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Original Article

A New Method for Calculating Fat Content and Determining Appropriate Fat Levels in Foods

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Abstract

Background: Calculating the fat content per 100 g or 100 mL, 50 g, or the reference amount customarily consumed (RACC) shows the fat content of some foods inappropriately. Therefore, making some food choices based on them to limit fat intake may increase the risks of some chronic diseases.

Methods: We calculated the fat content and determining appropriate fat levels (to limit fat intake) based on U.S. Food and Drug Administration (FDA), Codex Alimentarius Commission (CAC), and the proposed method were performed on 8,596 food items during July 2018 to June 2020 in Tehran, Iran. Information on food and fat profiles was provided from the USDA National Nutrient Database for Standard Reference, released in 2016.

Results: Making some food choices based on the CAC per 100 g or 100 mL or FDA per serving (the serving is derived from the RACC, 100 g, or 50 g) to limit fat intake exceeded fat needs, which may increase the risks of some chronic diseases. Some foods that did not exceed fat needs were not appropriate food choices based on the CAC per 100 g or 100 mL or FDA per serving to limit fat intake. Some foods were free of, but not low in, fat, based on the FDA per serving.

Conclusion: Making food choices based on the proposed method to limit fat intake did not exceed fat needs and the appropriate percentage of energy from fat. Also, foods that did not exceed fat needs were appropriate food choices based on the proposed method to limit fat intake.

Keywords: Dietary fat; Excessive fat intake; Appropriate fat intake; Obesity; Coronary heart disease

Introduction

Fat is a major source of fuel energy for the body and aids in the absorption of fat-soluble vitamins (vitamins A, D, E, and K) and carotenoids (1). Fatty acids function in cell signaling and alter the expression of specific genes involved in lipid and carbohydrate metabolism (2). High fat diets in excess of energy needs can cause obesity (2,3-7). Several studies have shown associations between high fat intakes and an increased risk of coronary heart disease (2,4,6,7), cancer (2,4,7), and insulin resistance (2,4-6); however, the type of fatty acid

consumed is very important in defining these associations (2).

The fat content is mainly calculated in reference amounts of food, including 100 g (for solids) or 100 mL (for liquids) and RACC (8). The fat content is directly associated with the amount of food, so increasing the amount of food enhances the fat content, and decreasing the amount of food reduces the fat content (except food without fat). Calculating the fat content per 100 g or 100 mL shows the fat content of some foods inappropriately high or low because some foods are customarily consumed in amounts less or more than 100 g or 100 mL per eating occasion. Moreover, since the RACC for some foods is small and exceeding the RACC can easily occur for small RACCs, calculating the fat content per RACC shows the fat content of small RACCs inappropriately low, and excessive intake of fat can increase the risks of some chronic diseases.

According to the regulatory requirements for nutrient content claims, appropriate fat levels (to limit fat intake) in foods should be determined based on the fat free and low fat claims. The fat free and low fat claims indicate the presence of fat at insignificant and low levels, respectively. If one food meets the definition of the low fat or fat free claim, that food is considered low fat or fat free food, respectively. Foods that meet the fat free or low fat claim are known as foods containing appropriate fat levels. Nutrient content claims were established by several authorities, and the CAC and FDA are the most important among them (8). The fat free and low fat claims are expressed in reference amounts of 100 g (for solids) or 100 mL (for liquids) and serving size (serving) based on the CAC and FDA, respectively (9-11). According to the fat free and low fat claims under the FDA per serving, the serving is derived from the RACC, 100 g, or 50 g (9).

We calculated the fat content and determined appropriate fat levels based on the FDA per serving and CAC per 100 g or 100 mL. Also, we introduced a new method for calculating the fat content and determining appropriate fat levels in foods. The proposed method was used for calculating contents and determining appropriate levels of calcium (12), thiamin (13), copper (14), and dietary fiber (15) in foods.

Methods

Food items

This study was performed during July 2018 to June 2020 in Tehran, Iran. Information on food and fat profiles was provided from the USDA National Nutrient Database for Standard Reference, released in 2016 (SR28) (16).

RACCs

RACC values represent the amount (edible portion) of food customarily consumed per eating occasion (17). RACCs were not provided in the SR28 Excel data file. However, the preparation of results on the basis of the serving required the allocation of RACCs to food items. Thus, RACCs were allocated to SR28 food items using the guidance prepared by the Office of Nutrition and Food Labeling (17). RACCs were allocated to 8,596 food items.

