Association between dairy food consumption and weight change over 9 y in 19 352 perimenopausal women

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ABSTRACT
Background: Dairy foods may play a role in the regulation of body weight. 
Objective: We examined the association between changes in dairy product consumption and weight change over 9 y. 
Design: The study was conducted in 19 352 Swedish women aged 40–55 y at baseline. Data on dietary intake, body weight, height, age, education, and parity were collected in 1987–1990 and 1997. The intake frequencies of whole milk and sour milk (3% fat), medium-fat milk (1.5% fat), low-fat milk and sour milk (≤0.5% fat), cheese, and butter were calculated at baseline and follow-up. The women were categorized into 4 groups according to their intake: 1) constant, <1 serving/d; 2) increased from <1 serving/d to ≥1 serving/d; 3) constant, ≥1 serving/d; and 4) decreased from ≥1 serving/d to <1 serving/d. Odds ratios (ORs) with 95% CIs for an average weight gain of ≥1 kg/y were calculated by using multivariable logistic regression analyses, with group 1 as the reference. 
Results: Mean (±SD) body mass index (in kg/m²) at baseline was 23.7 ± 3.5. The constant (≥1 serving/d) intakes of whole milk and sour milk and of cheese were inversely associated with weight gain; ORs for group 3 were 0.85 (95% CI: 0.73, 0.99) and 0.70 (95% CI: 0.59, 0.84) respectively. No significant associations were seen for the other 3 intake groups. When stratified by BMI, the findings remained significant for cheese and, for normal-weight women only, for whole milk and sour milk. 
Conclusion: The association between the intake of dairy products and weight change differed according to type of dairy product and body mass status. The mechanism behind these findings warrants further investigation. 

KEY WORDS Dairy products, weight change, longitudinal study, perimenopausal women

INTRODUCTION
Dairy foods such as butter, cheese, and milk products constitute a considerable part of the Western diet; however, the health effects of these foods are not clear. This food group represents a major source of saturated fat, which is a risk factor for cardiovascular disease and type 2 diabetes (1). However, dairy foods also contribute to the intakes of protein, calcium, and other nutrients, which may mediate beneficial health effects (2). The fat quality of dairy foods also differs from that of meat and other animal foods because of the relatively high content of short-chain fatty acids in dairy fat. Dairy fat, together with ruminant meat, is a source of conjugated linoleic acid (CLA), which has gained increasing attention because of its possible influence on fat metabolism and body composition (3).

The consumption of dairy foods has been suggested to play a beneficial role in the regulation of body weight (4, 5). Inverse associations between the consumption of dairy products or calcium and body weight or obesity have been observed in several cross-sectional (6–9) and longitudinal (10–12) studies of adults, but not in some studies of adolescents (13, 14) and Pima Indians (15). Recent data from the Health Professionals Follow-Up Study showed no association between changes in calcium and dairy intakes and changes in body weight over 12 y; however, men with the largest increase in high-fat dairy products gained significantly more weight than did men who decreased their intake the most (16).

Results from intervention studies are inconsistent; some studies have found that calcium, particularly dairy calcium, can accelerate weight loss during energy restriction in obese people (17, 18), whereas some have not (19–21). In a study of nonobese young women consuming their usual diet, an increased consumption of dairy products had no effect on body weight after 1 y (22). A review of randomized trials showed little evidence of an effect of dairy products or calcium on body weight (23); however, these studies were not originally designed to address this issue. The effect of dairy products on body weight has mainly been attributed to the content of calcium (5); however, additional effects on adiposity have been observed when calcium comes from dairy products (17, 18). Therefore, other components of these foods may also play a role.

In the current study, we examined the association between changes in intake of dairy products and changes in body weight over 9 y in a sample of 19 352 perimenopausal and early menopausal women, a population vulnerable for weight gain, who participated in the Swedish Mammography Cohort in 1987–1990 and were examined again in 1997. We investigated the effects of different types of dairy products because it is the effects of foods rather than of nutrients that are of interest from a public health perspective. The range of consumption of dairy products has increased over time (24), increasing the importance of these foods in the Western diet (25). Other studies have found that calcium, particularly dairy calcium, can accelerate weight loss during energy restriction in obese people (17, 18), whereas some have not (19–21). In a study of nonobese young women consuming their usual diet, an increased consumption of dairy products had no effect on body weight after 1 y (22). A review of randomized trials showed little evidence of an effect of dairy products or calcium on body weight (23); however, these studies were not originally designed to address this issue. The effect of dairy products on body weight has mainly been attributed to the content of calcium (5); however, additional effects on adiposity have been observed when calcium comes from dairy products (17, 18). Therefore, other components of these foods may also play a role.

