Appendix E-3.9
Reducing Cholesterol-Raising Fatty Acids: Food Pattern Modeling Analysis

RESEARCH QUESTION

What is the impact on food choices and overall nutrient adequacy of limiting cholesterol-raising (CR) fatty acids to <7% of total calories and to <5% of total calories, with CR fatty acids operationalized as total saturated fatty acids minus stearic acid?

BACKGROUND

The current USDA food patterns were designed to meet adequacy and moderation goals. These goals include 20-35% of calories from total fat and <10% of calories from saturated fats.

The food patterns were developed by identifying amounts of foods that would meet all nutritional goals within caloric limits, using the most nutrient-dense form of each food in all food groups—which means that the food items selected are in forms without excess solid fats. For example, 95% lean ground beef represents all ground beef, low fat or fat-free cheeses represent all cheeses, baked chicken without skin represents all chicken. Nutrient profiles for each food group are calculated using foods such as these, all in nutrient-dense forms, to represent all foods in the food group. (For a description of the representative foods, how nutrient profiles for each of the food groups are calculated, and how the overall patterns are developed, see Appendix E-3.1 *Adequacy of USDA Food Patterns*.)

To allow for flexibility in food choices, each pattern identifies the number of additional calories that fit within the calorie goal after nutrient needs are met from nutrient-dense food choices. These additional calories are termed "discretionary calories" (DC) since they are not needed to meet nutrient needs.[1] Amounts of DC in the patterns are very small in comparison to consumed amounts of food components that are always discretionary (solid fats, added sugars, and alcohol). Inclusion of a small number of DC, however, allows for some flexibility in food choices while still meeting nutrient needs within calorie limits. For example, using the DC allowance, a person could choose to consume whole milk OR 80% lean ground beef OR regular cheese OR fried chicken, rather than a nutrient-dense form of the food. For almost all individuals, the DC is not large enough to allow many of these choices on any single day.

To permit analysis of macronutrients in the patterns, the DC allowance is split between equal amounts (by caloric value) of solid fats and added sugars. Solid fats are a composite of the various types of fat consumed that are solid at room temperature—for example, the fat in regular ground beef, cheese, butter, or shortening. Solid fats may be consumed either as part of a food or added to a food. Oils are not considered to be solid fats and are a separate component of the food patterns. Solid fats are a major contributor to the saturated fat content of the food patterns. Since solid fats are not needed for nutrient adequacy, modifying the amount of solid fats in the patterns is the preferred approach to modifying the fat content of the patterns.

[1] The term "discretionary calories" (DC) is no longer used in the 2010 DGAC report. DC allowances in the USDA food patterns have been replaced with maximum limits on solid fats and added sugars (SoFAS). For purposes of this analysis, the term DC is used and can be directly translated to limits on SoFAS.

The amounts of total fat, saturated fat, MUFAs, PUFAs, and stearic acid in a reference amount of each food group and component in the USDA food patterns are listed in Table 1.

Table 1. Total fat and fatty acids in reference amounts of each food group and the oils and solid fats components of the USDA food intake patterns

Food group or component	Reference amount	Total fat (g)	Total saturated fatty acids (g)	MUFAs (g)	PUFAs (g)	Stearic acid (g)
Fruit	1 cup eq	0.31	0.054	0.039	0.087	0.004
Vegetables						
Dark green	1 cup eq	0.46	0.078	0.037	0.192	0.011
Red-Orange	1 cup eq	0.29	0.042	0.037	0.123	0.009
Dry beans & peas	1 cup eq	1.48	0.282	0.256	0.673	0.026
Starchy	1 cup eq	2.81	0.738	1.389	0.360	0.261
Other	1 cup eq	1.10	0.167	0.585	0.212	0.011
Grains						
Whole	1 ounce eq	1.35	0.260	0.407	0.488	0.035
Nonwhole	1 ounce eq	1.16	0.281	0.441	0.315	0.106
Meat						
Meats	1 ounce eq	1.93	0.751	0.855	0.097	0.255
Poultry	1 ounce eq	1.88	0.514	0.656	0.426	0.126
Fish (high n-3)	1 ounce eq	2.50	0.533	0.858	0.887	0.072
Fish (low n-3)	1 ounce eq	0.62	0.134	0.207	0.176	0.028
Eggs	1 ounce eq	5.31	1.634	2.039	0.707	0.414
Soy products	1 ounce eq	1.90	0.426	0.541	0.651	0.084
Nuts & seeds	1 ounce eq	7.53	1.162	3.685	2.368	0.231
Milk	1 cup eq	1.47	0.878	0.389	0.082	0.168
Oils	10 grams	9.73	1.468	3.442	4.448	0.405
Solid fats	10 grams	9.13	3.476	3.408	1.724	1.008