Calculation of fat content per 100 mL

The fat content of food items in the SR28 was provided per 100 g. Since the fat content of liquid food items based on the CAC per 100 mL should have been provided per 100 mL, the densities of liquid food items were calculated by Formula 1. Then, the fat content was converted from 100 g to 100 mL by Formula 2. Solid and liquid foods refer to foods that are usually measured by weight and volume, respectively.

Formula 1: $\text{Density}_{(g/mL)} = \text{mass}_{(g)} \div \text{volume}_{(mL)}$

Formula 2: $\text{Fat content}_{(g)}$ per 100 mL (for liquids) = $\text{density}_{(g/mL)} \times \text{fat content}_{(g)}$ per 100 g

Calculation of fat content based on the proposed method in conditions of appropriate RACC

If RACC is not small, the fat content of foods is calculated per RACC. Moreover, if RACC is not small, the fat free and low fat claims are determined per RACC. The fat content per RACC for solid and liquid foods was calculated by Formulas

3 and 4, respectively. According to the proposed method, small RACC means RACC less than 30 g.
Formula 3: Fat content $_{(g)}$ per RACC (for solids) = (RACC $_{(g)}$ ÷ 100) × fat content $_{(g)}$ per 100 g
Formula 4: Fat content $_{(g)}$ per RACC (for liquids) = (RACC $_{(mL)}$ ÷ 100) × (density $_{(g/mL)}$ × fat content $_{(g)}$ per 100 g).

Calculation of fat content based on the proposed method in conditions of small RACC

The RACC for some foods is small, and exceeding the RACC can easily occur for small RACCs. Thus, if RACC is less than 30 g, the fat content is calculated per 30 g of food. If RACC is less than 30 g, the fat free and low fat claims are determined per 30 g of food. The fat content per 30 g of food was calculated by Formula 5. The 30 g criterion refers to the prepared form of the food. The process of calculating the fat content of foods based on the proposed method is shown in Fig. 1.
Formula 5: Fat $_{(g)}$ content per 30 g = fat content $_{(g)}$ per 100 g × 0.3

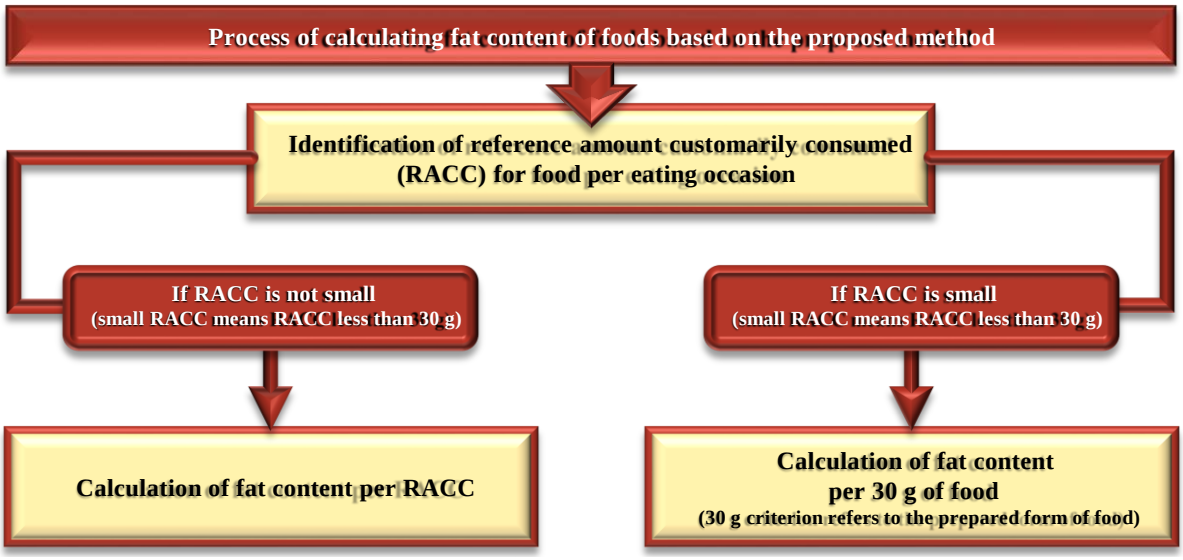

Fig. 1: The process of calculating the fat content of foods based on the proposed method

Daily values for fat

Daily values (DVs) for fat (total fat) were considered 77.78 g for all foods, excluding baby foods, and 38.9 g for baby foods in this study (21CFR101.9, revised as of Apr 1, 2018).

