Fat and calcium intake in women dieters1–3

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ABSTRACT Low-fat diets are widely recommended to treat hyperlipidemia and obesity and to reduce the risk of coronary heart disease, but concern has been expressed that they may not provide adequate calcium. This study assessed the calcium intake of 247 women from Otago, New Zealand aged 50–65 y consuming a variety of diets. Calcium intake was not reduced in women consuming a lipid-lowering or weight-reducing diet compared with nondieters. Intake was also similar in women consuming <25–30%, or >33% of energy from fat, indicating that calcium intake is not specifically compromised in a low-fat diet. The mean calcium intake of 754 mg/d was, however, below that recommended, with 80% of women receiving 1000 mg Ca/d and one-third <600 mg. Thus, most women need to increase their calcium intake irrespective of dietary energy and fat intakes. Am J Clin Nutr 1996;63:67–71.

KEY WORDS Calcium intake, hyperlipidemia, low-fat diet

INTRODUCTION Osteoporosis and coronary heart disease (CHD) are chronic diseases that are common in many countries and both are costly in terms of individual suffering and use of health care resources. Osteoporotic fractures annually affect ∼2000 women aged >65 y in New Zealand. Osteoporosis is a multifactorial disease, but several lifestyle factors such as regular weight-bearing exercise, not smoking, and an adequate intake of calcium have been identified as important in prevention (1). The New Zealand Working Party Report for the Department of Health recommends a calcium intake of 800 mg/d for women aged <55 y and 1000 mg/d for women aged ≥55 y (1). Some studies suggest that even higher intakes could be beneficial (2, 3). The national Life in New Zealand (LINZ) dietary survey (4) and several regional studies (5, 6) showed that a large proportion of middle-aged women have inadequate calcium intakes.

CHD, diabetes mellitus, and obesity are major causes of morbidity, and low-fat diets play a major role in the treatment of these disorders. In addition, the Nutrition Taskforce advises a reduction in dietary fat to <30–35% of total energy to reduce the risk of developing CHD (7). Dairy products can supply significant amounts of energy and fat, especially saturated fatty acids (SFAs) and are often reduced in the diets of women trying to lose weight or lower their cholesterol concentration. Because more than one-half of the calcium in the diets of New Zealand women generally comes from dairy products, there is concern that this may result in inadequate calcium intake and increase their risk of osteoporosis.

The few studies that have investigated the nutritional adequacy of low-fat diets indicate that calcium intake can be maintained (8–13). However, in some of these studies the diet was actually provided. This study aimed to document the adequacy of calcium intake in free-living women aged 50–65 y who were eating self-selected low-fat diets to reduce their weight or blood lipids.

SUBJECTS AND METHODS

Subject recruitment and background information

Two hundred sixty-three women were selected for this study from screening trials performed by the Department of Human Nutrition (n = 166) and from patients attending the Lipid Clinic at Dunedin Hospital (n = 97) during December 1989–June 1991. All white women aged 50–65 y were asked to participate. The study had ethical approval from the Otago Area Health Board and individual consent was obtained. Information on the participants’ ages, health, menopausal status, smoking practices, education, occupations, use of medication and dietary supplements, and sources of dietary advice was collected in an interview. Socioeconomic status was classified by education and occupation according to the Elley and Irving scale (14).

Dietary information

In the interviews the women were given instructions for completing a semiquantitative food-frequency questionnaire (FFQ). This FFQ contained questions about the consumption of 120 food and drink items (15). This questionnaire and its analysis program were designed in the Nutrition Department for use in a large study in people aged >50 y and was validated against 10-d diet records (15). Some questions were modified slightly to provide additional information about the type and serving size of low-fat and high-calcium foods. For the remaining food items standard serving sizes obtained from data on women aged 45–65 y in the LINZ were used (16). Season was accounted for with items such as fruit, vegetables,

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and soups. The absolute nutrient intakes and the contribution of each food group to the calcium intake were calculated by using nutrient data from the New Zealand food composition database (17).

**Anthropometric information**

The participants’ heights, weights, and waist and hip girths were measured with the subjects wearing light clothing and no shoes. Body mass index (BMI; weight (kg)/height (m²)) and waist-hip ratio were calculated (18).