In the current study, we examined the association between changes in intake of dairy products and changes in body weight over 9 y in a sample of 19 352 perimenopausal and early menopausal women, a population vulnerable for weight gain, who participated in the Swedish Mammography Cohort in 1987–1990 and were examined again in 1997. We investigated the effects of different types of dairy products because it is the effects of foods rather than of nutrients that are of interest from a public health perspective. The range of consumption of dairy products has increased over time (24), increasing the importance of these foods in the Western diet (25).
is relatively broad in Sweden; therefore, the current study population should be suitable for detecting a possible association.

SUBJECTS AND METHODS

Study design and subjects

The analyses in this study are based on data from the Swedish Mammography Cohort. In 1987–1990, all women born between 1914 and 1948 living in the counties of Västmanland and Uppsala in central Sweden were invited to participate in a mammography screening program. A 6-page questionnaire including questions on anthropometric measures, dietary intake, education, and parity was filled in by 74% (n = 66 651) of the invited women. In 1997, an extended follow-up questionnaire was mailed to 56 030 women remaining in the cohort after exclusion of those who had died or permanently moved out of the study area. Seventy percent of the women filled in the questionnaire. We excluded women with an incorrect or missing identification number on the questionnaire (n = 243), which yielded an identifiable cohort of 38 984 women. The study was approved by the Ethics Committees at the Uppsala University Hospital and the Karolinska Institutet (Stockholm, Sweden).

For the current study, subjects were excluded if data on body weight or height were missing at baseline or follow-up (n = 1783); if they, according to hospital diagnoses, had suffered from cancer, cardiovascular disease (angina, coronary disease, and stroke), or diabetes before 1997 (n = 8643), because these diseases may affect body weight through mechanisms that are difficult to control for; or if the mean change in body mass index (BMI; in kg/m²) between baseline and follow-up was >2/kg (n = 12). Because our objective was to investigate effects on weight gain, we restricted the cohort to women aged 40–55 y at baseline, i.e., perimenopausal and early postmenopausal women, who are vulnerable to weight gain because of hormonal changes. It was reported earlier in the nationally representative survey of Swedish women that the average weight gain among women is highest in this age period (24), as was also observed in our cohort. This left a total of 19 352 women who were included in the analyses.

Dairy product intake

In 1987, dietary intake was measured with a 67-item food-frequency questionnaire (FFQ). The participants were asked to estimate their average frequency of consumption of whole milk (3% fat), medium-fat milk (1.5% fat), low-fat milk (≤0.5% fat), whole sour milk (3% fat), low-fat sour milk (0.5% fat), cheese, and butter (80% fat) spread on bread during the previous 6 mo. Eight answer options were given ranging from “never/seldom” to “4 or more servings per day.” In 1997, dietary intake was measured with an extended 96-item FFQ, and the frequency of dairy products during the previous year was assessed by using open-ended questions requesting participants to report the number of servings per day or the number of servings per week certain foods were consumed. The 1987 and 1997 questionnaires contained the same number of questions relating to the previously described dairy products, except for cheese, which, in 1997, was divided into 2 questions (relating to whole and low-fat cheese, respectively). The intake frequencies of the 2 cheese types were summed, resulting in 1 cheese variable also in 1997. In both 1987 and 1997, the intakes of whole milk and whole sour milk were collapsed into one “whole milk and sour milk” variable, and the same was done for the intakes of low-fat milk and low-fat sour milk, resulting in one “low-fat milk and sour milk” variable.

A validation study of the FFQ at baseline was conducted in 129 women who were randomly chosen from the cohort. Spearman correlation coefficients (r) between the mean intake, which was assessed from four 1-wk diet records, and the FFQ ranged from 0.33 (for whole milk) to 0.64 (for low-fat milk) for dairy foods (r = 0.50) (25).

