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Socio-economic status and abdominal obesity among Finnish adults from 1992 to 2002

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Objective: To examine 10-year changes in waist circumference (WC) and identify socio-economic groups having higher WC than expected by their body mass index (BMI).
Design: Population based cross-sectional surveys carried out in four regions of Finland in 1992, 1997 and 2002.
Subjects: A total of 9026 women and 8173 men, aged 25–64 years.
Measurements: Waist circumference, BMI, socio-economic indicators (education, household income, employment status, marital status) and health behaviors (smoking, alcohol use, physical activity).
Results: In 2002, women had about 2.7 cm and men about 1.0 cm higher WC than subjects 10 years previously. Waist circumference increased more than BMI among women, especially among unemployed women. Higher WC among non-employed women was not explained by socio-economic indicators or health behaviors. Among men, smaller WC was associated with lower socio-economic status. However, associations partly disappeared after adjustment for health behaviors including physical activity at work.
Conclusion: Socio-economic patterning of WC is divergent and gender-specific. More attention should be paid to increasing waistlines among women.
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Keywords: waist circumference; socio-economic indicators; employment; health behaviors

Introduction

Numerous studies from various populations have reported increasing body mass index (BMI)[1] and increasing waist circumference (WC)[2–4] during the past decades. Moreover, it seems that WC indicating abdominal obesity is increasing even more rapidly than BMI,[5–7] and increasing waistlines or abdominal obesity are observed not only among the obese but also among normal weight subjects.[3,8,9] These are alarming findings, as high WC is even more strongly associated with mortality,[10,11] metabolic abnormalities[12,13] and health-care costs[14] than BMI. There is an urgent need to develop public health strategies for early identification and prevention of abdominal obesity,[8] and therefore we need to be able to identify population groups at risk for increasing waistlines.

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It is well known that obesity measured by BMI is inversely associated with socio-economic status in affluent societies, especially among women.[15] Previous studies have also shown that educational level,[3,5,16–18] occupational status[17–19] and income level[17] are inversely associated with WC, especially among women. Moreover, being unemployed,[5,16] retired[18] or a house wife[5] is associated with higher WC, and unemployed women have even larger WC than expected by their BMI.[16]

A recent review revealed that weight gain among non-black populations is more common among those with low occupational status; less strong evidence is found for educational level and inconsistent findings for income.[20] However, little is known about socio-economic characteristics of population groups with increasing waistlines, but overall, there seems to be a greater increase in WC in women.[4,6,7] One study reported that there appears to be more consistent increase in WC with deprivation for both sexes,[5] whereas another showed the greatest increase in waistline among most highly educated women.[3]

Data on socio-economic characteristics of those with abdominal obesity are thus limited and results are usually

presented separately for BMI and WC. Although WC and BMI are highly correlated,[3] they measure different aspects of obesity. Body mass index is a measure of relative body size, whereas WC provides a measure of abdominal adiposity. In this study, we aimed to identify socio-economic groups that have larger WC than expected by their BMI. Secondly, we aimed to study whether findings can be explained by health-related habits that have previously shown to be associated with abdominal obesity including smoking,[3,5,21–23] alcohol consumption[16,18,24] and physical activity.[16,22,23,25] Finally, we aimed to identify socio-economic groups with the highest increase in waistline from 1992 to 2002.

Materials and methods

Participants

The data were collected from three cross-sectional population-based surveys carried out in four regions in Finland (North Karelia and Kuopio provinces; Helsinki capital area; and southwestern Finland including the cities of Turku and Loimaa together with their nearby rural municipalities) in 1992, 1997 and 2002. For each survey, an independent stratified random sample of population aged 25–64 years was drawn from the population register. Less than 1% of the questionnaires sent were returned because of incomplete contact information illustrating the high quality of the Finnish population registration system. The study was conducted according to the international WHO MONICA (MONItoring trends and determinants in CArdiovascular disease) study protocol[26] and followed the ethical guidelines of the Finnish National Public Health Institute and the Helsinki Declaration. Together, the three surveys included 9026 women and 8173 men. The response rates among men were 73% in 1992, 68% in 1997 and 65% in 2002; corresponding rates for women were 81, 76 and 76%. Pregnant women ($n = 289$) were excluded from the analysis.