Nutrient reference values for fat

Nutrient reference values (NRVs) for fat were considered 66.667 g (6) for all foods, excluding baby foods, and 38.9 g (21CFR101.9, revised as of Apr 1, 2018) for baby foods in this study.

Meals and main dishes

Meals and main dishes in the SR28 food items were specified using the main dish product and meal product definitions established in 21CFR101.13 (revised as of Apr 1, 2018).

Number of daily servings

Establishing fat amounts of the fat free and low fat claims based on the proposed method required to determine the number of daily servings. The number of daily servings at three energy levels (1,600 kcal, 2,200 kcal, and 2,800 kcal) was 15-26 servings: fruits, 2-4 servings; vegetables, 3-5 servings; dairy, 2-3 servings; grains, 6-11 servings; and protein foods, 5-7 ounces to provide a total of 2-3

servings (18). According to the number of daily servings at three energy levels, the number of daily servings at the 2,000 kcal level was determined 17.8-20 servings. Since exceeding the number of daily servings could result in exceeding the DVs or NRVs (fat) for some foods low in fat, the number of daily servings was determined 20 in this study. Since a typical consumer eats 20 or fewer servings of food per day (19,20), the definition of "low" should enable that consumer to stay at or below 100 percent of the DV or NRV for a given nutrient (20).

Fat free and low fat claims

Table 1 presents the fat free and low fat claims based on the proposed method, FDA per serving, and CAC per 100 g or 100 mL.

Table 1: Fat free and low fat claims based on the proposed method, FDA per serving, and CAC per 100 g or 100 mL

Claim	*Proposed method*	*FDA per serving (9)*	*CAC per 100 g or 100 mL (10,11)*
Fat free claim	2,000 kcal: 0.389 g (0.5% of DV) or less of fat per RACC (and per 30 g of food if RACC is less than 30 g) and 35% or less of energy from fat 1,000 kcal: 0.195 g (0.5% of DV) or less of fat per RACC (and per 30 g of food if RACC is less than 30 g) and 35% or less of energy from fat	All foods, excluding meals and main dishes: Less than 0.5 g (0.643% of DV) of fat per RACC and per labeled serving Meals and main dishes: Less than 0.5 g (0.643% of DV) of fat per labeled serving	Solids: 0.5 g (0.75% of NRV) or less of fat per 100 g Liquids: 0.5 g (0.75% of NRV) or less of fat per 100 mL
Low fat claim	2,000 kcal: 3.889 g (5% of DV) or less of fat per RACC (and per 30 g of food if RACC is less than 30 g) and 35% or less of energy from fat 1,000 kcal: 1.945 g (5% of DV) or less of fat per RACC (and per 30 g of food if RACC is less than 30 g) and 35% or less of energy from fat	All foods, excluding meals and main dishes: 3 g (3.857% of DV) or less of fat per RACC (and per 50 g of food if RACC is 30 g or less or 2 tablespoons or less) Meals and main dishes: 3 g (3.857% of DV) or less of fat per 100 g and 30% or less of energy from fat	Solids: 3 g (4.5% of NRV) or less of fat per 100 g Liquids: 1.5 g (2.25% of NRV) or less of fat per 100 mL

Results

Foods containing appropriate fat levels based on the proposed method

About 95.7% of foods contained fat. On the basis of the proposed method, the averages (%) of fat free and low fat foods in food groups were 15.73% and 44.35%, respectively. The averages (%) of foods containing appropriate fat levels based on the proposed method in food groups are shown in Fig. 2.

