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ORIGINAL CONTRIBUTION

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Diet, obesity and obesogenic trends in two generations of Swedish women

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Abstract *Objective* Secular trends in obesity and related lifestyle factors are reported in two generations of 38- and 50-year old Swedish women. Specifically, we describe changes in obesity and fat patterning, while examining concurrent shifts in factors that are proposed to be causally related to the modern obesity epidemic. *Methods* A total of 1,270 women aged 38 or 50 were selected from population registries and examined in 1968/69 (born 1930 or 1918) or 2004/05 (born 1966 or 1954). Anthropometric methods and lifestyle questions were unchanged between earlier and later surveys. Dietary comparisons were based on 24-h recall, with additional questions about usual alcohol and salt consumption patterns. In subgroups, 24-h urinary sodium was determined. *Results* Weight, height, waist circumference, waist-hip ratio, triceps and subscapular skinfold measures were all significantly higher in later-born cohorts, although BMI and obesity were not significantly changed. Higher sodium excretion was observed among later-born sub-groups, consistent with reports of increasing salt preference. Lower proportions of energy as fat and sucrose, but higher carbohydrate, protein and fiber concentrations were reported by later-born cohorts. There were shifts towards increased frequency of wine and liquor consumption, but decreased beer. Leisure time physical activity and perceived stress levels both increased significantly over 36 years. *Conclusions* A number of anthropometric and lifestyle differences between two generations of Swedish women were observed. Increases in subcutaneous and abdominal fatness were detected without significantly increasing BMI. While some aspects of diet showed improvement, increases in salt preference and sodium excretion are cause for concern.

Key words obesity – diet – salt – lifestyle – secular trends

Introduction

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Although the prevalence of obesity in Sweden has increased over the past decades, the epidemic has recently displayed some unique patterns, relative to other parts of the world. For example, upward trends in overweight and obesity in schoolchildren show recent signs of leveling off, and possibly reversing in girls [29, 30]. Moreover, BMI levels have remained surprisingly stable in middle-aged women from western Sweden [4, 5], while increasing in adults of most other age and sex groups [4]. On the other hand, we previously observed that centralized obesity increased in middle-aged women during the end of the 20th century [20], a pattern which has subsequently been confirmed in other female populations in western Sweden [4], in Finns [28], in some US populations [10, 18], and in children [24].

In search of effective preventive interventions to manage the epidemic, key reasons for increases in total and/or central obesity have been debated. Besides usual explanations involving energy intake and expenditure, it has been proposed that other factors in the environment may be modifying susceptibility to obesity, including smoking practices, stress, sleep disturbances, consumption of sweetened or alcoholic beverages, and even salt intake—to name a few [8, 12, 23, 31]. The specific role of dietary fat has been debated over many years, and the literature is characterized by divergent findings using different study designs [11, 14, 21].

This paper reports secular trends in obesity, diet, and other related lifestyle factors in different generations of 38- and 50-year old women from western Sweden examined 36 years apart. We previously reported that a small sample of middle aged women surveyed in the early 1990's had similar BMI's but considerably higher waist-hip ratios, compared to same-aged cohorts recruited in the late 1960's [20]. The aim of the new survey was to recruit a larger and more recently-born cohort of 38 and 50 year olds and inquire on a number of potentially etiological risk factors for generalized and central obesity.

Methods

A total of 1,270 women aged 38 or 50 were selected from population registries and examined at one of two surveys: in 1968/69 or 2004/05. Subjects were selected based on their date of birth, in order to obtain a representative sample of women in the age-groups studied [2, 5]. The original sample of 38 and 50 year olds was born in 1930 or 1918; the contemporary group was born in 1966 or 1954. Similar anthropometric methods and questions about diet and lifestyle were used for both examinations in 1968/69 and 2004/05. Anthropometric measures included weight, height, waist circumference, hip circumference, triceps and subscapular skinfold thicknesses, using identical procedures [2] in 1968/69 and 2004/05. Questions on leisure time and occupational activity levels, stress, sleep, smoking and alcohol intake have also remained unmodified over the years and have been described in previous publications [5, 6, 15, 19, 25].