Measurements

Subjects were invited to a local municipal health-care center, where weight, height and WC were measured according to the WHO MONICA study protocol by a specially trained research nurse. Weight and height were measured without shoes and in light clothing. Body mass index was calculated as weight in kilograms (kg) divided by the square of height in meters (m). Waist circumference was measured at the level of midway between the lower rib margin and the iliac crest. The measures of weight were rounded to the nearest 100 g and the measures of height and WC to the nearest 0.5 cm.

Along with the invitation to participate in the survey, a self-administered questionnaire was sent to the subjects to be completed at home in advantage. The questionnaire covered questions on socio-economic factors and lifestyle. We used educational level, household income, employment status and living with a spouse as measures of socio-economic status. Smoking status, consumption of alcohol, leisure time physical activity and physical activity at work were used as health behavioral indicators.

Educational level was asked using four preset alternatives on educational attainment and categorized into three groups: (1) basic level education only; (2) secondary level education including vocational training and matriculation examination and (3) university level education.

Employment status was asked with seven preset alternatives and categorized into four groups: (1) employed; (2) unemployed (those not working but looking for a job); (3) non-employed (those outside workforce, including homemakers and students) and (4) retired.

Household income was asked using nine fixed alternatives and divided into tertiles in each survey.

Marital status was categorized into (1) living with a spouse (including married and co-habiting subjects) and (2) others (including singles, divorced and widow(er)s).

Smoking status was asked by three separate questions about past and current smoking and categorized into three groups: (1) current regular smokers; (2) former regular smokers and (3) never smokers.

The consumption of alcohol was estimated by asking how many bottles of beer, glasses of wine and portions of strong alcoholic drinks a subject had consumed during the past week. Responses were categorized according to the criteria of the US National Institute on Alcohol Abuse and Alcoholism (www.niaaa.nih.gov) into (1) abstainers (no alcohol), (2) light drinkers (1–2 drinks per week), (3) moderate drinkers (4–14 drinks per week for men and 4–7 drinks for women) and heavy drinkers (more than 14 drinks per week for men and more than seven drinks for women).

Physical activity at leisure time was defined to be at least 20–30 min of activity that makes one at least slightly breathless and sweating. Subjects were asked how frequently they engage in this type of activity with six preset alternatives. Responses were categorized into three groups: (1) at least twice per week; (2) from two to three times per month and (3) a few times per year or less.

Physical activity at work was asked using four preset alternatives: (1) light work with only occasional walking; (2) work with moderate physical activity but mostly walking (no lifting or carrying heavy objects); (3) work with moderate physical activity with walking, climbing stairs or lifting objects and (4) heavy physical work.

Statistical analyses

Statistical analyses were carried out by ordinary linear regression model with WC as the dependent variable. All analyses were conducted separately for women and men. The modeling was carried out by the Stata statistical package.[27]

In the statistical modeling, firstly, the results for each socio-economic and health behavioral variables are presented after adjusting for study year, study area and age by including them as covariates in the model. Because the

association between age and WC was nonlinear, age was included in all models both as a linear variable and as a categorized variable classified into 5-year groups. This model (Model 1) illustrates the level of WC in each category of the socio-economic and health behavioral variables compared to their reference category in centimeters.

Secondly, BMI was included into the model as an independent variable (Model 2). This model illustrates how WC differs in each category of the socio-economic and health behavioral variables from the reference category after the differences in BMI between the categories were adjusted for.

Thirdly, it was studied whether these differences in the residuals of WC based on Model 2 could be explained by other socio-economic variables by adjusting the model for living with a spouse, education, employment status and household income. This had only minor effect on the results (data not shown). We continued by adjusting the model for health behavioral variables including smoking status, alcohol consumption, leisure time physical activity and physical activity at work simultaneously (Model 3).

Finally, the interactions between study year and socio-economic indicators were analyzed to find out whether the 10-year change in WC has been similar in different socio-economic groups. Analyses were conducted by adding an interaction term of study year and a socio-economic variable, that is, living with a spouse, education, employment status or household incomes in tertiles, as classified variables and comparing the χ^2-value and degrees of freedom of this model to the model with only the main effects of study year and the socio-economic indicator. In the interaction models, age, study area and BMI were adjusted for.

