip strength (kg.)	23.6 (9.4)	24.4 (9.9)	22.9 (8.8)	.002
SPPB score	7.38 (1.59)	7.35 (1.60)	7.40 (1.58)	.48
Disability score	1.40 (0.39)	1.43 (0.40)	1.37 (0.38)	.01
Self-rated health	2.76 (0.77)	2.87 (0.74)	2.64 (0.78)	<.001

Note: Short Physical Performance Battery (SPPB) score - range from 1 (low) to 9 (high); disability score - range from 1 (no difficulty reported) to 5 (unable to do tasks); self-rated health score - range from 1 (excellent) to 5 (poor).

*P-values for unadjusted differences in physical capacity measures, disability score, and self-rated health between participants with and without metabolic syndrome.

Table 4

Estimated Absolute Difference in Physical Capacity, Disability Score, and Self-Rated Health between Participants with and without Metabolic Syndrome, Stratified According to Diabetes.

	Overall Sample (N=1535)				Participants with Diabetes (N=399)				Participants without Diabetes (N=1129)			
	M_0		M_1		M_0		M_1		M_0		M_1	
	Δ (95% CI)	P-value	Δ (95% CI)	P-value	Δ (95% CI)	P-value	Δ (95% CI)	P-value	Δ (95% CI)	P-value	Δ (95% CI)	P-value
Physical Capacity												
400m walk time (sec.))	19.7 (8.3, 31.0)	<.001	10.6 (−2.1, 23.4)	.10	15.5 (−16.6, 47.5)	.34	13.8 (−20.0, 47.6)	.42	17.2 (4.0, 30.4)	.01	10.2 (−3.5, 23.9)	.14
Grip strength (kg.)	1.6 (0.6, 2.5)	.001	1.2 (0.3, 2.1)	.01	1.0 (−1.7, 3.6)	.47	1.4 (−0.9, 3.6)	.24	1.6 (0.4, 2.7)	.01	1.2 (0.3, 2.2)	.01
SPPB score	−0.1 (−0.2, 0.1)	.48	−0.02 (−0.2, 0.2)	.85	−0.2 (−0.6, 0.3)	.47	−0.1 (−0.6, 0.3)	.56	0.0 (−0.2, 0.2)	.73	0.0 (−0.2, 0.2)	.98
Disability Score	0.1 (0.01, 0.1)	.01	0.02 (−0.03, 0.1)	.51	0.1 (0.01, 0.2)	.04	0.1 (−0.04, 0.2)	.21	0.0 (−0.02, 0.1)	.28	0.0 (−0.05, 0.05)	.92
Self-Rated Health	0.2 (0.2, 0.3)	<.001	0.1 (0.01, 0.2)	<.001	0.2 (0.1, 0.4)	.01	0.2 (−0.01, 0.4)	.06	0.1 (0.01, 0.2)	.03	0.1 (−0.02, 0.2)	.11

Δ indicates mean estimated difference in scores between participants with and without MetS, i.e., [(mean estimate for MetS participants) minus (mean estimate for non-MetS participants)].

Short Physical Performance Battery (SPPB) score - range from 1 (low) to 9 (high); disability score - range from 1 (no difficulty reported) to 5 (unable to do tasks); self-rated health score - range from 1 (excellent) to 5 (poor).

M_0 is the unadjusted model; M_1 is the model adjusted for demographics (gender, race, education, age, field site), health status (comorbidity index, 3MSE), health risk factors (BMI category, CHAMPS score, smoking status, alcohol use), and diabetes (only for the overall sample).