Dietary comparisons, not previously reported, are based on 24-h recalls in addition to frequency-based questions for alcohol. The 24-h dietary recalls were conducted on Monday–Friday by dieticians, using generic food models for portion sizes that were similar in 1968–69 and 2004–05. The original nutrient calculations were done with food composition tables in 1969; the same dietary recalls were re-coded in the 1990's using newer food composition tables, in order to estimate intakes of nutrients that are not available in the original dietary data base (i.e. fatty acids, fiber, sucrose). However, because the nutrient composition of many food items changes over time, originally calculated nutrient values are reported here wherever available. In special circumstances 24 h recalls were conducted on Saturdays, thereby reflecting intakes on Fridays. However, due to the fact that most 24 h recalls described alcohol intake on Sunday–Thursday, this report emphasizes frequency-based data on alcoholic beverage consumption, which can be assumed to represent all days of the week.

Lastly, to describe changing salt intake patterns, we compared responses to the following statements in 1968/69 and 2004/05, for which each subject chose one of the following: "I usually think that my food is too salty"; "I usually think that my food is sufficiently salty"; and "I usually add extra salt to my food with/without tasting before". At both examinations, a subset of women provided 24-h urine collections, based on which sodium intake was estimated. In 2004/05, using para-aminobenzoic acid (PABA) validation to assess the completeness of the 24-h urine collection [27], 78% of collections were complete. Since this technique was not available in 1968/69, the results are presented for all subjects in both sub-studies, under the assumption of similar completeness. Sampling was not random but convenience-based in both sub-surveys.

The analytical study cohort consisted of 579 women aged 38 years and 691 aged 50 years. For continuously scaled variables, arithmetic mean values and SD are presented for and tested for secular difference. Multiple regression was used to adjust changes in skinfold and waist circumference measures for changes in height. For the urinary sodium analyses, 2-sample t tests were calculated without assumption of equal variance. For ordinally scaled variables, we tested whether shifts in proportions were explained by year of birth by applying an ordinal logistic regression model with year of birth as the explanatory variable, for 38 and 50 year olds separately. These ordinal variables (alcoholic beverages, salt use, leisure time physical activity, activity at work, perceived stress) were fitted with the lowest category as reference category. Consequently, all significant positive beta estimates for year of birth can be interpreted a secular increase due to upwards shifting proportions across the ordinally scaled variables between the two examination points, whereas a negative beta value indicates a shift of proportions towards lower levels between 1968/69 and 2004/05. These changes were further investigated by testing the proportions of each level at the two time points using χ^2 test. By doing so, we evaluated where the shifts in the outcome categories/levels occurred. Finally, smoking (never, ex- and current) is not considered an ordinal scaled variable, so we only present χ^2 statistics for each level of the outcome variable.

The overall study design is shown schematically in Fig. 1, illustrating that the cohorts compared here represented part of a larger study, in which the original sample has been followed prospectively by means of repeated examinations [22]. The study was approved by the regional ethics committee at University of Gothenburg.

Results

Anthropometry

Anthropometric results are shown in Table 1. Mean body mass index (BMI) and prevalence of obesity (BMI ≥ 30) and overweight (BMI ≥ 25) were similar in earlier- versus later-born groups. Weight, height, waist circumference and waist-hip ratio (WHR) were significantly higher, while hip circumference was unchanged. Triceps and subscapular skinfolds were significantly higher in the later-born cohorts.

Because the 1954 and 1966 birth cohorts were taller than those born 1918 and 1930, statistical correction for height was made for anthropometric measures that would be expected to increase with increasing stature. After this adjustment, secular increases in waist circumference, triceps skinfold and subscapular skinfold were almost unchanged and maintained previously strong statistical significance levels. In both adjusted analyses (not shown) and unadjusted analyses (Table 1), waist circumferences of later-born cohorts were around 6 cm higher, triceps skinfolds were 6 mm thicker, and subscapular skinfolds were 2–3 mm thicker, compared to the earlier examined cohorts.

Diet

According to 24-h diet recalls (see Table 2), later-born women in both age groups reported consuming significantly more energy, protein, carbohydrates, and fiber. Considering macronutrients as percentages of energy, significantly lower total, saturated, monounsaturated, and polyunsaturated fatty acids were consumed. Higher proportions of energy as carbohydrate were also reported and more fiber/energy, but less energy-percent sucrose, in the later examinations (Table 2).