On the basis of the variables obtained from the 1987 and 1997 questionnaires, for each of the 5 types of dairy products (whole milk/sour milk, medium-fat milk, low-fat milk and sour milk, cheese, and butter), the subjects were categorized into 4 groups according to their change in intake of these foods during the follow-up period: constant, <1 serving/d (subjects with an intake of <1 serving/d at both baseline and follow-up); increased intake (subjects who during follow-up increased their intake from <1 serving/d to ≥1 serving/d); constant, ≥1 serving/d (subjects with an intake of ≥1 serving/d at both baseline and follow-up); and decreased intake (subjects who during follow-up decreased their intake from ≥1 serving/d to <1 serving/d).

Weight change

At baseline and follow-up, participants were asked to report their body weight to the nearest 0.1 kg. The correlation between self-reported weight and measured weight has been shown to be high (r = 0.9) in Swedish women (26). Although self-reported body weight was underestimated to a larger extent in overweight subjects (26), our study concerns changes in weight; therefore, it is unlikely that systematic misestimation of weight biased the results. Mean annual weight change during follow-up was calculated as the change in weight from baseline to follow-up divided by the number of years of follow-up. Subjects were categorized into 2 groups according to mean annual weight change: <1 or ≥1 kg/y.

Other variables

Information on age and height at baseline and parity were obtained through the 1987 questionnaire; age at baseline was categorized into 5-y age groups, height at baseline was used as a continuous variable, and parity was categorized into 4 groups (0, 1, 2, or ≥3). Data on education were obtained through the 1997 questionnaire, and subjects were grouped into 3 categories (<10, 10–12, and >12 y education). Nutrient intake at baseline and follow-up was calculated as the frequency of consumption multiplied by the nutrient content of age-specific (<53, 53–65, and ≥66 y, based on tertiles of the whole cohort) portion sizes, with the use of composition values from the Swedish Food Administration Database (27). CLA intake was estimated according to published data on the concentrations of CLA found in the total fat of various foods (28). Changes in intakes of energy, protein, fat, carbohydrates, fiber, alcohol, calcium, and CLA between 1987 and 1997 were calculated and categorized into quartiles. For coffee, changes in intake were calculated as changes between categories of ≤1 serving/d, 2–3 servings/d, and ≥4 servings/d. BMI at baseline was calculated as weight (in kg) divided by the square of height (in m), and stratified analyses were performed according to overweight at baseline (BMI < 25 and ≥25).

Smoking habits and physical activity were assessed in 1997 only; therefore, we were not able to determine changes in smoking and physical during follow-up. However, we examined the
### TABLE 1
Characteristics of 19,352 women aged 40–55 y who participated in the study according to the frequency consumption of dairy products at baseline in 1987

<table>
<thead>
<tr>
<th>Dairy product consumption (servings/d)</th>
<th>Low-fat milk and sour milk</th>
<th>Medium-fat milk</th>
<th>Whole milk and sour milk</th>
<th>Cheese</th>
<th>Butter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median intake (servings/d)</td>
<td>0.0</td>
<td>1.0</td>
<td>0.0</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>64.3 ± 1.5</td>
<td>64.2 ± 1.6</td>
<td>64.1 ± 1.6</td>
<td>64.1 ± 1.5</td>
<td>64.3 ± 1.6</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>159.7 ± 4.8</td>
<td>159.7 ± 4.5</td>
<td>159.7 ± 4.2</td>
<td>159.7 ± 4.3</td>
<td>159.7 ± 4.4</td>
</tr>
<tr>
<td>Energy (kcal/d)</td>
<td>1725 ± 512</td>
<td>1725 ± 512</td>
<td>1725 ± 512</td>
<td>1725 ± 512</td>
<td>1725 ± 512</td>
</tr>
<tr>
<td>Fat (% of energy)</td>
<td>28.7 ± 4.5</td>
<td>28.7 ± 4.5</td>
<td>28.7 ± 4.5</td>
<td>28.7 ± 4.5</td>
<td>28.7 ± 4.5</td>
</tr>
<tr>
<td>Carbohydrate (% of energy)</td>
<td>56.1 ± 5.7</td>
<td>56.1 ± 5.7</td>
<td>56.1 ± 5.7</td>
<td>56.1 ± 5.7</td>
<td>56.1 ± 5.7</td>
</tr>
<tr>
<td>Fiber (g/d)</td>
<td>15.8 ± 2.6</td>
<td>15.8 ± 2.6</td>
<td>15.8 ± 2.6</td>
<td>15.8 ± 2.6</td>
<td>15.8 ± 2.6</td>
</tr>
<tr>
<td>Calcium (mg/d)</td>
<td>1000 ± 310</td>
<td>1000 ± 310</td>
<td>1000 ± 310</td>
<td>1000 ± 310</td>
<td>1000 ± 310</td>
</tr>
</tbody>
</table>

