MAYO CLINIC

ORIGINAL ARTICLE

Standing, Obesity, and Metabolic Syndrome: Findings From the Cooper Center Longitudinal Study

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Abstract

Objective: To examine the cross-sectional relationships between standing time, obesity, and metabolic syndrome alongside and independent of leisure-time physical activity (LTPA).

Participants and Methods: The primary study sample consisted of 7075 adult patients (aged 20-79 years) from Cooper Clinic (Dallas, Texas). In this cross-sectional study we assessed the associations between reported standing time and directly measured obesity (body mass index ≥30), elevated waist circumference (men: ≥102 cm; women: ≥88 cm), body fat percentage (men: ≥25%; women ≥30%), and metabolic syndrome (yes/no). In addition, the joint associations of standing and LTPA on each outcome were examined. Multivariable logistic regression adjusting for confounders was used for statistical analyses.

Results: Standing a quarter of the time or more was significantly associated with reduced odds of an elevated body fat percentage in men ($P<.001$) and a reduced likelihood of obesity ($P<.009$) and abdominal obesity ($P=.04$) in women. In addition, joint association analyses indicated that compared with the reference group (ie, not meeting the physical activity guidelines/standing almost none of the time), men and women who met the physical activity guidelines had lower odds of all obesity outcomes and metabolic syndrome with incremental additions of standing time (ie, a dose-response relationship).

Conclusion: Standing a quarter of the time per day or more is associated with reduced odds of obesity. The inverse relationship of standing to obesity and metabolic syndrome is more robust when combined with health-promoting LTPA. Prospective studies are warranted to confirm these findings and establish a causal relationship.

 ■ Mayo Clin Proc. 2015;■■(■):1-9

During the past several decades, there has been a major reduction in daily energy expenditure in developed and developing countries as a result of physical activity being "engineered" out of our lives through increased use of motorized transportation and a sedentary lifestyle at home and at work.[1] Recent analyses of US national time use data in women, for example, found a 25% increase in screen-based media use replacing light- to moderate-intensity household work.[2,3] Similarly, a study by Ng and Popkin[4] observed a decrease in total physical activity in the United States from 235 metabolic equivalent (MET) hours per week in 1965 to 160 MET hours per week in 2009 stemming from reduced occupational, domestic, and transportation-related physical activity; they projected additional decreases in activity through 2030. This decline in overall physical activity levels coupled with increased sedentary time (7.7 hours daily in the United States) and an abundance of available food has resulted in the high prevalence of obesity today.[5,6] Indeed, in 2011-2012, almost 35% of US adults were obese, which is a major independent risk factor for numerous chronic diseases (eg, type 2 diabetes, coronary heart disease, and some cancers) and premature death.[7]

Recent studies have specifically explored the effects of sedentary behavior (activities in a sitting or reclining posture requiring expending 1.0-1.5 times the resting metabolic rate) on obesity and other health outcomes, independent of physical activity.[8-11] Prolonged sedentary time has been linked to obesity and other chronic diseases and to mortality from all causes and from cardiovascular disease.[10] Thus, recent tools and interventions have specifically focused on assessing

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TABLE 1. Characteristics of the 7075 Study Participants by Standing Time Stratified by Sex: The Cooper Center Longitudinal Study 2010-2014

Characteristic	Men (n=4923) Standing time[a]					Women (n=2152) Standing time[a]				
	Almost none of the time (n=1360)	1/4 of the time (n=2923)	1/2 of the time (n=442)	≥3/4 of the time (n=198)	*P* value	Almost none of the time (n=398)	1/4 of the time (n=1002)	1/2 of the time (n=390)	≥3/4 of the time (n=362)	*P* value
Age (y), mean ± SD	49.2±9.3	51.0±9.7	51.1±10.3	50.4±12.0	.12	46.5±9.9	49.2±10.2	49.0±11.3	49.4±11.1	<.001
Physical activity guidelines (No. [%])[b]										
Not meeting	399 (29.3)	902 (30.9)	146 (33.0)	68 (34.3)		158 (39.7)	361 (36.0)	127 (32.6)	105 (29.0)	
Meeting	961 (70.7)	2021 (69.1)	296 (67.0)	130 (65.7)	.07	240 (60.3)	641 (64.0)	263 (67.4)	257 (71.0)	.001
Current smoker (No. (%])										
No	1241 (91.3)	2595 (88.8)	384 (86.9)	167 (84.3)		387 (97.2)	967 (96.5)	375 (96.2)	346 (95.6)	
Yes	119 (8.8)	328 (11.2)	58 (13.1)	31 (15.7)	<.001	11 (2.8)	35 (3.5)	15 (3.9)	16 (4.4)	.21
Obese (No. [%])[c]	342 (25.2)	651 (22.3)	113 (25.6)	42 (21.2)	.22	66 (16.6)	114 (11.4)	21 (5.4)	28 (7.7)	<.001
Elevated waist circumference (No. [%])[c]	299 (22.0)	597 (20.4)	98 (22.2)	38 (19.2)	.43	85 (21.4)	157 (15.7)	50 (12.8)	38 (10.5)	<.001
Elevated body fat percentage (No. [%])[c]	241 (34.0)	387 (26.0)	48 (22.5)	23 (25.8)	<.001	64 (31.1)	126 (25.5)	46 (22.0)	41 (22.2)	.02
Metabolic syndrome (No. [%])[d]	293 (21.5)	648 (22.2)	95 (21.5)	38 (19.2)	.89	40 (10.1)	74 (7.4)	27 (6.9)	20 (5.5)	.02

[a]Standing was based on responses to the following survey question: "For those activities that you do most days of the week (such as work, school, and housework), how much time do you spend standing? Almost all of the time; approximately three-quarters of the time; approximately half of the time; approximately one-quarter of the time; almost none of the time." For analysis, the categories "almost all of the time" and "about three-quarters of the time" were combined.

[b]Physical activity was based on responses to a survey gauging the frequency, duration, and intensity of leisure-time physical activities; resultant metabolic equivalent (MET) minutes per week were divided into the following 2 categories based on the US Department of Health and Human Services Physical Activity Guidelines: (1) not meeting the guidelines (<500 METs) and (2) meeting/exceeding the guidelines (≥500 METs).

[c]Obese was defined as a body mass index of at least 30; elevated waist circumference, at least 102 cm for men and at least 88 cm for women; and elevated body fat percentage (n=2502 for men; n=1094 for women), at least 25% for men and at least 30% for women.

[d]Metabolic syndrome was defined as meeting at least 3 of the following criteria: (1) an elevated waist circumference (≥102 cm for men or ≥88 cm for women), (2) an elevated level of triglycerides (≥150 mg/dL [to convert to mmol/L, multiply by 0.0113]), (3) a personal history of hypertension or measured blood pressure of at least 130 mm Hg systolic or at least 85 mm Hg diastolic, (4) a personal history of diabetes or a fasting glucose level of at least 100 mg/dL (to convert to mmol/L, multiply by 0.0555), and (5) an abnormal high-density lipoprotein cholesterol level less than 40 mg/dL (to convert to mmol/L, multiply by 0.0259) for men or less than 50 mg/dL (to convert to mmol/L, multiply by 0.0259) or women.