Women in the later survey were significantly less likely to report that they found their food too salty, and more likely to add extra salt. In the sub-studies sodium excretion was over 50% higher in 2004/05 compared to the original sample, suggesting

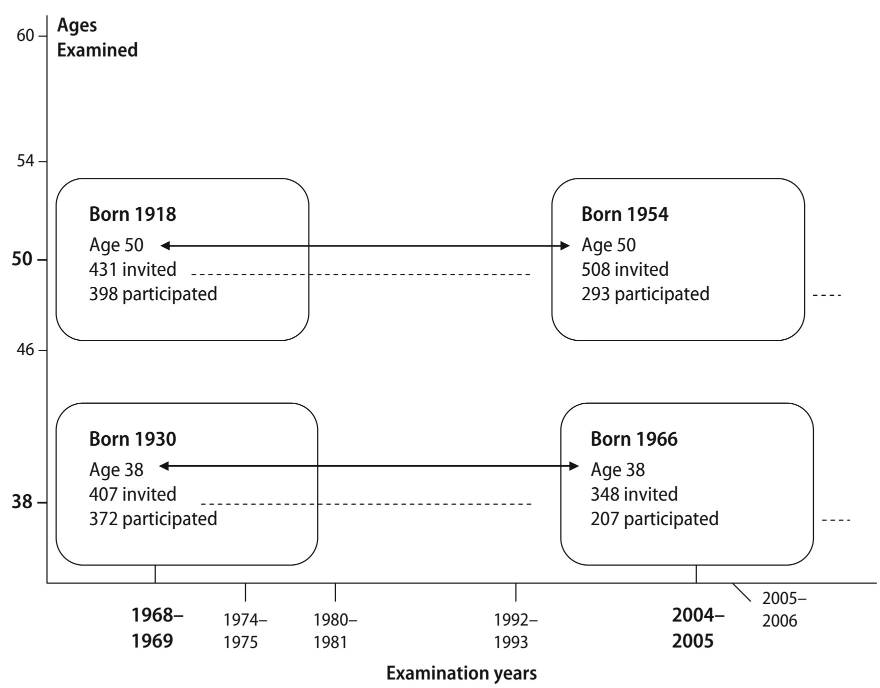

Fig. 1 Overview of 36-year cohort comparisons within prospective population study of women in Gothenburg. To left, earlier-born (original) cohorts; to right, later-born cohorts. *Arrows* indicate cohort comparisons in this report. *Dashed lines* illustrate follow up of original cohorts, most recently examined in 2005–06. Dates in small text refer to prospective study but not included in present report. Ages in small text refer to ages at baseline in prospective study. Numbers of participants may vary per analysis

Table 1 Secular differences in anthropometric measures, with mean and standard deviations (SD) unless otherwise indicated

	38 year olds		Significance 1968/69–2004/05 difference	50 year olds		Significance 1968/69–2004/05 difference
	Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)	
Examination year	1968/69	2004/05		1968/69	2004/05	
N(1)	372	202		398	292	
Weight (kg)	63.4 (11.2)	67.0 (13.1)	***	66.2 (11.1)	68.7 (12.1)	**
Height (cm)	164.6 (5.7)	167.3 (6.6)	****	163.5 (5.6)	166.3 (6.2)	****
BMI (kg/m^2)	23.4 (3.8)	23.9 (4.3)	NS	24.8 (3.8)	24.8 (4.3)	NS
Obese, BMI ≥ 30 number (%)	20 (5.4)	14 (6.9)	NS	40 (10.1)	33 (11.3)	NS
Overweight including obese, BMI ≥ 25 number (%)	98 (26.3)	61 (30.2)	NS	156 (39.2)	115 (39.4)	NS
Overweight without obesity, number (%)	78 (21.0)	47 (22.7)	NS	116 (29.2)	82 (28.0)	NS
Underweight, number (%)	15 (4.0)	5 (2.5)	NS	10 (2.5)	5 (1.7)	NS
Normal weight, number (%)	259 (69.6)	136 (65.7)	NS	232 (58.3)	172 (58.7)	NS
N(2)	353	201		378	292	
Waist (cm)[§]	71.6 (8.2)	78.1 (10.5)	****	74.8 (8.7)	82.6 (11.1)	****
Hip (cm)	98.9 (7.5)	98.7 (8.5)	NS	100.2 (8.0)	99.9 (8.5)	NS
Waist-hip ratio (WHR)	0.73 (0.05)	0.79 (0.07)	****	0.75 (0.05)	0.83 (0.07)	****
WHR > 0.85 (%)	7 (2.0)	29 (14.4)	****	14 (3.7)	100 (34.3)	****
N(3)	372	202		398	289	
Triceps skinfold (mm)[§]	16.7 (5.9)	22.1 (8.7)	****	18.2 (5.3)	24.6 (8.8)	****
Subscapular skinfold (mm)[§]	15.4 (7.2)	18.1 (9.3)	***	18.9 (8.2)	20.9 (9.3)	**