Results

Subject characteristics are presented in Table 1. Mean BMIs and WCs were slightly higher in the 2002 cohort than in previous cohorts, especially among women. Educational level was higher in the 2002 cohort than in previous cohorts among both women and men. There was a drop in the proportion of employed subjects in 1997 owing to high unemployment, but this attenuated by 2002. There were no differences in mean age and proportion of married subjects between the survey years. The proportion of never smokers fell slightly among women and the proportion of abstainers among both women and men. Light, moderate and heavy drinking was more common among women in 2002 than 10 years previously whereas among men only heavy drinking increased. Weekly leisure time physical activity was somewhat more common in 2002 than 10 years earlier, especially in women, with no changes in the physical activity at work.

The associations between WC and socio-economic indicators are presented in Table 2. As the first model shows, compared to men and women in 1992, subjects in 2002 had higher waistlines. In 2002, men had about 0.8 cm and women about 2.8 cm larger WC than their counterparts in 1992. Among men, however, results became statistically nonsignificant when BMI and socio-economic and health behavior variables were included in the model. Contrary to men, in women the mean waistlines remained significantly higher even after adjusting for BMI, socio-economic factors and health behaviors.

Education was inversely associated with WC in the first models for both genders, but in women this association disappeared when BMI was added into the model. Among men, the association between WC and education became positive when BMI was adjusted for, that is, men with higher education had higher WC compared with less educated men. This finding remained when other socio-economic factors were adjusted for (data not shown), but became nonsignificant when health behaviors were added into the model.

Non-employed men had smaller WC than employed men in all models. Compared with men being employed, retired men had higher WC in the first model and after adjustments for BMI, but results became insignificant after full adjustments. In women, employment status was clearly associated with WC: employed women had smaller WC than unemployed, non-employed and retired women in all models.

Household income was not associated with WC among men. Women in the lowest income category had higher WC than women in the highest income category, but the results became nonsignificant when BMI was added into the model.

Living with a spouse was not associated with WC in any of the models.

For both men and women, current smoking was associated with smaller WC compared to former smokers and never smokers. Compared to those who had not used alcohol during previous week, men reporting heavy drinking had higher WC, whereas light and modest drinking was associated with smaller WC in both genders. However, the results for light and moderate drinkers became nonsignificant when BMI and other variables were added into the model. Heavy drinking was associated with higher WC after adjustments for BMI and other variables among both women and men. Physical inactivity at leisure time was clearly associated with high WC in all models. Among men, physical activity at work was also associated with smaller WC in all models. Data on women showed inconsistent results: compared with light activity at work, moderate physical activity without lifting was associated with lower WC in the base models, whereas moderate physical activity with lifting was associated with higher WC in the first model and in the fully adjusted model.

We also tested whether menopausal status and hormone replacement therapy had an influence on WC by additionally adjusting for them after adjustments for BMI. As menopausal status and hormone replacement did not have an effect on the results (data not shown), these were not included in the final models.

There was an interaction between employment status and study year among women when BMI, age and study area

Table 1 Subject characteristics by survey year among men and women

	Men			*Women*		
	1992	*1997*	*2002*	*1992*	*1997*	*2002*
BMI (kg/m^2)[a]	26.7 (26.5–26.8)	26.9 (26.8–27.1)	27.1 (26.9–27.3)	25.9 (25.7–26.0)	26.1 (25.9–26.2)	26.2 (26.0–26.4)
Waist circumference (cm)[a]	94.3 (93.9–94.7)	94.5 (94.0–94.9)	95.3 (94.8–95.8)	80.6 (80.1–81.0)	81.1 (80.7–81.6)	83.3 (82.8–83.8)
Age (years)	45	46	46	45	45	45
Education (%)						
University level	11	12	19	10	12	20
Secondary level	47	57	56	45	61	61
Basic level	43	31	25	45	27	19
Employment status (%)						
Employed	75	67	74	70	65	71
Unemployed	5	12	9	4	11	7
Non-employed	3	4	3	10	11	10
Retired	17	17	14	16	13	12
Household incomes (%)						
Highest tertile	32	35	35	28	31	30
Intermediate tertile	37	30	32	34	30	31
Lowest tertile	31	35	33	38	39	39
Living with a spouse (%)						
Yes	78	74	75	72	71	71
No	22	26	25	28	29	29
Smoking status (%)						
Never smoker	39	41	41	66	64	61
Former smoker	31	33	30	17	19	21
Current smoker	30	26	29	17	17	18
Average consumption of alcohol in previous week (%)						
Men/women						
No alcohol	29	26	24	48	41	36
Light	15	14	15	24	26	27
Moderate	40	41	39	17	20	22
Heavy	16	19	22	11	13	15
Leisure time physical exercise (%)						
$\geqslant$2 times per week	48	54	52	49	57	58
2–4 times per month	32	31	32	34	30	31
A few times per year or less	20	15	16	17	13	11
Physical activity at work (%)						
Light	47	51	47	51	51	51
Moderate (no lifting)	23	19	22	29	29	29
Moderate (includes lifting)	22	21	22	19	18	18
Heavy	8	9	9	1	2	2