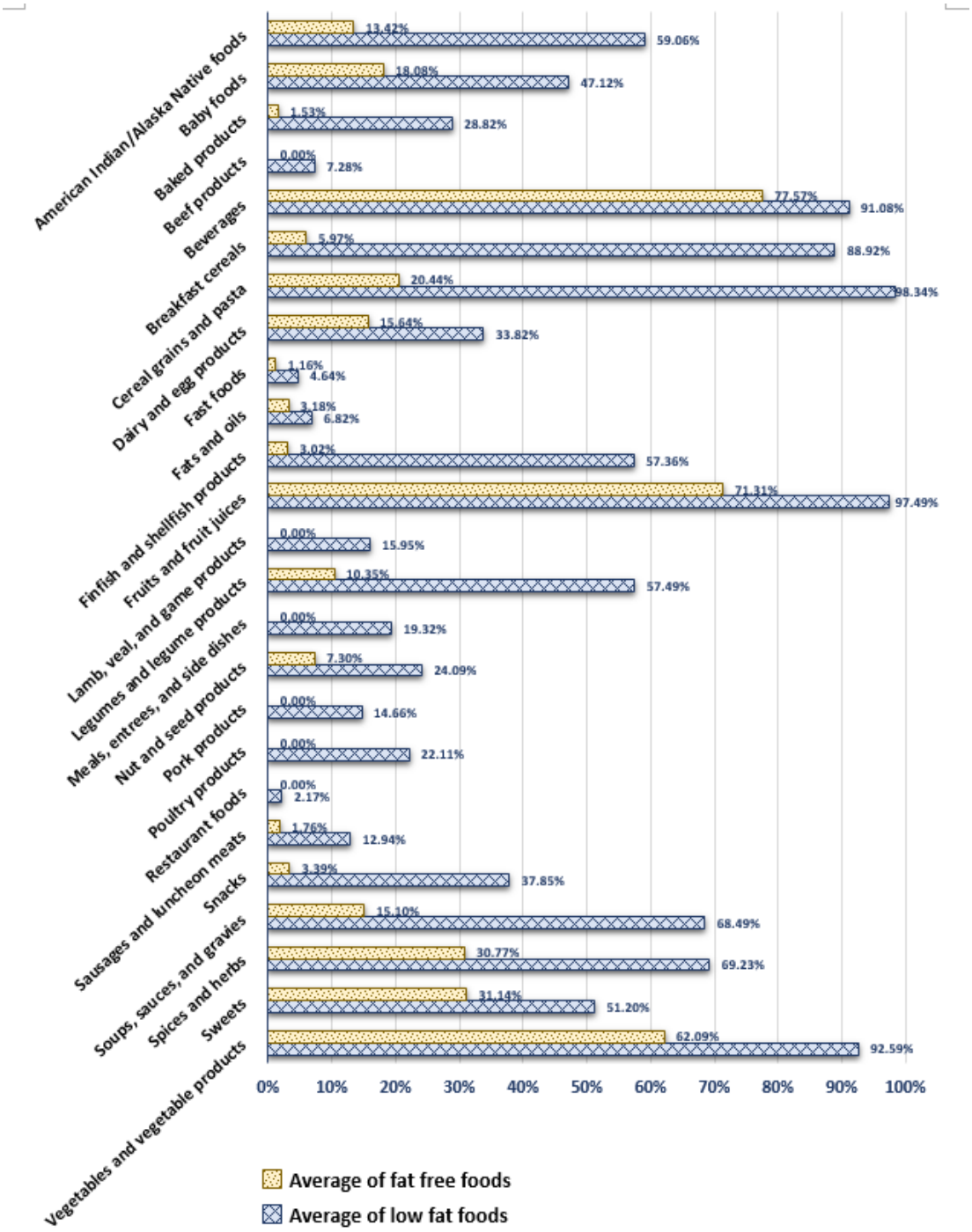

Fig. 2: Averages (%) of foods containing appropriate fat levels (to limit fat intake) based on the proposed method in food groups. All low fat and fat free foods, excluding low fat and fat free baby foods, are based on the reference energy intake of 2,000 kcal for adults and children aged 4 yr and older. Low fat and fat free baby foods are based on the reference energy intake of 1,000 kcal for children 1 through 3 yr of age