N(1) refers to number with complete weights and heights, N(2) refers to complete waist and hip, N(3) refers to complete skinfolds
NS non-significant;
****$P < 0.0001$; ***$P < 0.001$; **$P < 0.01$; *$P < 0.05$; [§]Unchanged after adjustment for secular difference in height

Table 2 Secular differences in intake of energy and macronutrients

Intake estimated from single 24-h recalls	38 year olds		Significance 1968/69–2004/05 difference	50 year olds		Significance 1968/69–2004/05 difference
	Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)	
Examination year	1968/69	2004/05		1968/69	2004/05	
N	309	203		311	283	
Energy (MJ)	6.82 (2.12)	7.69 (2.33)	****	6.33 (2.15)	7.07 (2.25)	***
Macronutrients in grams						
Protein	58.0 (19.6)	78.4 (28.3)	****	53.8 (18.1)	72.1 (25.5)	****
Fat	72.3 (29.6)	72.5 (30.8)	NS	66.0 (28.6)	64.7 (29.7)	NS
Saturated fatty acids[a]	30.8 (13.7)	29.2 (13.0)	NS	28.5 (12.8)	26.4 (13.0)	*
Monounsaturated fatty acids[a]	24.3 (10.4)	26.5 (12.4)	*	22.5 (10.1)	23.6 (12.0)	NS
Polyunsaturated fatty acids[a]	9.9 (5.4)	11.6 (7.8)	*	9.3 (6.4)	10.1 (7.3)	NS
Carbohydrate	171 (56)	213 (72)	****	160 (61)	195 (69)	****
Sucrose[a]	33.5 (21.7)	33.2 (22.5)	NS	30.4 (21.5)	30.9 (25.2)	NS
Alcohol	2.7 (9.8)	2.6 (7.7)	NS	3.2 (8.4)	4.3 (11.4)	NS
Fiber[a]	12.7 (6.3)	18.1 (8.2)	****	12.7 (5.5)	18.1 (7.9)	****
Macronutrients as percentage of energy intake						
Protein (%)	14.5 (3.2)	17.4 (4.6)	****	14.6 (3.7)	17.5 (4.7)	****
Fat (%)	39.2 (7.9)	34.8 (8.5)	****	38.4 (8.0)	33.6 (9.2)	****
Saturated fatty acids (%)[a]	18.1 (4.0)	14.0 (4.2)	****	17.9 (4.3)	13.7 (4.4)	****
Monounsaturated fatty acids (%)[a]	14.3 (3.2)	12.8 (4.0)	****	14.1 (3.3)	12.2 (4.0)	****
Polyunsaturated fatty acids (%)[a]	5.8 (2.1)	5.5 (2.8)	****	5.8 (2.7)	5.3 (3.3)	****
Carbohydrate (%)	42.4 (7.8)	46.6 (8.9)	****	42.6 (8.7)	46.8 (9.7)	****
Sucrose (%)[a]	8.8 (4.6)	7.1 (3.9)	****	8.5 (5.0)	7.4 (5.6)	*
Alcohol (%)	1.1 (3.7)	1.0 (2.8)	NS	1.6 (4.5)	1.6 (3.9)	NS
Fibre g/MJ[a]	2.1 (0.8)	2.4 (1.1)	****	2.2 (0.9)	2.7 (1.0)	****

NS non-significant
****$P < 0.0001$; ***$P < 0.001$; **$P < 0.01$; *$P < 0.05$
[a]1968 values calculated with newer database

higher discretionary and/or total consumption of salt (Table 3). Although total alcohol intake did not differ over time by 24 h recall (Table 2), significantly higher "usual" frequencies for drinking wine and liquor were reported by questionnaire, and lower frequencies of consuming beer, as shown in Table 4.

