Television Viewing Is Associated With Prevalence of Metabolic Syndrome in Hispanic Elders

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OBJECTIVE — We examined associations between television viewing and prevalence of the metabolic syndrome among a representative sample of Caribbean-origin Hispanic elders living in Massachusetts.

RESEARCH DESIGN AND METHODS — We conducted a cross-sectional analysis of 350 Puerto Rican and 105 Dominican elders (≥60 years). Information on television viewing hours was collected by a questionnaire. The metabolic syndrome was defined by using the definition from the National Cholesterol Education Program.

RESULTS — Prevalences for the metabolic syndrome were 50.1 and 56.9% among Puerto Ricans and Dominicans, respectively. Of the subjects, 82.6% had high blood pressure and 61.4% had high fasting glucose. Prevalence of the syndrome was significantly associated with television viewing. Each additional hour of television viewing was associated with a 19% greater likelihood of having the metabolic syndrome (odds ratio [OR] 1.19, 95% CI 1.1–1.3, *P* for trend 0.002), after adjusting for age, sex, ethnicity, BMI, education, alcohol use, smoking, household arrangement, physical activity, intake of energy and fat, and activities-of-daily-living score. We did not observe significant interactions of television viewing with sex, smoking status, alcohol use, or BMI (*P* for interaction >0.15 for all) in relation to presence of the metabolic syndrome.

CONCLUSIONS — A high prevalence of the metabolic syndrome in a representative sample of Caribbean-origin Hispanic elders was associated with prolonged television viewing, independent of physical activity and energy intake. Longitudinal studies are needed to clarify the causality of this relationship.

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The metabolic syndrome is a cluster of abnormalities that tend to occur together in some individuals. These include abdominal obesity, insulin resistance, glucose intolerance, dyslipidemia, and high blood pressure (1). This syndrome is associated with diabetes, cardiovascular disease, and mortality (2). It is prevalent, with up to 25% of adults and >40% of elders affected in the U.S. (3–5). Mexican Americans have been shown to have a higher prevalence of the syndrome relative to the general population (4). However, little information is available for other Hispanic subgroups. We have shown previously that hypertension, obesity, and diabetes were prevalent among Puerto Rican and Dominican elders living in Massachusetts (6,7).

Prolonged television viewing, a major sedentary behavior in the U.S., has been identified as a risk factor for diabetes and obesity (8–10) and has been associated with components of the metabolic syndrome (9–12). Television viewing may be associated with low physical activity and high energy intake. It may also contribute to the metabolic syndrome through associated poor eating habits (13). It has been suggested that television viewing is associated with lower metabolic rate than other sitting activities, such as reading (14). Recently, several studies showed positive associations between television viewing and the metabolic syndrome (15–17). However, most participants in these studies were non-Hispanic whites. Because the metabolic syndrome is more prevalent in Hispanic groups than in the general population, it is of considerable importance to identify potential modifiable risk factors in this group. We, therefore, hypothesized that prolonged television viewing time would be associated with risk of the metabolic syndrome among a representative sample of Puerto Rican and Dominican elders living in Massachusetts.

RESEARCH DESIGN AND METHODS

— The sampling and design for this study have been described elsewhere (6,18). To obtain a representative sample of Hispanic elders in Massachusetts, we used Census data in a two-stage method with sampling proportionate to size (19). First, counties were allowed to randomly fall into the sample, proportionate to the size of the Hispanic population. Within these selected counties, we randomly sampled census blocks where at least two Hispanic elders, aged ≥55 years, were reported in 1990. Subjects were then located through door-to-door enumeration. Return visits to the block were made up to three times, including evening and weekend visits, to complete information from a randomly selected starting household through the last household with an identified subject. This methodology was designed to minimize any potential design effect and to avoid the need for sampling weights.

In total, 940 eligible Hispanics were located and invited to participate, and 779 (471 Puerto Ricans, 143 Dominicans,

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Abbreviations: ADL, activities of daily living; IDF, International Diabetes Federation; NHANES, National Health and Nutrition Examination Survey.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

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and 165 of other origin) completed interviews between 1993 and 1997. In the present study, we included only the two largest Hispanic subgroups, Puerto Ricans and Dominicans. More than 90% of Puerto Ricans and 86% of Dominicans invited agreed to participate. Hispanics of other origin were not included, due to small numbers in diverse groups. Approximately 75% of subjects (350 Puerto Ricans and 105 Dominicans) had available data on both television viewing and fasting plasma measurements for the current analyses. Subjects without blood data had similar sex distribution, education level, smoking status, and alcohol use as subjects with blood data. The institutional review board of Tufts University/New England Medical Center approved the protocol, and subjects gave written informed consent before participating.