**Laboratory measurements**

Plasma cholesterol measurement for each subject was made on a fasting blood specimen collected into EDTA by an enzymatic method on a Cobas Fara analyzer (Roche Diagnostics Ltd, New York) using Boehringer kits (Boehringer Mannheim, Mannheim, Germany) or using a Reflotron analyzer (cholesterol screening group; Boehringer Mannheim). Most women from the Lipid Clinic took lipid-lowering medication, so results before drug treatment were noted.

**Statistical analysis**

The data were examined according to each participant’s self-reported dietary regimen with subgrouping into “nondieters,” or “weight-reducing,” “lipid-lowering,” and “lipid- and weight-reducing” diets. One-way analysis of variance using SPSS software (SPSS Inc, Chicago) was used to compare the anthropometric, laboratory, and dietary data of the different groups. The level of significance was taken as 95%. Tukey’s test was then used to determine which subgroups were significantly different (19). The chi-square test was used to determine differences in category information.

**RESULTS**

All women approached to join this study answered the demographic and background questions. 94% completed the FFQ, and 90% had anthropometric and lipid measurements. One-sixth of the women described their diet as weight-reducing, one-quarter as lipid-lowering, one-fifth as both of these, and one-third said they were not dieting. The dieters had been following their regimens for between 1 mo and 10 y.

Age and menopausal status were not significantly different among the diet groups. The mean age was 57.6 y and 91% of the women were postmenopausal. In the weight-reducing groups fewer women were skilled or semiskilled workers and more were retired. Significantly more dieters reported preexisting hyperlipidemia, hypertension, and CHD than did nondieters. In the weight-reducing groups significantly more women had non-insulin-dependent diabetes and BMIs above the recommended value (50% > 30 compared with 15% of nondieters; *P < 0.001, chi-square test*) and central obesity (57% with a waist-hip ratio > 0.8 compared with 15% of nondieters; *P < 0.001, chi-square test*) (18). The mean cholesterol concentration of the lipid-lowering groups was high (7.7 ± 1.7 mmol/L), as expected because most of these women attended the Lipid Clinic. However, those in the nondieting (6.4 ± 1.4 mmol/L) and weight-reducing (6.4 ± 1.4 mmol/L) groups also had mean cholesterol concentrations above the amount recommended by the European Atherosclerosis Society, 5.6 mmol/L (20). Most women did not smoke, 58% had never smoked, and 29% were ex-smokers. More nondieters than dieters smoked. Few women in any group undertook regular weight-bearing exercise. Use of medications likely to influence calcium and bone metabolism was low, and only 8% were past users of estrogen-replacement therapy.

The types of dietary advice the women had received varied between the diet groups—largely reflecting their selection. Few nondieters (7%) had received advice from their general practitioner (GP). Forty percent of the weight-reducing group had been given some dietary advice from their GP only, 28% from a dietitian, 15% from a Lipid Clinic doctor, and 13% from a Lipid Clinic dietitian. Eighteen percent were members of Weight Watchers. Most women in the lipid-lowering groups had been given some information by their GP, and two-thirds had talked to a dietitian or a Lipid Clinic doctor or dietitian at some time.

**Table 1** summarizes the mean energy, fat, SFA, and calcium intakes of the women in each diet group. Fat and SFA intakes varied. The weight- and lipid-lowering group had the lowest energy intake. The lipid-lowering groups had significantly lower fat and SFA intakes than nondieters. All the women consuming lipid-lowering diets obtained < 35% of their energy from fat and < 15% from SFAs, except for eight women with very low energy intakes who consumed < 45 g fat. Two-thirds of the women consuming lipid-lowering diets were consuming a low-fat diet (< 30% of energy as fat) or a low-SFA diet (< 10% of energy as SFAs) as were 40% and 25% of the weight-reducing group, which was significantly more than the nondieters. The proportion of polyunsaturated (PUFA) and monounsaturated (MUFA) fatty acids ingested was significantly higher in the lipid-lowering groups.