Table 3 Secular differences in salt intake patterns in all participants, and 24-h sodium excretion in sub-samples

	38 year olds			50 year olds		
	1968/69	2004/05	Secular change $\beta(P)$	1968/69	2004/05	Secular change $\beta(P)$
All subjects	$N = 347$	$N = 203$		$N = 375$	$N = 288$	
Food too salty (%)	8.9	2.5**	0.01[a] (0.0084)	11.5	3.8***	0.02[a] (0.0004)
Salt sufficient (%)	66.6	66.0		69.9	69.8	
Adds extra salt (%)	24.5	31.5***		18.7	26.4*	
Sub-sample	$N = 48$	$N = 16$		$N = 119$	$N = 26$	
Urinary sodium mmol/24 h	106.8 (46)	172.3** (69.1)		101.4 (44.7)	154.1*** (55.5)	
Corresponding to approx g salt/day	6	10		6	9	

% answering affirmative for salt use; mean (SD) for urinary sodium
$P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$ significance level for comparison to women examined in 1968/69 (χ^2 and t tests)
[a]Ordinal logistic regression (lowest ordered outcome category = reference) coefficients for year of birth

Other obesity-related lifestyle factors

Comparisons of smoking practices, physical activity, perceived stress, and usual hours of sleep are shown in Table 5. Physical activity during leisure time increased significantly, whereas occupational activity did not show significant trends. However, a shift from the moderately active work category in favor of both the low and vigorously active work categories was observed in both age groups. Current smoking decreased while proportion of ex-smokers increased consistently in both ages. Perceived stress increased dramatically in both age groups, while hours of sleep per night decreased in the 38-year olds only.

Table 4 Secular differences over 36 years for consumption of alcoholic beverages in 38 year old and 50 year old women

Variable	38-year olds		50-year olds	
	1968/69 ($n = 370$)	2004/05 ($n = 201$)	1968/69 ($n = 396$)	2004/05 ($n = 284$)
Beer (%)				
Never	27.3	34.3	35.6	31.7
Monthly	20.0	47.8***	17.9	46.5***
Weekly	44.6	17.4***	34.3	21.5***
Daily	8.1	0.5***	12.1	0.4***
Secular change $\beta(P)$[a]	−0.03 (<0.0001)		−0.01 (0.0002)	
Wine (%)				
Never	46.2	15.4***	47.7	10.6***
Monthly	37.3	35.8	31.1	31.3
≥Weekly	16.5	48.8***	21.2	58.1***
Secular change $\beta(P)$[a]	0.04 (<0.0001)		0.05 (<0.0001)	
Liquor (%)				
Never	74.9	47.8***	71.2	49.7***
Monthly	21.9	47.3***	22.5	44.7***
≥Weekly	3.2	5.0	6.3	5.6
Secular change $\beta(P)$[a]	0.03 (<0.0001)		0.27 (<0.0001)	

$^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$ significance level for comparison to women examined in 1968/69 (χ^2 Test)
[a]Ordinal logistic regression (lowest ordered outcome category = reference) coefficients for year of birth

Discussion

A number of anthropometric, dietary and other lifestyle differences, both positive and negative, were observed when comparing two generations of Swedish women. Despite minimal changes in BMI and obesity per se, certain adverse anthropometric changes were apparent, particularly an increased risk of centralized fat distribution and higher measurements of subcutaneous fat in subscapular and triceps regions. It is noted that the changes in subscapular skinfold thicknesses and waist circumference were independent of changes in height observed between earlier and later-born cohorts. This secular increase in body fatness and central body fat, in the absence of significantly increasing BMI or obesity, may indicate the emergence of a larger group of women with "normal-weight obesity", a condition that has been suggested to have cardiometabolic consequences [9]. These results also confirm the secular increases in waist-hip ratio that we previously reported from 1968 to 1992 in an earlier secular comparison in this study. Compared to the WHR increases previously described in the same age groups [20] only minor increases have subsequently occurred between 1992 and 2004. Skinfolds were not measured in 1992, so it is not possible to determine when these increases occurred. However it should be underscored that all of these changes occurred in a situation of relatively stable body mass index distributions. The observed changes in WHR are of special interest from a women's health perspective, as abdominal obesity is among the most potent cardiovascular risk factors in women [3].