Field data collection

Information on television viewing hours was collected by asking subjects to report the average number of hours they spent per day watching television in the past week. Similar methods have been used previously (8,15,16). Physical activity was estimated with a modified version of the Harvard Alumni Physical Activity Questionnaire. Participants were asked for the number of hours per day (mean of a regular weekday and a regular weekend day) spent sleeping, sitting, and engaged in light, moderate, and heavy (vigorous) activities. The time spent in each of these activity categories was multiplied by the weighting factors 1.0, 1.1, 1.5, 2.4, and 5.0, respectively, and then summed to create a physical activity score (7,20). The cutoff score of 29 was considered conservative for sedentary activity, assuming 8 h of sleep, 8 h of sitting, and 8 h of light activity (7).

According to the Adult Treatment Panel III (ATP III) report (1), the presence of three or more of the following criteria define the metabolic syndrome: *1*) abdominal obesity, waist circumference >102 cm in men or >88 cm in women; *2*) hypertriglyceridemia, plasma triacylglycerol ≥1.7 mmol/l (150 mg/dl); *3*) low HDL cholesterol, <1.04 mmol/l (40 mg/dl) in men or <1.30 mmol/l (50 mg/dl) in women; *4*) high blood pressure, ≥130/85 mmHg, or currently using antihypertensive medication; and *5*) high fasting glucose, ≥5.55 mmol/l (100 mg/dl), or current use of medications for diabetes (insulin or oral medicines). The International Diabetes Federation (IDF) recently proposed a new definition for the metabolic syndrome that is the same as the Adult Treatment Panel III, with the exception that ethnic group specific cutoff points for waist circumference are used (21). For Central and South Americans, the IDF proposed cutoff points of ≥90 cm in men or ≥80 cm in women for waist circumference (21). In the present study, we use the Adult Treatment Panel III definition as a primary analysis but also report the prevalence of the metabolic syndrome based on the IDF definition.

Blood pressure, body weight, and height were measured in duplicate by trained fieldworkers. BMI was calculated as weight (kg)/height (m^2). BMI ≥30 kg/m^2 was defined as obesity. Waist circumference was measured to the nearest tenth of a centimeter, with a nonstretchable measuring tape held at the level of the smallest area of the waist. We measured hip circumference at the level of the maximal protrusion of the gluteal muscles (hips). The position was verified by passing the tape measure above and below the observed maximum. Waist-to-hip ratio was calculated as waist circumference (cm)/hip (cm). Cutoff points of 0.90 cm in men or 0.85 cm in women were used in our study because they have been shown to relate to the presence of type 2 diabetes, hypertension, and dyslipidemia in Hispanic adults (22).

Fasting (12-h) blood samples were drawn and collected in tubes containing 0.15% EDTA and centrifuged at 2,500*g* for 20 min at 4°C to separate plasma. Plasma total cholesterol, triacylglycerol, and HDL cholesterol were measured by enzymatic methods with an automated analyzer (CCX analyzer; Abbott Diagnostics Spectrum, Irving, TX) and Abbott enzymatic reagents. Blood glucose was analyzed with the hexokinase enzymatic method (Sigma, St. Louis, MO). Plasma total cholesterol–to–HDL cholesterol ratios >4.5 were considered high.

Dietary intake was assessed with a semiquantitative food frequency questionnaire adapted and validated for use with this population (23). Current alcohol use was calculated from the food frequency questionnaire and then was categorized as moderate (up to one drink/day for women and up to two drinks/day for men) and heavy (greater than these intakes), based on 13.2 g alcohol/drink. Use of medication was assessed in the home by obtaining medication packaging. Information on age (years), household arrangement, education (years), and smoking (current, former, and never) was collected by questionnaire. Functional status was assessed with a 12-item activities-of-daily-living (ADL) questionnaire with a total score of 36 (6). Subjects with a score of 0 were defined as having "no disability," 1–5 as "some disability," and 6–36 as "considerable disability" (6).

Statistical analysis

Statistical analyses were completed with SAS version 8.1 (SAS Institute, Cary, NC). Subjects were divided into quartile categories of television viewing time. Means were compared using the General Linear Models procedure in SAS, with Dunnett adjustment for multiple comparisons (the lowest quartile as reference). Logistic regression was used to test differences in prevalence across quartiles and to calculate odds ratios (ORs) and 95% CIs. Analyses were adjusted for age (years), sex, ethnicity, BMI (kg/m^2), education (years), household arrangement (married/lives with spouse, unmarried/lives with others, and unmarried/lives alone), smoking (current, former, and never), current alcohol use (heavy drinker: more than one drink/day for women or two drinks/day for men; moderate drinker: less than these; and nondrinker, based on 13.2 g alcohol/drink), physical activity (by quartiles), total energy intake (MJ/day), saturated fat intake (% total energy), polyunsaturated fat intake (% total energy), trans fat intake (% total energy), fruit and vegetable intake (servings/day), and ADL score. They were selected as potential confounders that may be associated with both television viewing pattern and risk of metabolic syndrome. To avoid the influence of outliers, linear trends were tested for significance by assigning each subject the median of television viewing hours for the quartile, i.e., 1, 2, 4, and 7 h/day for quartiles 1–4, respectively. We treated these median values as a continuous variable in the regression model and calculated the OR associated with each additional hour of television viewing, as done in previous studies (8,11,18).