**Note:** SD (all such values). *P < 0.01,* **P < 0.001,** ***P < 0.0001,* significantly different from < 1 serving/d (Student's t-test): **P < 0.001,** ***P < 0.0001.
influence of these confounders on the association of the intake of dairy products and overweight in cross-sectional analyses using data from the 1997 questionnaire. Subjects were classified as never smokers, current smokers, and former smokers. Physical activity was measured as the time spent walking/bicycling (almost never, <20 min/d, 20–40 min/d, 40–60 min/d, 1–1.5 min/d, and >1.5 min/d) and exercising (<1 h/wk, 1 h/wk, 2–3 h/wk, 4–5 h/wk, and >5 h/wk); the time was summed and categorized into tertiles. Information on calcium supplements was also obtained in 1997, and subanalyses were done in which subjects reporting an intake of such supplements were excluded.

**Statistical analyses**

For each of the 5 types of dairy product variables (whole milk and sour milk, medium-fat milk, low-fat milk and sour milk, cheese, and butter), the associations between the change in intake and a mean weight gain of ≥1 kg/y during follow-up were calculated as age-adjusted odds ratios (ORs) with the use of logistic regression analyses; the group with constant low intake was used as a reference group. Further adjustments were made for height (continuous) and weight (quartiles) at baseline; education (<10, 10–12, and >12 y); parity; intakes at baseline of energy, fat, carbohydrate, protein, fiber, and alcohol; the absolute change in intakes of these nutrients during follow-up (quartiles); and the studied categories of change in intake of the other 4 dairy products presented in the table.

### Table 2

<table>
<thead>
<tr>
<th>Dairy product consumption at baseline (servings/d)</th>
<th>&lt;1</th>
<th>Increased to ≥1 serving/d at follow-up</th>
<th>≥1</th>
<th>Decreased to &lt;1 serving/d at follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy product consumption at baseline (servings/d)</td>
<td>10341</td>
<td>3046</td>
<td>1.6</td>
<td>0.7</td>
</tr>
<tr>
<td>Age-adjusted model</td>
<td>1</td>
<td>0.91 (0.80, 1.01)</td>
<td>0.75 (0.65, 0.86)</td>
<td>0.84 (0.74, 0.95)</td>
</tr>
<tr>
<td>Multivariable-adjusted model</td>
<td>1</td>
<td>0.94 (0.82, 1.07)</td>
<td>0.85 (0.73, 0.99)</td>
<td>0.91 (0.79, 1.05)</td>
</tr>
<tr>
<td>Medium-fat milk, 1.5% fat</td>
<td>13713</td>
<td>2384</td>
<td>1.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Median intake (servings/d)</td>
<td>4.0</td>
<td>0.9</td>
<td>1.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Age-adjusted model</td>
<td>1</td>
<td>0.92 (0.80, 1.06)</td>
<td>0.88 (0.73, 1.07)</td>
<td>0.85 (0.73, 0.99)</td>
</tr>
<tr>
<td>Multivariable-adjusted model</td>
<td>1</td>
<td>0.95 (0.82, 1.10)</td>
<td>0.90 (0.74, 1.10)</td>
<td>0.84 (0.72, 0.99)</td>
</tr>
<tr>
<td>Low-fat milk and sour milk, 0.5% fat</td>
<td>8810</td>
<td>3553</td>
<td>1.15 (1.02, 1.30)</td>
<td>1.25 (1.12, 1.40)</td>
</tr>
<tr>
<td>Median intake (servings/d)</td>
<td>10341</td>
<td>3046</td>
<td>1.25 (1.12, 1.40)</td>
<td>1.14 (1.00, 1.31)</td>
</tr>
<tr>
<td>Age-adjusted model</td>
<td>1</td>
<td>1.09 (0.95, 1.24)</td>
<td>1.03 (0.90, 1.18)</td>
<td>1.01 (0.87, 1.18)</td>
</tr>
<tr>
<td>Multivariable-adjusted model</td>
<td>1</td>
<td>0.95 (0.82, 1.10)</td>
<td>0.90 (0.74, 1.10)</td>
<td>0.84 (0.72, 0.99)</td>
</tr>
<tr>
<td>Cheese</td>
<td>1765</td>
<td>3196</td>
<td>2.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Median intake (servings/d)</td>
<td>4.4</td>
<td>1.4</td>
<td>2.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Age-adjusted model</td>
<td>1</td>
<td>0.90 (0.76, 1.06)</td>
<td>0.67 (0.58, 0.78)</td>
<td>0.87 (0.72, 1.05)</td>
</tr>
<tr>
<td>Multivariable-adjusted model</td>
<td>1</td>
<td>0.87 (0.72, 1.04)</td>
<td>0.70 (0.59, 0.84)</td>
<td>0.93 (0.76, 1.14)</td>
</tr>
<tr>
<td>Butter</td>
<td>9838</td>
<td>2534</td>
<td>2.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Median intake (servings/d)</td>
<td>0.0</td>
<td>1.1</td>
<td>2.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Age-adjusted model</td>
<td>1</td>
<td>0.92 (0.80, 1.05)</td>
<td>0.78 (0.69, 0.89)</td>
<td>0.94 (0.83, 1.06)</td>
</tr>
<tr>
<td>Multivariable-adjusted model</td>
<td>1</td>
<td>0.97 (0.84, 1.11)</td>
<td>0.92 (0.80, 1.05)</td>
<td>1.02 (0.90, 1.15)</td>
</tr>
</tbody>
</table>