Abbreviaton: BMI, body mass index. [a]Means with 95% confidence intervals.

were adjusted for ($P=0.04$). Compared to women in 1992, women in 2002 had higher WC in all employment groups from 1092 to 2002, with the greatest increase among the unemployed (Table 3). No other interactions between study year and the socio-economic indicators were found.

Discussion

Our study revealed gender-specific results and divergent trends in increasing waistlines in Finland. Compared to women in 1992, women in 2002 had significantly higher waistlines, whereas among men BMI-adjusted results were even slightly smaller in 1997 than in 1992. Socio-economic patterning of WC was also clearly gender-specific. Men with low education or not working had smaller WC than could be expected by their BMI, whereas women who were out of labor market had higher WC, and unemployment among women was associated with most increase in waistlines. In addition, although health behaviors changed significantly during the study period and they were significantly associated with WC in both women and men, they

Table 2 The association between waist circumference and socio-economic indicators in men and women (regression coefficients (β) with 95% confidence intervals)

	Men			*Women*		
	Model 1	*Model 2*	*Model 3*	*Model 1*	*Model 2*	*Model 3*
Study year						
1992	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1997	0.08 (−0.49, 0.65)	−0.48 (−0.73, −0.23)	−0.47 (−0.73, −0.22)	0.52 (−0.05, 1.10)	0.00 (−0.25, 0.25)	−0.02 (−0.27, 0.23)
2002	0.75 (0.16, 1.34)	−0.18 (−0.44, 0.08)	−0.14 (−0.41, 0.12)	2.83 (2.25, 3.42)	2.01 (1.75, 2.27)	1.97 (1.71, 2.23)
Education[a]						
University level	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Secondary level	1.80 (1.06, 2.54)	−0.24 (−0.57, 0.09)	−0.16 (−0.51, 0.19)	2.25 (1.53. 2.98)	−0.07 (−0.38, 0.25)	−0.21 (−0.53, 0.11)
Basic level	2.71 (1.89, 3.53)	−0.43 (−0.80, −0.07)	−0.31 (−0.71, 0.10)	4.76 (3.93, 5.58)	0.05 (−0.33, 0.43)	−0.17 (−0.55, 0.22)
Employment status[a]						
Employed	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Unemployed	−0.04 (−0.92, 0.83)	0.21 (−0.18, 0.59)	−0.14 (−0.59, 0.30)	2.37 (1.40, 3.33)	0.71 (0.29, 1.14)	0.79 (0.34, 1.25)
Non-employed	−2.79 (−4.21, −1.37)	−1.00 (−1.62, −0.37)	−1.00 (−1.66, −0.35)	1.22 (0.41, 2.04)	0.58 (0.22, 0.94)	0.71 (0.34, 1.08)
Retired	0.94 (0.19, 1.70)	−0.01 (−0.34, 0.33)	−0.24 (−0.64, −0.16)	3.20 (2.40, 4.00)	0.46 (0.10, 0.82)	0.55 (0.15, 0.95)
Household incomes[a]						
Highest tertile	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Intermediate tertile	−0.05 (−0.64, 0.54)	−0.20 (−0.46, 0.06)	−0.06 (−0.33, 0.22)	0.97 (0.35, 1.59)	−0.16 (−0.44, 0.11)	−0.17 (−0.44, 0.11)
Lowest tertile	−0.10 (−0.70, 0.50)	−0.35 (−0.61, −0.09)	−0.28 (−0.61, 0.05)	1.87 (1.28, 2.47)	−0.25 (−0.57, 0.07)	−0.25 (−0.58, 0.07)
Living with a spouse[a]						
Yes	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
No	−0.49 (−1.05, 0.08)	−0.12 (−0.37, 0.13)	−0.04 (−0.32, 0.24)	−0.38 (−0.91, 0.16)	−0.04 (−0.31, 0.24)	−0.11 (−0.39, 0.16)
Smoking status[a]						
Current smoker	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Former smoker	3.12 (2.55, 3.68)	0.67 (0.42, 0.92)	0.62 (0.37, 0.88)	2.29 (1.68, 2.91)	0.85 (0.59, 1.12)	0.79 (0.52, 1.06)
Never smoker	0.56 (−0.03, 1.14)	1.02 (0.76, 1.27)	0.74 (0.46, 1.01)	1.17 (0.51, 1.82)	1.11 (0.83, 1.38)	0.95 (0.66, 1.24)
Average consumption of alcohol in previous week[a]						
No alcohol	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Light	−1.34 (−2.13, −0.56)	−0.01 (−0.35, 0.34)	0.04 (−0.43, 0.21)	−2.02 (−2.62, −1.42)	−0.15 (−0.40, 0.11)	−0.11 (−0.37, 0.15)
Moderate	−0.88 (−1.48, −0.28)	0.19 (−0.07, 0.45)	0.13 (−0.14, 0.40)	−1.57 (−2.23, −0.90)	−0.06 (−0.23, 0.34)	0.02 (−0.27, 0.31)
Heavy	1.57 (0.84, 2.29)	1.30 (0.98, 1.62)	1.06 (0.73, 1.39)	−0.39 (−1.17, 0.40)	1.02 (0.69, 1.36)	0.79 (0.45, 1.14)
Leisure time physical exercise[a]						
⩾2 times per week	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
2–4 times per month	1.90 (1.36, 2.43)	1.18 (0.94, 1.41)	1.16 (0.92, 1.41)	1.96 (1.43, 2.50)	0.40 (0.17, 0.63)	0.40 (0.17, 0.63)
A few times per year or less	2.83 (2.16, 3.50)	1.47 (1.18, 1.76)	1.42 (1.11, 1.72)	3.45 (2.73, 4.17)	0.67 (0.36, 0.97)	0.54 (0.22, 0.86)
Physical activity at work[a]						
Light	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Moderate (no lifting)	−0.35 (−0.98, 0.28)	−0.38 (−0.66, −0.10)	−0.55 (−0.85, −0.24)	−1.24 (−1.80, −0.68)	−0.24 (−0.48, 0.00)	−0.01 (−0.27, 0.25)
Moderate (includes lifting)	−1.05 (−1.68, −0.42)	−0.71 (−0.98, −0.43)	−0.94 (−1.26, −0.62)	1.08 (0.43, 1.74)	0.14 (−0.14, 0.42)	0.40 (0.09, 0.72)
Heavy	0.07 (−0.80, 0.94)	−0.68 (−1.06, −0.29)	−0.81 (−1.23, −0.40)	1.15 (−0.71, 3.01)	−0.35 (−1.14, 0.44)	−0.05 (−0.87, 0.78)