Because earlier evidence has suggested that sex might be an effect modifier for the association between television viewing and metabolic syndrome, we examined interactions of television viewing with sex. We also examined interaction of television viewing with other important risk factors of the metabolic syndrome, including current smoking status (yes/no), current alcohol use (yes/no), and

Table 1—*Characteristics and dietary intake by quartile of television viewing time*

	Television viewing time by quartile (h/day)			
	1 [1.0 (0–1.5)]*	2 [2.0 (1.6–3.4)]	3 [4.0 (3.5–5.5)]	4 [7.0 (5.6–18.0)]
n	93	148	100	114
Age (years)	69.5 ± 7.3	68.9 ± 7.3	68.8 ± 7.0	68.0 ± 6.9
Female	60.0	51.3	62.0	68.4
BMI (kg/m^2)	27.8 ± 6.3	27.7 ± 4.8	28.4 ± 5.3	28.5 ± 6.0
Education (years)	4.3 ± 4.8	5.0 ± 4.2	4.4 ± 3.5	4.4 ± 3.7
Puerto Rican	75.3	79.0	75.0	77.2
Smoking				
Never smoker	54.8	41.9	42.0	44.7
Former	31.2	44.6	44.0	32.5
Current	14.0	13.5	14.0	22.8
Alcohol use†				
Non-drinker	85.7	76.1	76.0	76.6
Moderate	12.1	20.3	18.8	21.6
Heavy	2.2	3.6	5.2	1.8
Household arrangement				
Married/lives with spouse	23.7	32.4	39.0‡	41.2§
Unmarried/lives with others	41.9	25.7‡	34.0	33.3
Unmarried/lives alone	34.4	41.9	27.0	25.5
Physical activity score	29.4 ± 3.1	29.8 ± 3.3	29.3 ± 2.5	27.7 ± 2.2‖
ADL score	5.8 ± 7.6	4.0 ± 5.5	3.7 ± 5.8	5.7 ± 7.0
Energy intake (MJ/day)	7.8 ± 3.2	7.1 ± 2.7	7.3 ± 3.6	6.9 ± 2.7
Total fat intake (% total energy)	31.6 ± 5.1	30.5 ± 5.7	29.9 ± 5.8	30.6 ± 5.6
Saturated fat intake (% total energy)	10.0 ± 2.5	9.7 ± 3.1	9.0 ± 2.7‡	10.1 ± 2.9
Polyunsaturated fat intake (% total energy)	9.2 ± 2.4	8.8 ± 2.3	9.3 ± 2.4	8.5 ± 2.4
Trans fat intake (% total energy)	1.2 ± 0.6	1.0 ± 0.6	0.9 ± 0.5§	1.1 ± 0.6

Data are means ± SD or percent. *Median (range) (hours/day). †Moderate: up to one drink/day for women and up to two drinks/day for men; heavy: greater than these intakes. Based on 13.2 g of alcohol/drink. ‡$P < 0.05$, §$P < 0.01$, and ‖$P < 0.001$ compared with lowest quartile, adjusted for age.

obesity (BMI <30 vs. ≥30 kg/m^2), to determine if there was different risk associated with categories of these variables. To test significance for interaction, we included multiplicative terms in the logistic regression models, with adjustment for other potential confounders.

RESULTS — There was a sevenfold difference in median television viewing hours between the highest and lowest quartiles of the population (Table 1). Those who were married and living with a spouse spent more time watching television than other subgroups. Those in the highest television viewing category were more likely to have a low physical activity score relative to those watching less television.

Prevalences for the metabolic syndrome were 50.1 and 56.9% among Puerto Ricans and Dominicans, respectively, according to the Adult Treatment Panel III definition. Prevalences of individual metabolic abnormalities were 44.2% for abdominal obesity, 41.8% for hypertriglyceridemia, 35.6% for low HDL, 82.6% for high blood pressure, and 61.4% for high fasting glucose. Among subjects with the metabolic syndrome, 56% self-reported diabetes, 72.8% hypertension, and 27.6% heart disease; 34.6% reported use of diabetes medications, 72.7% of diuretics or cardiovascular medications, and 67.1% of other antihypertensive drugs.