1 Odds ratios were calculated by using logistic regression.
2 The average level of exposure during follow-up (the sum of the intake at baseline and follow-up divided by 2).
3 Adjusted for age (5-y groups) at baseline.
4 Odds ratios; 95% CIs in parentheses (all such values).
5 Adjusted for age; height and weight at baseline; education (<10, 10–12, and >12 y); parity; intakes at baseline of energy, fat, carbohydrate, protein, fiber, and alcohol; the absolute change in intakes of these nutrients during follow-up (quartiles); and the studied categories of change in intake of the other 4 dairy products presented in the table.
FIGURE 1. Odds ratios (ORs) and 95% CI for the association between the frequency of dairy product consumption (increased intakes, decreased intakes, constant intakes) and a mean weight gain of ≥1 kg/y over 8.8 y of follow-up in normal-weight [BMI (in kg/m²) <25] and overweight (BMI ≥25) women at baseline, calculated by using logistic regression. Risk estimates were adjusted for age and height at baseline; education (<10, 10-12, and ≥12 y); quartiles of changes in intakes of energy, fat, carbohydrate, protein, fiber, and alcohol; and the change in intake of the other 4 dairy products presented. n values are in italic type. The P value for the differences between normal-weight and overweight women, calculated by including an interaction term in the logistic-regression model, was 0.003 for whole milk and sour milk, 0.016 for medium-fat milk, 0.039 for low-fat milk, 0.011 for cheese, and <0.001 for butter.
RESULTS

For the whole study sample of 19,352 women, the mean (±SD) age at baseline was 46.3 ± 4.5 y, and the mean (±SD) BMI was 23.7 ± 3.5. Baseline characteristics of the study sample according to their consumption of dairy products are shown in Table 1. Except for cheese, for which 74% of the women consumed ≥1 serving/d, most of the women consumed <1 serving/d of each type of dairy product. For whole milk and sour milk, cheese, and butter, BMI was statistically significantly higher in subjects with a low intake than in subjects with a high intake, whereas for low-fat milk and sour milk, BMI was statistically significantly lower in subjects with a low intake.

For each type of dairy product, the reported energy intake was significantly higher in women who consumed the product ≥1 serving/d than in women who consumed the product less often; however, the difference was small for low-fat milk and sour milk. The percentage of energy from fat differed between the 2 consumption levels in line with the fat content of the dairy products; for instance, for whole milk and sour milk the fat intake was higher in the women with a high intake than in the women with a low intake of these foods. For all dairy products with the exception of butter, the intake of calcium was significantly higher in the women with a high intake than in the women with a low intake of the product (Table 1).