Model 1 = age and study center. Model 2 = Model 1+body mass index. Model 3 = Model 2+living with a spouse+education+employment status+household incomes+smoking status+average consumption of ethanol in previous week+leisure time physical activity+physical activity at work. [a]All models are additionally adjusted for study year.

generally failed to explain found differences, especially among women.

In keeping with other studies,[5–7] our cross-sectional study confirms that waistlines are increasing more rapidly than BMI. However, we found this among women only, whereas some others have reported increasing waistlines for both genders[5,6] or somewhat greater increase among adolescent girls than boys.[7] Moreover, our results for women remained

Table 3 Interaction effect between employment status and year on waist circumference, regression coefficients (β) with 95% confidence intervals, models are adjusted for age, study center and body mass index

	1992	*1997*	*2002*
Men			
Employed	0.00	−0.66 (−0.96, −0.36)	−0.30 (−0.60, 0.01)
Unemployed	−0.12 (−0.93, 0.69)	−0.32 (−0.88, 0.23)	0.02 (−0.67, 0.72)
Non-employed	−0.92 (−1.98, 0.14)	−1.61 (−2.59, −0.64)	−1.44 (−2.62, −0.25)
Retired	−0.47 (−0.97, 0.04)	−0.32 (−0.83, 0.19)	−0.12 (−0.70, 0.45)
Women			
Employed	0.00	0.08 (−0.22, 0.38)	2.03 (1.73, 2.32)
Unemployed	1.04 (0.13, 1.95)	0.23 (−0.34, 0.81)	3.25 (2.50, 4.00)
Non-employed	1.07 (0.49, 1.65)	0.35 (−0.22, 0.92)	2.22 (1.61, 2.83)
Retired	0.32 (−0.18, 0.81)	0.74 (0.19, 1.28)	2.37 (1.78, 2.97)