More frequent television viewing was associated with a higher prevalence of the syndrome (Fig. 1*A*) and of number of individual metabolic abnormalities (Fig. 1*B*) (*P* for trend <0.01 for both). Subjects in the highest quartile of television watching had a risk for the metabolic syndrome 2.2 times (OR 2.2, 95% CI 1.1–4.2) that for those in the lowest quartile, after adjusting for age, sex, ethnicity, BMI, education, alcohol use, smoking, and household arrangement. Each additional hour per day of television viewing was associated with a 16% greater likelihood of having the metabolic syndrome (OR 1.16, 95% CI 1.1–1.3, *P* for trend = 0.004). With further adjustment for physical activity, total energy intake, dietary intake of saturated fatty acids, polyunsaturated fatty acids, and trans fatty acids, the OR for the metabolic syndrome with each hour of television viewing remained significant. Further adjustment for the ADL score produced a similar result (OR 1.19, 95% CI 1.1–1.3, *P* for trend = 0.002). Excluding subjects with ADL scores >5, i.e., considerable limitation, did not change the associations materially (OR 1.16, 95% CI 1.0–1.3, *P* for trend = 0.03).

When we used the IDF definition of metabolic syndrome, the prevalences increased to 53.2 and 60.6% among Puerto Ricans and Dominicans, respectively, and the association between television viewing and the syndrome remained significant. The OR for each additional hour per day of television viewing was 1.21 (95% CI 1.1–1.4, *P* = 0.0008), after adjusting for ADL and other potential confounders.

Greater television viewing was associated with greater risk of high waist-to-hip ratio, low HDL cholesterol, high total–to–HDL cholesterol ratio, and high blood pressure, after adjusting for age, sex, eth-

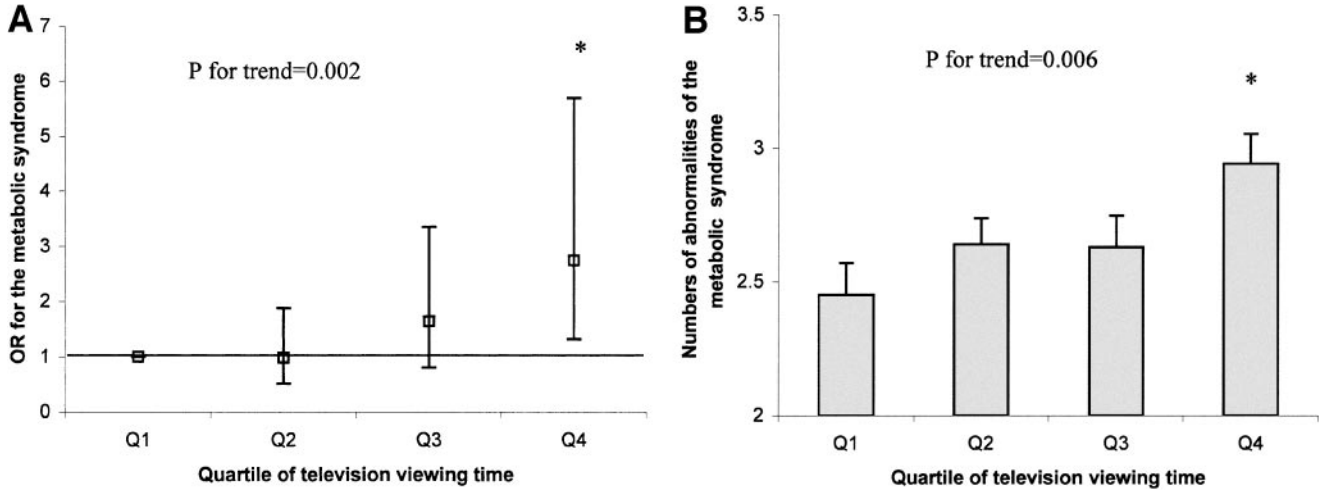

Figure 1—*Television viewing and relative likelihood (ORs and 95% CI) of the metabolic syndrome* (A) *and number of individual abnormalities of the metabolic syndrome* (B)*, adjusted for age (years), sex, ethnicity, education (years), BMI, household arrangement (married/lives with spouse, unmarried/lives with others, and unmarried/lives alone), smoking (current, former, and never), current alcohol use (heavy drinker: more than one drink/day for women or two drinks/day for men; moderate drinker: less than these; and nondrinker, based on 13.2 g alcohol/drink), total energy intake (MJ/day), saturated fat intake (% total energy), polyunsaturated fat intake (% total energy), trans fat intake (% total energy), fruit and vegetable intake (servings/day), physical activity score (in quartiles), and ADL score.* *$P < 0.05$*, relative to the lowest quartile.*

nicity, BMI, education, alcohol use, smoking, and household arrangement (Table 2). However, with the exception of low HDL, high total–to–HDL cholesterol ratio, and high waist-to-hip ratio, further control for physical activity and for energy and fat intakes attenuated those relationships to nonsignificance. Further adjustment for ADL score did not change the results.