On average, 63% of the women had <10 y of education and 27% had ≥12 y of education. Most of the women had ≥2 children and 9% had no children. Statistically significant differences in education and parity between the 2 consumption levels for some of the dairy products were observed (Table 1).

The mean (±SD) duration of follow-up was 8.8 ± 0.8 y. The mean (±SD) weight gain in the whole cohort was 0.33 ± 0.63 kg/y. The association between changes in intake of the 5 types of dairy products and the risk of a mean weight gain of ≥1 kg/y is presented in Table 2. For whole milk and sour milk and cheese, the women with a constant intake of ≥1 serving/d during the follow-up period had a statistically significant lower risk of gaining ≥1 kg/y than did the women with a constant lower intake of these products. The odds ratios for the women who increased or decreased their intake of these dairy products were not statistically significant; however, the trends indicated that women who increased their intake had a lower risk of gaining ≥1 kg/y than did the women with a constant low intake and that the women who decreased their intake had a higher risk of gaining ≥1 kg/y than did the women with a constant high intake. For medium-fat milk, no clear trends were seen. No statistically significant associations were seen for low-fat milk and butter.

Further adjustments for the intakes of calcium, CLA, and coffee (at baseline and change during follow-up) did not affect the results. Furthermore, the findings did not change when the women who reported the use of calcium supplements in the 1997 questionnaire were excluded.

To address effect modification by body weight, analyses were performed separately for normal-weight and overweight women (BMI < 25 and ≥ 25, respectively, at baseline; Figure 1). P values for the interaction between BMI and dairy products are presented in the figure legend. For cheese intake, results similar to those presented in Table 2 were observed, whereas a constant intake of ≥1 serving/d of whole milk and sour milk was associated with a lower risk of gaining ≥1 kg/y in the normal-weight women only. No statistically significant results were observed for medium-fat milk, low-fat milk, or butter for either overweight or normal-weight women.

For whole milk and sour milk for normal-weight women, multivariable regression analyses using weight gain as a continuous outcome showed that, compared with the group with a constant intake of <1 serving/d, the average change in body weight for a 10-y period was −0.42 kg (P = 0.004) in the group with a constant intake of ≥1 serving/d, −0.34 kg (P = 0.014) for the group who decreased their intake from ≥1 to <1 serving/d, and −0.40 kg (P = 0.004) for the group who increased their intake from <1 to ≥1 serving/d. The respective values for cheese were −0.57 kg (P = 0.001), −0.26 kg (P = 0.24), and −0.25 kg (P = 0.22). The combination of a constant high intake of both whole milk and sour milk and cheese corresponds to a difference of −0.99 kg compared with a low intake of these products. For overweight women, no statistically significant parameter estimates were observed for either whole milk and sour milk or cheese.

The influence of smoking and physical activity on the association between the intake of dairy products and body weight was examined by using cross-sectional data from 1997. For each type of dairy product, the association between the intake frequency and the prevalence of overweight was calculated by using logistic regression adjusted for age, education, and dietary intake (energy, protein, fat, carbohydrates, fiber, and alcohol). The association was not changed when further adjustments for smoking and physical activity were made (data not shown).

DISCUSSION

The consumption of dairy products has become of considerable interest from a public health point of view because these foods have been suggested to play a beneficial role in the regulation of body weight. Inverse associations between the intake of dairy foods or calcium have been observed in several cross-sectional studies (6–10). However, longitudinal observational data are sparse. In the CARDIA (Coronary Artery Risk Development in Young Adults) study of US adults, an inverse association between the intake frequency of total dairy products and the 10-y cumulative incidence of obesity (BMI < 30) was observed at baseline in overweight subjects (BMI ≥ 25) but not in normal-weight subjects (11). In a smaller study of young women participating in an exercise intervention, calcium intake at baseline was inversely related to changes in weight and body fat over 2 y, regardless of exercise group (12). Also, in a reevaluation of 2 studies of calcium intake in middle-aged women that was originally designed with skeletal endpoints, an inverse association was observed between the ratio of calcium to protein in the diet and weight change (10).