METHODS

- Calculated the percent of calories from total saturated fatty acids, stearic acid, and CR fat (saturated fatty acids minus stearic acid) in the current USDA food patterns at each calorie level.
- Removed the solid fats component from the food patterns, and substituted isocalorically with oils.
- Calculated levels of total saturated fatty acids, stearic acid, and CR fat in the revised food patterns.
- Identified changes in the food patterns that would be needed to bring CR fat to <7% and <5% of calories, and identified the impact of each on food selections and other nutritional goals.

RESULTS

Saturated fatty acids and CR fatty acids in current USDA food patterns

The current USDA food patterns, with solid fats providing 50% of the DC allowance, meet the criteria of having less than 7% of calories from CR fats. As shown in Table 2, the level of saturated fatty acids in the patterns ranges from 7.9% to 9.2% of calories, and the level of CR fatty acids ranges from 5.8% to 6.7% of calories. (A complete list of all nutrients in each pattern is found in Appendix E-3.1, *Adequacy of USDA Food Patterns*, Table A4.) The levels of saturated fatty acids in the USDA food patterns are substantially lower than the average amount consumed by Americans age 2 years and older in 2005-2006: 27.8 grams/day (11.4% of calories). For example, the reference 2000 calorie pattern has 18.7 grams of saturated fatty acids (8.4% of calories).

Table 2. Energy, total fat, saturated fatty acids, stearic acid, and CR fatty acids in the USDA food patterns

Calorie level	Energy (kcal)	Total fat (g)	Total fat (% of kcal)	Total saturated fatty acids (g)	Total saturated fatty acids (% of kcal)	Stearic acid (g)	Stearic acid (% of kcal)	CR fatty acids (saturated minus stearic) (g)	CR fatty acids (saturated minus stearic) (% of kcal)
1000	992	36	33.0%	9.7	8.8%	2.6	2.3%	7.2	6.5%
1200	1200	43	32.3%	11.2	8.4%	3.0	2.2%	8.2	6.2%
1400	1389	47	30.5%	12.3	7.9%	3.3	2.1%	9.0	5.8%
1600	1602	55	30.8%	14.0	7.9%	3.6	2.0%	10.4	5.8%
1800	1797	61	30.7%	15.8	7.9%	4.2	2.1%	11.5	5.8%
2000	1997	71	32.1%	18.7	8.4%	5.0	2.2%	13.7	6.2%
2200	2190	77	31.8%	20.1	8.3%	5.4	2.2%	14.8	6.1%
2400	2384	86	32.3%	22.5	8.5%	6.0	2.3%	16.4	6.2%
2600	2583	92	32.1%	24.0	8.4%	6.5	2.3%	17.5	6.1%
2800	2795	99	31.8%	25.7	8.3%	6.9	2.2%	18.7	6.0%
3000	2985	111	33.4%	28.4	8.6%	7.7	2.3%	20.7	6.2%
3200	3182	126	35.6%	32.6	9.2%	8.9	2.5%	23.7	6.7%

The sources of saturated fatty acids, MUFAs, PUFAs, and CR fatty acids in the reference 2000 calorie pattern are shown in Table 3. The largest contributor to CR fat in the pattern is solid fats (3.9 g), with somewhat less contributed by the meat (3.0 g), oils (2.9 g), and milk (2.1 g). Little of the CR fat comes from fruit, vegetables, or grains.