Increases occurred in habitual consumption of wine and hard liquor, with concurrently decreasing frequency of beer consumption, but we could not demonstrate a change in alcohol consumption by 24 h recall. Because the 24 h diet recalls were normally collected from Monday to Friday (reflecting intakes on Sunday–Thursday), consumption patterns on Fri-

Table 5 Secular differences in smoking practices, leisure time physical activity (LTPA), work activity, stress, and sleep over 36 years in 38 year old and 50 year old women

	38-year olds			50-year olds		
	1968/69	2004/05	Secular change $\beta(P)$	1968/69	2004/05	Secular change $\beta(P)$
Smoking (%)	$n = 371$	$n = 204$		$n = 398$	$n = 291$	
Never	42.3	57.8***		56.8	41.6***	
Ex	11.1	30.9***		6.3	35.4***	
Current	46.6	11.2***		36.9	23.0***	
LTPA[a] (%)	$n = 372$	$n = 204$		$n = 397$	$n = 289$	
Seldom	16.9	22.6	0.02 (<0.0001)	17.9	16.6	0.02 (<0.0001)
Medium	72.0	36.3***		67.0	44.3***	
Regular	11.0	41.2***		15.1	39.1***	
Work activity[a] (%)	$n = 372$	$n = 203$		$n = 398$	$n = 287$	
Low	3.0	12.8***	0.01 (0.1545)	3.0	17.4***	−0.004 (0.3157)
Medium	56.2	34.0***		69.4	48.1***	
Vigorous	40.9	53.2**		27.7	34.5	
Stress[a] (%)	$n = 353$	$n = 199$		$n = 380$	$n = 288$	
Never	65.7	25.1***	0.04 (<0.0001)	70.8	26.4***	0.05 (<0.0001)
Sometimes	28.6	59.3***		23.2	58.0***	
Continuously	5.7	15.6***		6.0	15.6***	
Sleep [h/night]	$n = 372$	$n = 202$		$n = 398$	$n = 282$	
Mean (SD)	7.32 (1.07)	7.08*** (0.95)	$P = 0.0006$[b]	7.02 (1.11)	7.00 (1.04)	$P = 0.7538$[b]

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$ significance level for comparison to women examined in 1968/69 (χ^2 Test)
[a]Ordinal logistic regression (lowest ordered outcome category = reference) coefficients for year of birth
[b]Differences tested using Welch test (unequal variances) for each age group separately

days or Saturdays are not represented, and we cannot draw conclusions on whether total quantities of alcohol consumed have changed. However our data clearly show a 36-year shift in type of alcoholic beverage preferred by women. Despite limitations in quantitative information on alcohol, the 24-h recalls demonstrated highly significant changes in macronutrient composition on the group level, including a decrease in percent of energy from sucrose and all types of fat, with a relative increase in total carbohydrates and dietary fiber. These changes in self-reported fat are in agreement with national data on food availability trends [1], and the diet composition shifts reported by these women are generally consistent with conventional dietary recommendations.

In contrast, it is a matter of concern that salt preferences appear to be increasing considerably, including through discretionary use. It is known that non-discretionary salt intake is high in many processed foods, which may contribute to a decrease in sensitivity to saltiness. These changes, which imply total increases in the overall salt burden in the diet, are paralleled by over 50% increases in urinary sodium excretion in our sub-study. These Swedish findings may be contrasted with reports from Finland showing decreases in both sodium excretion and total salt intake over two decades, changes that are attributed to national nutrition policies and related efforts by public health authorities and food industry [17, 26]. The levels of sodium excretion observed in our contemporary Swedish sub-sample are comparable with levels measured in the 1980's in most European centers in the INTERSALT Study [16]. However it has been pointed out [17] that there is extremely limited literature regarding secular changes sodium intake and excretion over time in populations other than the Finns. Although the present study offers new knowledge on recent trends in both salt preferences and sodium excretion in Swedes, it must be kept in mind that the sodium study results are not population-based, but derived from a small sub-sample. Others have speculated that increased salt intake may cause increased consumption of sweetened beverages and thereby increase risk of excess energy consumption [12], a hypothesis we are unable to address with available data.