The highest amounts of fat were found in beef suet, caribou bone marrow, cured salt pork, pork jowl, coconut milk, whale (skin and subcutaneous fat), cheese quesadilla, poultry skin, lingcod liver,

domesticated duck (meat and skin), pork carcass (lean and fat), lamb flap, lamb rib (lean and fat), domesticated goose (meat and skin), pork tail, beef ribs (lean and fat), sandwich (with sausage, meat, cheese, bacon, ham, egg, butter, margarine, or mayonnaise), beef brisket navel end (lean and fat), cheese enchilada, caribou eye, chocolate mousse, fried chicken (meat and skin), beef top loin steak/roast (marble score 9), chicken nuggets, beef sweetbread, animal and plant fats, animal and plant oils, shortening, pesto sauce, butter, meat drippings, lamb loin (lean and fat), mechanically separated pork, cheesecake, fried shrimp, chocolate crème pie, chocolate-covered ice cream cone, onion rings (breaded and fried), pecan pie, mechanically deboned poultry, beef top loin steak/roast (marble score 4/5), walrus (meat and subcutaneous fat), beef carcass (lean and fat), fried mozzarella, pork spareribs (lean and fat), squab (meat and skin), pizza, mechanically separated lamb, mechanically separated beef, nachos, beef empanadas, whale eye, caribou tongue, chocolate cake (prepared with chocolate frosting), liqueur coffee with cream, beef brisket flat half (trimmed to 1/8" fat), lamb sirloin half (lean and fat), bacon and beef sticks, beef brisket point half (lean and fat), margarine (high fat type), margarine-like spread (high fat type), pork shoulder blade roll, corned beef hash, goose liver pate, beef tenderloin steak/roast (lean and fat), whale flipper, pili nuts, regular mayonnaise, beef chuck blade roast (lean and fat), chicken strips, guava pastries, ice cream (rich), chicken pot pie, pork sausage, General Tso's chicken, macadamia nuts, pecans, lamb shoulder (lean and fat), beef thymus, yellow cake (prepared with chocolate frosting), coconut crème pie, sweet and sour pork, beef striploin (lean and fat), beef tongue, beef lip-on ribeye (lean and fat), summer sausage (pork and beef with cheddar cheese), dried coconut meat (creamed), pine nuts, lamb tongue, beef pancreas, beef arm pot roast (trimmed to 1/8" fat), pork shoulder (lean and fat), Italian pork salami, beef outside skirt (lean and fat), Brazil nuts, fried pies, lamb neck chops (lean and fat), walnuts, and French toast sticks.

Exceeding the DVs for fat by consuming fat free foods required consuming more than 200 servings. Therefore, exceeding the DVs for fat by consuming fat free foods is impossible. Exceeding the DVs for fat by consuming low fat foods required consuming more than 20 servings. Therefore, exceeding the DVs for fat by consuming low fat foods is difficult. According to the proposed method, the serving is derived from the RACC or 30 g of food.

Foods containing appropriate fat levels based on the FDA per serving and CAC per 100 g or 100 mL

Since calculating the fat content and determining the low fat claim in some foods based on the CAC per 100 g or 100 mL and FDA per serving are performed in small amounts, making some food choices based on the CAC per 100 g or 100 mL or FDA per serving to limit fat intake exceeded fat needs, which may increase the risks of some chronic diseases (Fig. 3).

Since calculating the fat content and determining the low fat claim in some foods based on the CAC per 100 g or 100 mL and FDA per serving are performed in large amounts, some foods that did not exceed fat needs were not appropriate food choices based on the CAC per 100 g or 100 mL or FDA per serving to limit fat intake (Fig. 3).

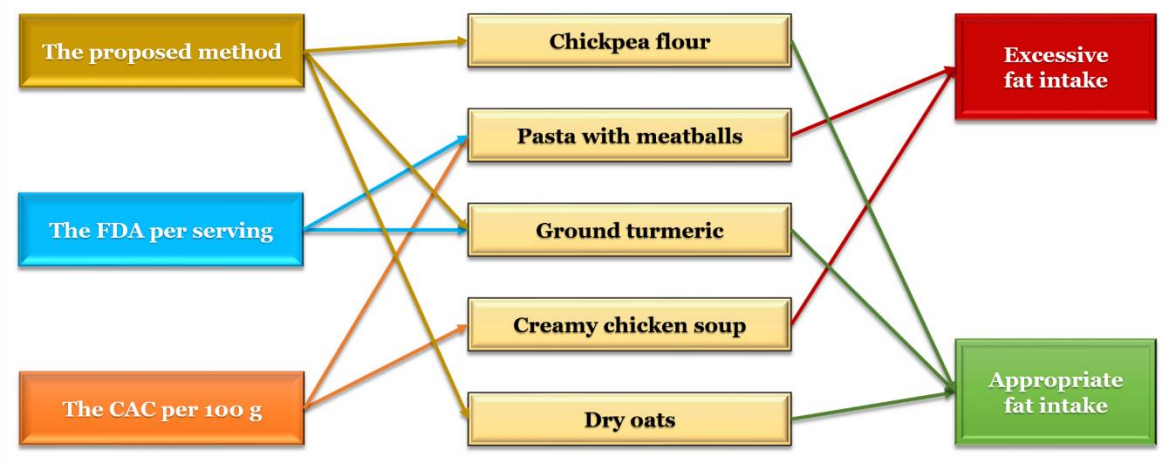

Fig. 3: Results of food choices based on different methods for limiting fat intake