Table 3. Sources of fatty acids in the reference USDA 2000-calorie pattern

Food group/component	Amount	Total fat (g)	Total saturated fatty acids (g)	MUFAs (g)	PUFAs (g)	CR fatty acids (g)
Fruit	2 cup eq	0.62	0.108	0.077	0.175	0.100
Vegetables	2 ½ cup eq	3.28	0.730	1.420	0.660	0.524
Grains	6 ounce eq	7.55	1.624	2.545	2.410	1.202
Meat & beans	5 ½ oz eq	14.46	4.082	6.118	2.638	2.939
Milk	3 cup eq	4.41	2.633	1.167	0.245	2.130
Oils	27 grams	26.28	3.962	9.294	12.010	2.868
Solid fats	16 grams*	14.61	5.562	5.453	2.759	3.949
Totals		71.20	18.703	26.073	20.895	13.712

*Assumes one-half of all DC are consumed as solid fats.

Modifications to current USDA food patterns to reduce CR fatty acids to <5% of calories

In an attempt to meet the lower criterion of <5% of calories from CR fats, all discretionary solid fats were removed from the patterns and were substituted isocalorically with oils. While lowering the CR fats substantially, this substitution resulted in some but not all levels of CR fats being <5% of total calories. Amounts of CR fats in the patterns after this substitution ranged from 4.9% to 5.3%, as shown in Table 4.

While oils contain a much greater percentage of MUFAs and PUFAs than solid fats do, they still contain some saturated fatty acids. As shown in Table 4, when substituting all of the solid fat calories with oils, the CR fat was slightly greater than 5% of calories in some of the patterns. Among solid fats, the percentage of fatty acids that are saturated is 38%; among oils that percentage is 15%. The percentage of fatty acids in solid fats that are CR is 11%; in oils it is 4%.

Table 4. Calories and fatty acids in USDA food patterns modified by substituting oils for solid fats

Calorie level	Energy (kcal)	Total fat (g)	Total fat (% of kcal)	Total saturated fatty acids (g)	Total saturated fatty acids (% of kcal)	Stearic acid (g)	Stearic acid (% of kcal)	CR fatty acids (saturated minus stearic) (g)	CR fatty acids (saturated minus stearic) (% of kcal)
1000	992	36	33.0%	7.8	7.1%	2.0	1.8%	5.8	5.3%
1200	1200	43	32.3%	9.3	7.0%	2.4	1.8%	6.9	5.2%
1400	1389	47	30.5%	10.4	6.7%	2.7	1.8%	7.7	5.0%
1600	1602	55	30.8%	12.5	7.0%	3.2	1.8%	9.4	5.3%
1800	1797	61	30.7%	13.7	6.9%	3.5	1.8%	10.2	5.1%
2000	1997	71	32.1%	15.4	6.9%	4.0	1.8%	11.4	5.1%
2200	2190	77	31.8%	16.6	6.8%	4.3	1.8%	12.3	5.1%
2400	2384	86	32.3%	18.1	6.8%	4.7	1.8%	13.3	5.0%
2600	2584	92	32.1%	19.2	6.7%	5.0	1.8%	14.2	4.9%
2800	2795	99	31.8%	20.4	6.6%	5.4	1.7%	15.1	4.9%
3000	2985	111	33.5%	22.3	6.7%	5.9	1.8%	16.4	5.0%
3200	3183	126	35.6%	24.6	7.0%	6.5	1.8%	18.1	5.1%

SUMMARY

The USDA food patterns include foods only in their most nutrient-dense forms (without excess solid fats). A small discretionary calorie (DC) allowance can be incorporated in each pattern, which allows for some solid fats and/or other less nutrient-dense choices. For analysis of macronutrients, the DC allowance is divided equally between calories from solid fats and calories from added sugars. With this division of DC, the USDA food patterns contain from 7.9% to 9.2% of calories from saturated fatty acids, and from 5.8% to 6.7% of calories from cholesterol-raising (CR) fatty acids (operationalized as saturated fats minus stearic acid). To further reduce levels of saturated and CR fatty acids, all solid fats were removed from the patterns and were isocalorically replaced with oils. With this modification, total saturated fatty acids were decreased to 6.6% - 7.1% of calories and cholesterol-raising (CR) fatty acids were decreased to 4.9% - 5.3% of calories.