**Figure 1** shows the distribution of calcium intakes among the diet groups. The mean calcium intake was 754 mg and the calcium density of the diet was 129 mg/MJ (542 mg/1000 kcal). The dieters and nondieters did not have significantly different intakes. Sixty percent had intakes < 800 mg Ca/d and 80% < 1000 mg Ca/d. Fewer women in the weight-reducing group (23%, *P < 0.01) had a calcium intake < 600 mg compared with the weight- and lipid-lowering (44%), nondieting (36%), and lipid-lowering (35%) groups.

Calcium intake according to actual fat intake is shown in **Figure 2**. In women consuming < 30% energy from fat (55% of total subjects) the median calcium intake was 781 mg compared with 647 mg for women consuming a higher-fat diet. Multiple-regression analysis in a model using calcium as the dependent variable and fat and energy intakes as the independent variables gave the following results: for those not dieting *r² = 0.52*, those weight-reducing *r² = 0.40*, those lipid-lowering *r² = 0.29*, and those weight- and lipid-lowering *r² = 0.66*. Women who had received advice from a GP or Lipid Clinic doctor or dietitian had significantly lower SFA intakes. Those attending the Lipid Clinic and consulting a dietitian had the highest calcium intake. However, there appeared to be no special relation between calcium intake and formal education or socioeconomic status.

Dairy products contributed approximately one-half the total calcium, with 82% of this from milk, particularly milk used in cooking (85%) rather than in drinks (15%). Cheese contributed significantly less calcium in the lipid-lowering groups (4%) than in the nondieters (8%, *P < 0.05*). Ice cream and cottage
TABLE 1
Energy, fat, saturated fatty acid (SFA), and calcium intakes for women in each diet group

<table>
<thead>
<tr>
<th></th>
<th>Not dieting (n = 90)</th>
<th>Weight-reducing (n = 40)</th>
<th>Lipid-lowering (n = 63)</th>
<th>Weight- and lipid-lowering (n = 54)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(MJ)</td>
<td>6.44 ± 1.68</td>
<td>5.93 ± 1.74</td>
<td>5.97 ± 1.27</td>
<td>5.37 ± 1.59</td>
</tr>
<tr>
<td>(kcal)</td>
<td>1533 ± 400</td>
<td>1412 ± 414</td>
<td>1421 ± 302</td>
<td>1279 ± 379</td>
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<tr>
<td><strong>Fat</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(g)</td>
<td>56.3 ± 18.5</td>
<td>49.8 ± 18.6</td>
<td>45.7 ± 14.1</td>
<td>41.9 ± 16.8</td>
</tr>
<tr>
<td>(% of energy)</td>
<td>32.1 ± 5.0</td>
<td>30.6 ± 4.3</td>
<td>28.1 ± 5.2</td>
<td>28.6 ± 6.4</td>
</tr>
<tr>
<td>Subjects with &lt; 35% of energy as fat (%)</td>
<td>72</td>
<td>83</td>
<td>88</td>
<td>87</td>
</tr>
<tr>
<td>Subjects with &lt; 30% of energy as fat (%)</td>
<td>26</td>
<td>40</td>
<td>68</td>
<td>61</td>
</tr>
<tr>
<td><strong>SFA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(g)</td>
<td>23.7 ± 9.7</td>
<td>19.4 ± 9.1</td>
<td>16.2 ± 7.2</td>
<td>14.8 ± 8.3</td>
</tr>
<tr>
<td>(% of energy)</td>
<td>13.5 ± 3.6</td>
<td>11.8 ± 2.7</td>
<td>10.0 ± 3.7</td>
<td>10.0 ± 3.9</td>
</tr>
<tr>
<td>Subjects with &lt; 15% of energy as SFA (%)</td>
<td>62</td>
<td>85</td>
<td>91</td>
<td>94</td>
</tr>
<tr>
<td>Subjects with &lt; 10% of energy as SFA (%)</td>
<td>20</td>
<td>25</td>
<td>60</td>
<td>57</td>
</tr>
<tr>
<td><strong>Calcium (mg)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium density</td>
<td>766 ± 303</td>
<td>769 ± 219</td>
<td>759 ± 281</td>
<td>716 ± 312</td>
</tr>
<tr>
<td>(mg/1000 kcal)</td>
<td>502.4 ± 162.5</td>
<td>568.3 ± 175.9</td>
<td>536.0 ± 169.9</td>
<td>563.3 ± 173.5</td>
</tr>
<tr>
<td>(mg/MJ)</td>
<td>120 ± 39</td>
<td>135 ± 42</td>
<td>128 ± 40</td>
<td>134 ± 45</td>
</tr>
</tbody>
</table>