As expected, metabolic syndrome was significantly associated with time

Table 2—***Likelihood of individual metabolic abnormalities and risk factors of the metabolic syndrome among Hispanic elders by quartile of television viewing time***

	Quartiles of television viewing time (h/day)						
	1 [1.0 (0–1.5)]*	2 [2.0 (1.6–3.4)]	3 [4.0 (3.5–5.5)]	4 [7.0 (5.6–18.0)]	P_{trend}†	P_{trend}‡	P_{trend}§
	Individual metabolic abnormalities of the metabolic syndrome						
Abdominal obesity (%)	40.9	36.6	45.9	56.3			
OR (95% CI)§	1	1.2 (0.4–3.0)	1.5 (0.7–3.6)	2.2 (0.8–5.9)	0.06	0.12	0.10
Hypertriglyceridemia (%)	33.3	43.2	42.0	46.5			
OR (95% CI)§	1	1.5 (0.9–2.8)	1.4 (0.7–2.6)	1.7 (0.9–3.2)	>0.2	>0.2	>0.2
Low HDL cholesterol (%)	32.3	27.0	39.0	50.0			
OR (95% CI)§	1	0.9 (0.4–2.0)	1.2 (0.5–2.7)	2.5 (1.0–5.9)‖	0.02	0.02	0.01
High blood pressure (%)	76.6	80.5	82.9	88.5			
OR (95% CI)†	1	1.4 (0.7–3.1)	1.4 (0.6–3.3)	2.5 (1.0–6.0)‖	0.04	0.09	0.09
High fasting glucose (%)	50.4	49.3	50.0	51.8			
OR (95% CI)†	1	1.1 (0.6–1.9)	1.3 (0.7–2.4)	1.5 (0.8–2.9)	0.14	>0.2	0.15
	Risk factors for the metabolic syndrome						
High total–to–HDL cholesterol ratio (%)	40.9	46.0	47.0	56.1			
OR (95% CI)†	1	1.2 (0.7–2.1)	1.3 (0.7–2.4)	2.0 (1.1–3.7)‖	0.01	0.03	0.04
High waist-to-hip ratio (%)	67.7	74.3	79.6	82.9			
OR (95% CI)†	1	1.6 (0.8–3.1)	2.3 (1.1–4.8)‖	3.9 (1.8–8.4)#	0.0003	0.0008	0.0006
High BMI (%)	29.0	32.0	32.7	36.0			
OR (95% CI)†	1	1.2 (0.6–2.4)	1.4 (0.7–2.7)	1.4 (0.7–2.8)	>0.2	>0.2	>0.2

Abdominal obesity, waist circumference >102 cm in men or >88 cm in women; hypertriglyceridemia, plasma triacylglycerol ≥1.7 mmol/l (150 mg/dl); low HDL cholesterol, <1.04 mmol/l (40 mg/dl) in men or <1.30 mmol/l (50 mg/dl) in women; high blood pressure, ≥130/85 mmHg, or current use of antihypertensive medication; and high fasting glucose, ≥5.55 mmol/l (100 mg/dl), or current use of medications for diabetes (insulin or oral medicines). Cutoff points for risk factors are: plasma total–to–HDL cholesterol ratio >4.5; waist-to-hip ratio >0.90 in men or >0.85 in women; BMI ≥30 kg/m^2. *Median (range) (hours/day). †Adjusted for age (years), sex, ethnicity, BMI (except for abdominal obesity, high waist-to-hip ratio, and high BMI), education (years), household arrangement (married/lives with spouse, unmarried/lives with others, and unmarried/lives alone), smoking (current, former, and never), and current alcohol use (heavy drinker: more than one drink/day for women or two drinks/day for men, moderate drinker: less than these, and nondrinker, based on 13.2 g alcohol/drink). ‡Additionally adjusted for total energy intake (MJ/day), saturated fat intake (% total energy), polyunsaturated fat intake (% total energy), trans fat intake (% total energy), fruit and vegetable intake (servings/day), and physical activity score (in quartiles). §Additionally adjusted for activities of daily living score. ‖$P < 0.05$ and #$P < 0.01$, relative to the lowest quartile.

spent doing moderate or vigorous activities (OR for each additional hour/day 0.82, 95% CI 0.7–1.0, *P* for trend = 0.02), after adjusting for age, sex, ethnicity, BMI, education, alcohol use, smoking, household arrangement, total energy intake, and fat intake. With further adjustment for television viewing, this association was attenuated slightly (OR 0.85, 95% CI 0.7–1.0, *P* for trend = 0.049).

We did not observe significant interactions of television viewing with sex, smoking status, alcohol use, or BMI (*P* for interaction >0.15 for all), in relation to presence of the metabolic syndrome.