practically unchanged after adjustments for socio-economic indicators and health behaviors. It is unclear why abdominal obesity among women is increasing, whereas a plateau was seen among men. However, there may be social, biological and behavioral explanations. Although our rather rough measures of health behaviors failed to explain this increase, it may still be explainable by changes in health behaviors. Total alcohol intake is associated with larger WC in women,[24] and consumption of alcohol among women has increased,[28] as suggested by our data as well; however the impact of alcohol consumption is difficult to estimate owing to under-reporting bias. Changes in dietary habits[22] may also explain our findings, but unfortunately comparable dietary data from three surveys were unavailable. It is also plausible that there are hormonal or other biological mechanisms that increase the risk of abdominal obesity among women.

Employment status was clearly associated with WC among women in our study. Previous studies have also reported that being unemployed,[5] housewife,[5] retired[16] or even living in an area with high unemployment[5] is associated with larger WC among women, but these studies have examined only WC without adjustments for BMI. Nevertheless, residual analysis of one previous study[16] found out that unemployed women had larger WC than expected from their BMI. Our study extends this finding to other non-employed groups as well. All women who were outside labor market had higher WC than employed women, and our results remained even after adjustments for BMI, other socio-economic indicators and health behaviors. On the other hand, we found contradictory and mixed results for men, with the smallest waistline especially among our small group of non-employed men. This group consists of students and homemakers who are younger than other men. Although we included age in our analysis, it is possible that we could not fully adjust for the effects of age on body composition.

Interaction analysis showed that employment status had an interaction with study year: waistlines in 2002 were somewhat higher than expected among unemployed women than among other employment groups. This finding may reflect changes in the structure and severity of unemployment during the study period. Economic recession started in Finland in the beginning of the 1990s, that is, during the time our first survey (1992) was conducted, and unemployment in the population was still very high in 1997, including probably also relatively unselective and short-term unemployment that was not associated with health problems.[29] After the economic recovery, those who remained unemployed and had prolonged unemployment may have had more health problems. Unemployed have more stress-related eating or drinking, and prospective studies have shown that long-term unemployment increases the risk of having high BMI, indicating obesity among women.[30] Our study revealed that WC is increasing even more rapidly than BMI among unemployed women. Biological mechanisms that increase the risk of abdominal fat accumulation such as elevated cortisol levels owing to prolonged stress[31] may partly explain this finding. Previous studies have also suggested[5] that deprivation increases the risk of abdominal obesity especially among women.

An inverse association between WC and educational attainment[3,5,16–18] or income level[17] among women has been previously reported and this was found in our data as well. Nevertheless, these results become statistically non-significant when BMI was added into the model, suggesting that differences in WC parallel the differences in BMI among women. Among men, on the other hand, the association between WC and both education and income was positive in the BMI-adjusted models. That is, those with the lowest education and the lowest household income had lower WC than would be expected by their BMI. This finding, however, attenuated and became statistically nonsignificant when socio-economic indicators and health behaviors, including physical activity at work, were added into the model. This finding highlights the importance of health behaviors to WC. It is also important to remember that BMI may not be an optimal indicator of obesity among men in lower socio-economic groups, especially among men who are doing physically active work and may have more lean mass than their better educated counterparts.

In this study, we were able to use unique population-based database with measured data on WC and BMI, collected by trained staff in a similar way throughout the survey years. However, participation rates decreased slightly with time, and data on socio-economic indicators and health behaviors were based on self-reported information only. Although the non-response rate has increased from 1992 to 2002, it is more likely to dilute the observed associations compared with the actual ones, as usually the non-respondents have more unfavorable risk factor levels and health behavior pattern. The cross-sectional design of the study does not allow for any causal conclusions to be drawn.

Our findings suggest that waistlines are increasing more rapidly than BMI among women, with most increase among the unemployed. Socio-economic patterning of WC is divergent and gender-specific, and further studies are required to investigate causal pathways that favor fat accumulation in the abdominal area among women who are out of paid employment in particular. Moreover, our study highlights the importance of measuring WC in addition BMI to get more comprehensive information about changes in body size.

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