*<i>± SD.</i>

<sup>1</sup> Significantly different from the not-dieting group, <i>P</i> < 0.05 (one-way ANOVA with Tukey’s test).

<sup>2</sup> Significantly different from the not-dieting group (chi-square test): <i>P</i> < 0.01, <sup>4</sup> <i>P</i> < 0.05, <sup>5</sup> <i>P</i> < 0.001.

<sup>4</sup> P, polyunsaturated fatty acids; S, SFAs; M, monounsaturated fatty acids.

<sup>7</sup> Significantly different from the not-dieting and weight-reducing groups, <i>P</i> < 0.05 (one-way ANOVA with Tukey’s test).

cheese both provided a mean of < 3% of the calcium. Vegetables (excluding potatoes) provided ~17%, and bread, cereals, fruit, and baked products each provided ~5% of calcium. Other food groups provided < 2% of total calcium.

The regular consumption of various types of dairy products differed. Low-fat milk (0.4% fat) was consumed regularly by almost everyone in the lipid-lowering groups, by most women in the weight-reducing group, but by only one-third of the nondieters. More women who were not dieting or on weight-reducing diets consumed full-fat milk (3.5–4.0% fat) compared with those consuming lipid-lowering diets, but only one-sixth of these women drank milk regularly. More than one-half of the non-dieters and weight reducers ate cheddar cheese at least three times a week, which was more than in either lipid-lowering group, in which the women were more likely to eat cottage cheese and lower-fat cheeses.

The most popular supplement was calcium: 25 women used it regularly and 5 took a multivitamin and mineral preparation containing calcium. The median dose was 37 mg Ca (range: 21–1000 mg) and this was included in the calcium intake calculation for these women.

**DISCUSSION**

Whereas a few studies have shown that calcium intake can be maintained with a low-fat diet, the design of these studies made it difficult to determine whether dietary calcium is likely to be maintained when women self-select a low-fat diet in a...
free-living situation. Several of the studies have been small (< 20 subjects; 8, 9, 12) or have had a very high dropout rate in the intervention group (48%) (11). In two studies detailed menus were provided by dietitians (9, 21). Most of the others have been intervention studies involving extensive nutrition education by dietitians, including individual and group counseling and a wide variety of support materials, including tables of low-fat, calcium-rich food products (8, 10–13). In these studies calcium intake was not reduced with the low-fat diet, but this might have been because of the intensive education the subjects received, the emphasis on calcium, and the degree of dietary control. The present study was unique in being a large study that observed the nutrient intake in free-living women who were choosing their own diets and using nutrition services available to the general public, without special emphasis on calcium intake.

The subjects were selected from groups in which the proportion of people consuming weight-reducing and lipid-lowering diets was high because we were specifically interested in their calcium intake. However, every woman in each group was considered for the study. The response rate was very high and a comparison of the demographic and background details of the small number of women (n = 16) who did not complete the FFQ indicated that they were not appreciably different from the participants.

The women were divided by self-reported diet pattern so that groups could easily be identified if it appeared that a particular diet gave an increased risk of low calcium intake. The subjects’ energy and fat intakes suggested that they were generally following the pattern they described. Sixty percent of the lipid-lowering group had received < 10% of their energy from SFAs, as would be advised. The dieters were more likely to have had information than the general public because of the mode of subject selection.