CONCLUSIONS — We observed a high prevalence of the metabolic syndrome in a representative sample of Puerto Rican and Dominican adults aged ≥60 years. More than 50% of this group had the metabolic syndrome. These results are higher than national estimates for adults aged ≥60 years (4,24). In the Third National Health and Nutrition Examination Survey (NHANES III) and NHANES 1999–2000, 40–50% Americans aged ≥60 years had the metabolic syndrome (5). Moreover, >80 and 60% of subjects in the present study had high blood pressure or high fasting glucose, respectively, relative to 30–40% observed in NHANES 1999–2000 (5).

Subjects with greater television viewing time were significantly more likely to have the syndrome. These findings are important because the metabolic syndrome is a large and growing public health problem. People with the metabolic syndrome have been estimated to be two and three times as likely to develop cardiovascular disease and type 2 diabetes, respectively, compared with subjects who do not have the syndrome (2). Our findings suggest that each additional hour of television viewing was associated with a 19% greater risk for the metabolic syndrome. These findings are consistent with findings in previous studies. In NHANES 1999–2000, Ford et al. (15) reported that the adjusted OR for having the metabolic syndrome was 2.1 for adults (≥20 years) watching television for ≥4 h/day compared with individuals watching ≤1 h/day. Similar positive associations were seen in populations of Australian (aged ≥35 years) (16) and French adults (aged ≥50 years) (17).

Sex was not a significant effect modifier for the associations between television viewing and the metabolic syndrome in the present study (*P* for interaction = 0.42), whereas previous studies reported that associations were stronger in women than in men (15–17). In a subgroup analysis stratified by sex, we saw effect sizes (ORs) of 2.9 for men and 2.3 for women, for highest versus lowest television viewing. However, our population was aged ≥60 years, relative to other studies including both premenopausal and postmenopausal women. Therefore, the possible role of menopausal status in the association between sedentary behavior and the metabolic syndrome in younger women needs further study.

There are several potential mechanisms for the relationship between television viewing and the metabolic syndrome. Some studies suggest that television viewing may be associated with greater intakes of energy, meat, sweets, and soft drinks and with lower intakes of fruit and vegetables (13,25,26). However, most of these observations were made among children and adolescents. We did not find associations between television viewing and either energy or fat intake in this group of older adults. Greater television viewing has also been associated with physical inactivity (27–32). The highest quartile of television viewing in our sample did have significantly lower mean physical activity scores relative to participants in the lowest quartile. Adjustment for physical activity attenuated the association between some metabolic syndrome components and television viewing, although the association with metabolic syndrome per se did not change.

These associations may also be mediated through abdominal obesity. The association of waist-to-hip ratio with television viewing was significant after adjustment for dietary intake and physical activity, consistent with this interpretation, and with previous observations (9). Television viewing has been shown to be associated with lower metabolic rate than other sedentary activities such as reading, writing, or driving a car, and therefore may contribute directly to weight gain (14). One prospective study showed that high waist-to-hip ratio led to a significantly greater risk for development of the metabolic syndrome, after adjustment for covariates and after 8 years of follow-up (33). Interestingly, in a French population, Bertrais et al. (17) found that television viewing, but not reading, was associated with higher prevalence of the metabolic syndrome.

We also observed that greater television viewing time was significantly associated with low HDL cholesterol, independent of physical activity, dietary intake, and ADL score. These observations are consistent with other studies (9,10,17). Abdominal obesity could contribute to this association. Several studies reported an inverse association between waist-to-hip ratio and plasma HDL cholesterol (34,35). Additional adjustment for waist-to-hip ratio attenuated the associations between television viewing and low HDL cholesterol, but it remained significant (*P* = 0.04). This suggests an alternative mechanism underlying the associations.

Our study has several limitations. Although our door-to-door enumeration was carefully done, it remains possible that our sample may include more individuals who tend to be at home than those who are frequently away from home. However, because of the older age of our target population, we do not believe this is a large problem in this sample, and we believe that it represents Hispanic elders in Massachusetts well. Our study is also limited by its cross-sectional design. Causal relationships between television viewing and increased risk for the metabolic syndrome cannot be inferred. It is possible that subjects with the metabolic syndrome spent more time viewing television because their activities were limited by the syndrome. However, the relationship between television viewing and the metabolic syndrome remained significant after additional adjustment for ADL score, which was used to measure functional status. It remains possible, though, that ADL may not be sufficiently sensitive to detect all deficiencies in vitality and physical and mental well-being (related to the syndrome) that may dispose people toward television viewing.