Similarly, the interpretation of the physical activity changes in the context of obesity is not simple. Although leisure time physical activity patterns shifted upwards, as previously reported in the Swedish MONICA/InterGene surveys [4], it was also noted that middle levels of occupational activity are now reported less frequently, with concomitant increases in both low and vigorous work activity patterns in these cohorts. It should be pointed out that the questionnaire was not designed to capture types of sedentary leisure activity that are widely believed to contribute to energy imbalance in contemporary populations, e.g. television habits. Therefore, from the data available in this study it is not possible to determine whether and how total physical activity levels may have changed. However, it may be speculated that increases in leisure time activity, together with decreases in selection of fat and sucrose, may have contributed to the accompanying stability of BMI in Swedish women, which remains lower than in many other parts of the world.

Finally, the large increases in self-reported experiences of stress may also have various explanations. While such differences are likely to reflect changing social norms regarding the concept, experience and social desirability of stress, they may also reflect real increases in perceived levels of stress among women in these ages. Accompanying decreases in sleep in the younger age group might be consequences of increasing stress levels, which in turn have been proposed to affect abdominal fat deposition [7].

This is one of the few studies to our knowledge that makes obesity-related comparisons with such an extended time perspective. However, this type of research poses major methodological challenges that need to be considered when interpreting the results. First, use of modern food composition tables to estimate intakes of dietary components such as type of dietary fat decades earlier is risky, and comparisons are bound to be inexact. It is possible that modern food composition tables contain more accurate estimates of some nutrients than the original ones, but the reverse may also be true for some items. Therefore we chose a combined approach, using modern databases for nutrients not originally calculated, but otherwise using originally calculated nutrient levels.

Another important concern involves decreasing participation rates. Certain difficulties were experienced in the recent survey due to increasing numbers of subjects with unlisted mobile phone numbers who were thus not accessible for an initial personal contact. This and other differences in recruiting conditions resulted in lower participation rates in the later survey. We recently conducted a comparative study of participants and non-participants by linking their personal numbers to selected medical and fiscal registries, which revealed small but in a few instances significant differences [5]. Therefore it cannot be excluded that some of the comparisons are biased by non-participation in less healthy or lower income groups. For instance, the apparent stability of overweight and obesity may be overly optimistic, although other Swedish and Nordic population studies have tended to find minimal increases in middle-aged women [4, 13]. In contrast, the dramatic increases in centralized obesity, together with higher skinfold measures and major dietary shifts are unlikely to reflect increased self-selection of our sample.

Finally, it should be noted that the simultaneous changes in obesity and related lifestyle factors observed in specific age groups over time constitute ecological evidence that cannot be considered causal, and we thus refrain from drawing etiological conclusions. Since multiple factors are changing in populations at the same time, conclusions based on ecological data may be spurious. At the same time this problem underscores the importance of describing multiple dynamic factors that may be driving the epidemic. In this paper, we have chosen to describe many potentially "obesogenic" factors, to present the evidence in totality rather than selecting isolated aspects. Multivariate modeling may shed future light on which observed lifestyle factors are driving observed changes in obesity.

In conclusion, these data provide a historical picture of changes in obesity, diet and lifestyle in mid-life among female cohorts from western Sweden. BMI and obesity prevalence rates were among the most stable variables to be compared, indicating that same-aged cohorts maintained similar weight-for-height status after more than three decades. This occurred during a period of some lifestyle trends assumed to be health promoting, including reduced fat consumption, less smoking, and increasing leisure-time physical activity. However, a number of less encouraging observations must also be considered, including the findings of increasing subcutaneous skinfold thickness and higher waist-hip ratio compared to earlier generations, findings that may reflect women's changing lives and psychosocial conditions. Moreover, the changing salt preference and sodium excretion patterns signal changes in the food supply that may have multiple adverse health consequences.

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