To our knowledge, only one previous study has specifically investigated the relation between changes in intake of dairy products or calcium and long-term weight gain. In this study, The
Health Professionals Follow-Up Study, no association between changes in dairy intakes and calcium and changes in body weight over 12 y were observed; however, men with the largest increase in high-fat dairy product intakes gained significantly more weight than did the men who decreased their intake the most (16). Our study is similar to the Health Professionals Follow-Up Study in its prospective design, large sample size, and long follow-up period. However, the current study was a population-based cohort of middle-aged Swedish women and we also specifically looked at the intake of different types of dairy products. Our cohort was restricted to women aged 40–55 y to avoid effects of weight loss because of aging. The Health Professionals Follow-Up Study included men aged 40–75 y; however, no effect modification by age at baseline (≤65 and ≥65 y) was observed. Another difference is that we looked at absolute intakes of dairy products (<1 and ≥1 serving/d), whereas the change in intake was categorized as quintiles in the Health Professionals Follow-Up Study. Similar to the Health Professionals Follow-Up Study, we found no association between intake of low-fat milk products and weight gain in the current study. The trend, if any, was rather the opposite. However, an inverse association between the intake of whole milk and sour milk was observed, which is not in line with the findings of the Health Professionals Follow-Up Study.

Several possible mechanisms for a potential beneficial role of dairy products on body weight have been proposed. Dietary calcium has been suggested to play a key role in the regulation of energy metabolism by down-regulating the concentrations of circulating parathyroid hormone and calcitriol. This increases the uptake of calcium in adipocytes, which in turn stimulates lipolysis and inhibits fatty acid synthesis (5). In recent studies, a positive association between whole-body fat oxidation and acute (29) and long-term (1 y) calcium intakes (30) was observed, whereas no significant effects were detected in 2 studies of short-term (1 wk) calcium intake (31, 32). Dietary calcium may also affect energy regulation by increasing fcal fat and, hence, the excretion of this energy-rich nutrient (32). However, the content of calcium does not differ between low-fat and full-fat products and the lack of an inverse association between the intake of low-fat milk and sour milk and weight gain seen in both the normal-weight and the overweight women in the current study does not support the significance of dairy calcium intake in weight control. Neither did the adjustment for calcium intake affect the results for any of the dairy products. These results agree with those of the Health Professionals Follow-Up Study and add further evidence that weight gain is not affected by calcium intake, at least in subjects eating their usual diet.

An obvious difference between low-fat and full-fat dairy products is the content of fatty acids. In the current study, no positive association between the consumption of high-fat dairy products and weight gain was observed that might have been expected because of the higher energy density of these products. Our findings were the opposite, at least for the normal-weight women. Dairy fat, together with ruminant fat, is a dietary source of CLA, and short-term supplementation studies in humans have shown that CLA may have fat-reducing effects (3, 33) but also possible adverse effects on insulin sensitivity (34) and blood lipids (35). Although these effects mainly have been attributed to the trans-10, cis-12 isomer of CLA and not to the cis-9, trans-11-CLA, which accounts for 90% of the natural composition of CLA in cow milk, the long-term effects of these fatty acids are not known. However, the adjustment for the intake of CLA did not affect the results in our study.

A limitation of the current study is that we were not able to adjust the results for changes in smoking or physical activity during follow-up; however, in cross-sectional analyses these factors did not affect the association between intake of dairy products and overweight. Although we adjusted the results for the intakes of energy, macronutrients, and fiber, these variables are subject to errors in measurement, and dietary and other lifestyle confounders may not have been fully controlled for. Therefore, the intake of whole milk and sour milk could possibly be a marker for a behavior that promotes weight control and a different role of dairy products in the dietary and lifestyle habits of Swedish women and of American men may contribute to the different results seen in the 2 studies. It is possible that a different role of dairy products in the dietary and lifestyle habits explains the different results observed in overweight and normal-weight women in the current study. However, another methodologic concern in this study is the validity of the dietary data; the correlations between the FFQ and diet records were relatively weak, particularly for whole milk. Errors in the dietary data may be differential, and a contributing factor to the different results in the normal-weight and overweight women could be the lower accuracy of the dietary assessment in the overweight women than in the normal-weight women (36).

In conclusion, the association between the intake of dairy products and weight gain differed according to the type of dairy product and according to the body weight status at baseline. Further studies are needed to elucidate the effects of different types of dairy products and the linkage between the consumption of dairy products and other dietary and lifestyle factors.

REFERENCES
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