Some studies have suggested that appropriate cutoff points for waist circumference for Hispanics may be lower than the current recommendation, which is based on non-Hispanic white populations (22,36), whereas the recommended cutoff point for waist-to-hip ratio remains similar among ethnic groups (22). We saw inconsistent associations of television viewing with waist circumference and with waist-to-hip ratio. We obtained similar nonsignificant results when we used the cutoff points for waist circumference recommended for a Mexican population (90 cm for men and 85 cm for women) (22) or for Central Americans (90 cm for men and 80 cm for women), as recommended by the IDF (21). However, the

IDF cutoff points were based on studies conducted primarily among South Asians (21). Further studies are needed to determine an appropriate cutoff point for waist circumference in the Puerto Rican and Dominican populations.

In summary, in a representative sample of Caribbean origin Hispanic elders, we observed a clear and significant relationship between television viewing and risk for metabolic syndrome, independent of physical activity and energy intake. Further studies are needed to explore potential mechanisms underlying these associations.

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References

1. Grundy SM, Brewer HB Jr, Cleeman JI, Smith SC Jr, Lenfant C: Definition of metabolic syndrome: Report of the National Heart, Lung, and Blood Institute/American Heart Association Conference on Scientific Issues Related to Definition. *Circulation* 109:433–438, 2004
2. Ford ES: Risks for all-cause mortality, cardiovascular disease, and diabetes associated with the metabolic syndrome: a summary of the evidence. *Diabetes Care* 28:1769–1778, 2005
3. Park YW, Zhu S, Palaniappan L, Heshka S, Carnethon MR, Heymsfield SB: The metabolic syndrome: prevalence and associated risk factor findings in the US population from the Third National Health and Nutrition Examination Survey, 1988–1994. *Arch Intern Med* 163: 427–436, 2003
4. Ford ES, Giles WH, Dietz WH: Prevalence of the metabolic syndrome among US adults: findings from the Third National Health and Nutrition Examination Survey. *JAMA* 287:356–359, 2002
5. Ford ES, Giles WH, Mokdad AH: Increasing prevalence of the metabolic syndrome among US adults. *Diabetes Care* 27:2444–2449, 2004
6. Tucker KL, Falcon LM, Bianchi LA, Cacho E, Bermudez OI: Self-reported prevalence and health correlates of functional limitation among Massachusetts elderly Puerto Ricans, Dominicans, and non-Hispanic white neighborhood comparison group. *J Gerontol A Biol Sci Med Sci* 55:M90–M97, 2000
7. Tucker KL, Bermudez OI, Castaneda C: Type 2 diabetes is prevalent and poorly controlled among Hispanic elders of Caribbean origin. *Am J Public Health* 90: 1288–1293, 2000
8. Hu FB, Li TY, Colditz GA, Willett WC, Manson JE: Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA* 289:1785–1791, 2003
9. Kronenberg F, Pereira MA, Schmitz MK, Arnett DK, Evenson KR, Crapo RO, Jensen RL, Burke GL, Sholinsky P, Ellison RC, Hunt SC: Influence of leisure time physical activity and television watching on atherosclerosis risk factors in the NHLBI Family Heart Study. *Atherosclerosis* 153:433–443, 2000
10. Jakes RW, Day NE, Khaw KT, Luben R, Oakes S, Welch A, Bingham S, Wareham NJ: Television viewing and low participation in vigorous recreation are independently associated with obesity and markers of cardiovascular disease risk: EPIC-Norfolk population-based study. *Eur J Clin Nutr* 57:1089–1096, 2003
11. Fung TT, Hu FB, Yu J, Chu NF, Spiegelman D, Tofler GH, Willett WC, Rimm EB: Leisure-time physical activity, television watching, and plasma biomarkers of obesity and cardiovascular disease risk. *Am J Epidemiol* 152:1171–1178, 2000
12. Tucker LA, Bagwell M: Relationship between serum cholesterol levels and television viewing in 11,947 employed adults. *Am J Health Promot* 6:437–442, 1992
13. Stroebele N, de Castro JM: Television viewing is associated with an increase in meal frequency in humans. *Appetite* 42: 111–113, 2004
14. Ainsworth BE, Haskell WL, Leon AS, Jacobs DR Jr, Montoye HJ, Sallis JF, Paffenbarger RS Jr: Compendium of physical activities: classification of energy costs of human physical activities. *Med Sci Sports Exerc* 25:71–80, 1993
15. Ford ES, Kohl HW 3rd, Mokdad AH, Ajani UA: Sedentary behavior, physical activity, and the metabolic syndrome among US adults. *Obes Res* 13:608–614, 2005
16. Dunstan DW, Salmon J, Owen N, Armstrong T, Zimmet PZ, Welborn TA, Cameron AJ, Dwyer T, Jolley D, Shaw JE: Associations of TV viewing and physical activity with the metabolic syndrome in Australian adults. *Diabetologia* 48:2254–2261, 2005
17. Bertrais S, Beyeme-Ondoua JP, Czernichow S, Galan P, Hercberg S, Oppert JM: Sedentary behaviors, physical activity, and metabolic syndrome in middle-aged French subjects. *Obes Res* 13:936–944, 2005
18. Gao X, Bermudez OI, Tucker KL: Plasma C-reactive protein and homocysteine concentrations are related to frequent fruit and vegetable intake in Hispanic and non-Hispanic white elders. *J Nutr* 134: 913–918, 2004
19. Lemeshow S, Levy PS: *Sampling for Health Professionals*. Belmont, CA, Lifetime Learning Publications, 1980
20. Kannel WB, Sorlie P: Some health benefits of physical activity: the Framingham Study. *Arch Intern Med* 139:857–861, 1979
21. Alberti KG, Zimmet P, Shaw J: Metabolic syndrome: a new world-wide definition: a consensus statement from the International Diabetes Federation. *Diabet Med* 23:469–480, 2006
22. Berber A, Gomez-Santos R, Fanghanel G, Sanchez-Reyes L: Anthropometric indexes in the prediction of type 2 diabetes mellitus, hypertension and dyslipidaemia in a Mexican population. *Int J Obes Relat Metab Disord* 25:1794–1799, 2001
23. Tucker KL, Bianchi LA, Maras J, Bermudez OI: Adaptation of a food frequency questionnaire to assess diets of Puerto Rican and non-Hispanic adults. *Am J Epidemiol* 148:507–518, 1998
24. Ford ES: Prevalence of the metabolic syndrome in US populations. *Endocrinol Metab Clin North Am* 33:333–350, 2004
25. Phillips SM, Bandini LG, Naumova EN, Cyr H, Colclough S, Dietz WH, Must A: Energy-dense snack food intake in adolescence: longitudinal relationship to weight and fatness. *Obes Res* 12:461–472, 2004
26. Lowry R, Wechsler H, Galuska DA, Fulton JE, Kann L: Television viewing and its associations with overweight, sedentary lifestyle, and insufficient consumption of fruits and vegetables among US high school students: differences by race, ethnicity, and gender. *J Sch Health* 72:413–421, 2002
27. Panagiotakos DB, Pitsavos C, Chrysohoou C, Skoumas J, Tousoulis D, Toutouza M, Toutouzas P, Stefanadis C: Impact of lifestyle habits on the prevalence of the metabolic syndrome among Greek adults from the ATTICA study. *Am Heart J* 147: 106–112, 2004
28. Laaksonen DE, Lakka HM, Salonen JT, Niskanen LK, Rauramaa R, Lakka TA: Low levels of leisure-time physical activity and cardiorespiratory fitness predict development of the metabolic syndrome. *Diabetes Care* 25:1612–1618, 2002
29. Stewart KJ, Bacher AC, Turner K, Lim JG, Hees PS, Shapiro EP, Tayback M, Ouyang P: Exercise and risk factors associated with metabolic syndrome in older adults. *Am J Prev Med* 28:9–18, 2005
30. Nakanishi N, Takatorige T, Suzuki K: Daily life activity and risk of developing cardiovascular risk factors. *Diabetes Care* 28:1500–1502, 2005
31. Lakka TA, Laaksonen DE, Lakka HM, Mannikko N, Niskanen LK, Rauramaa R, Salonen JT: Sedentary lifestyle, poor cardiorespiratory fitness, and the metabolic syndrome. *Med Sci Sports Exerc* 35:

1279–1286, 2003
32. LaMonte MJ, Barlow CE, Jurca R, Kampert JB, Church TS, Blair SN: Cardiorespiratory fitness is inversely associated with the incidence of metabolic syndrome: a prospective study of men and women. *Circulation* 112:505–512, 2005
33. Han TS, Williams K, Sattar N, Hunt KJ, Lean ME, Haffner SM: Analysis of obesity and hyperinsulinemia in the development of metabolic syndrome: San Antonio Heart Study. *Obes Res* 10:923–931, 2002
34. Mansfield E, McPherson R, Koski KG: Diet and waist-to-hip ratio: important predictors of lipoprotein levels in sedentary and active young men with no evidence of cardiovascular disease. *J Am Diet Assoc* 99:1373–1379, 1999
35. Crowther NJ, Ferris WF, Ojwang PJ, Rheeder P: The effect of abdominal obesity on insulin sensitivity and serum lipid and cytokine concentrations in African women. *Clin Endocrinol (Oxf)* 64:535–541, 2006
36. Zhu S, Heymsfield SB, Toyoshima H, Wang Z, Pietrobelli A, Heshka S: Race-ethnicity-specific waist circumference cutoffs for identifying cardiovascular disease risk factors. *Am J Clin Nutr* 81:409–415, 2005