Dietary assessment with FFQs is not ideal for quantifying intake, but the FFQ used in the present study had been shown to give a good correlation with 10-d diet records. The overall correlation for calcium was 0.62, and for calcium and SFAs, 83% and 77%, respectively, were correctly classified within one quintile of the diet-record quintile. Additional quantitative information was also obtained on foods high in fat and calcium. The FFQ used tends to be accurate for assessing usual relative intakes in groups and it was easy to complete, facilitating a high response rate. The women may have guessed that fat intake was being assessed but were not aware that the investigators were interested in calcium intake.

Generally, studies examining the adequacy of calcium intake from a low-fat diet have used an intervention diet with ~ 25% of energy from fat and 10% from SFAs, which reflects a dramatic reduction in fat intake. The mean quantity of fat ingested has varied substantially from 50 g (9, 12, 13) to 35 g (8, 10); men were included in some studies, with higher energy intakes.

In the present study, women who were not dieting or who were consuming weight-reducing diets had fat intakes comparable with baseline intakes in the two studies in women only, and women consuming lipid-lowering diets had slightly higher fat intakes than the subjects consuming low-fat intervention diets in the studies by Buzzard et al (8) and Insull et al (10). The apparent difference, however, may have been due to the method of dietary assessment because FFQs may overestimate nutrient intakes whereas the diet records used by Buzzard et al (8) and Insull et al (10) may underestimate intake because of the inconvenience of recording everything consumed (22). Many of the women in the present study consuming low-fat diets, particularly lipid-lowering diets, had also replaced some SFAs with PUFAs, although the ratio of PUFAs to SFAs was less than in the studies of Nordevang et al (11), Pietinen et al (12), and Retzlaff et al (13), who modified the fat composition to give a ratio of ~ 1.

This study demonstrated that calcium intake did not appear to be reduced when women self-selected a low-fat diet for reasons of weight or blood lipid-lowering despite the achievement of reasonable fat intakes. This is consistent with the findings of other studies with similar fat intakes but much more controlled diets (8–13) although actual intakes do vary. Studies including men generally have higher calcium intakes (12, 21). The calcium intake in the present study was similar to that in other studies of women of their age (8, 10) in which the mean intakes were 628 and 721 mg, respectively. Pietinen et al (12) studied men and younger women (aged 40–49 y) whereas neither Dougherty et al (9) nor Retzlaff et al (13) reported the subjects’ ages. This is relevant because calcium intake has been reported to be appreciably lower in older women compared with their past intakes or with the intake of younger women (4, 23, 24).

The contribution of calcium from different foods in the dieters and nondieters is important. The women generally obtained more than one-half of their calcium from dairy products, mostly from milk, and nondieters ate dairy foods with a frequency similar to that of women in the LINZ study but everyone consuming lipid-lowering diets and most consuming weight-reducing diets chose fat-reduced milk, compared with only one-third of the nondieters. Cheese was a less important source of calcium than in the LINZ study (in which fat intake was 36% of total energy) in women of similar age, possibly indicating a reduction in those dieting. Thus, the calcium from low-fat, high-calcium products, such as low-fat and nonfat dairy products and vegetables, becomes more important as fat intake is reduced. Other studies examining food changes in low-fat diets have also found increased consumption of low-fat dairy products. However, many of these studies were conducted in the United States where low-fat foods, and especially low-fat, high-calcium foods, are more widely available than in New Zealand; the consumption of such foods may be correlated with availability in local stores and point-of-purchase promotion material (25).

Women who reduced their fat intake, generally because they were advised to by their GP or by a Lipid Clinic doctor or dietitian did not appear to reduce their calcium intake, but rather obtained it from different sources. The low calcium intake of all groups is, however, of considerable concern. More than 70% had an intake below the recommended 1000 mg Ca for postmenopausal women and virtually all had an intake below the 1500 mg advised by the recent Hong Kong Consensus Conference on Osteoporosis (26). One-third had intakes < 600 mg. This is consistent with results from the LINZ study (4), in which the average intake was only 556 mg, and with regional studies (5, 6). Most women need encouragement to eat low-fat, calcium-rich foods as well as to undertake other lifestyle changes such as increased weight-bearing exercise, to reduce their risk of developing osteoporosis.
We thank Ross Marshall for assisting with the analysis of the food-frequency questionnaires.

REFERENCES