Since the fat content of small RACCs based on the FDA per serving is calculated per RACC and per labeled serving for the fat free claim and per 50 g of food for the low fat claim, some foods were free of, but not low in, fat, even though the fat amount of the fat free claim (less than 0.5 g of fat) was much lower than the fat amount of the low fat claim (3 g or less of fat). On the basis of the FDA per serving, one food in the group of fats and oils (NDB number 4679), one food in the group of legumes and legume product (NDB number 16112), two foods in the group of baked products (NDB numbers 18242 and 18375), two foods in the group of dairy and egg products (NDB numbers 1206 and 42136), two foods in the group of vegetables and vegetable products (NDB numbers 11667 and 11978), and 28 foods in the group of spices and herbs (NDB numbers 2001, 2002, 2004, 2005, 2006, 2007, 2009, 2011, 2013, 2014, 2015, 2016, 2018, 2019, 2022, 2023, 2024, 2025, 2028, 2031, 2033, 2034, 2035, 2036, 2038, 2041, 2042, and 2066) were fat free, but not low fat, foods.

According to the CAC per 100 g or 100 mL and FDA per serving, since the fat free foods and the low fat foods (except meals and main dishes under the FDA per serving) are determined without considering the percentage of energy from fat, some foods that had high percentages of energy from fat were appropriate food choices based on the CAC per 100 g or 100 mL or FDA per serving to limit fat intake.

Exceeding the DV for fat in low fat foods under the FDA per serving was started by consuming 11.11 RACCs of two foods in the group of meals, entrees, and side dishes (NDB numbers 22940 and 22942). Exceeding the DV for fat in these two low fat foods was due to not considering RACCs of meals and main dishes. Exceeding the NRV for fat in low fat foods under the CAC per 100 g or 100 mL was started by consuming 2,223 g of one food in the group of dairy and egg products (NDB number 1294) and one food in the group of sweets (NDB number 19232). Exceeding the NRV for fat in these two low fat foods was due to not considering RACCs.

Discussion

The CAC per 100 g, in contrast to the proposed method, FDA per serving, and some scientific literature (21,22), defined cardamom as food containing an inappropriate fat level. Consuming 1,161.1 g of cardamom (NDB number 2006; 6.7 g of fat per 100 g; 0.03 g of fat per RACC; 19.4% of energy from fat) results in exceeding the DV for fat. Besides, consuming 995.1 g of the cardamom results in exceeding the NRV for fat, and this cardamom is customarily consumed 10 g per day in 20 eating occasions.

The CAC per 100 g and some scientific literature, in contrast to the proposed method and FDA per serving, defined fenugreek seed (23) and buckwheat (24) as foods containing inappropriate fat levels. Consuming 1,213.6 g of fenugreek seed (NDB number 2019; 6.41 g of fat per 100 g; 0.06 g of fat per RACC; 17.9% of energy from fat) or 2,288 g of dry buckwheat (NDB number 20008; 3.4 g of fat per 100 g; 1.53 g of fat per RACC; 8.9% of energy from fat) results in exceeding the DV for fat. In addition, consuming 1,040.1 g of the fenugreek seed or 1,961 g of the dry buckwheat results in exceeding the NRV for fat, and these fenugreek seed and dry buckwheat are customarily consumed 18 g and 900 g per day in 20 eating occasions, respectively.

The FDA per serving, CAC per 100 g, and some scientific literature, in contrast to the proposed method, defined oats (25,26) and oat bran (27,28) as foods containing inappropriate fat levels. Consuming 1,127.4 g of dry oats (NDB number 20038; 6.9 g of fat per 100 g; 3.105 g of fat per RACC; 16% of energy from fat) or 1,106.6 g of raw oat bran (NDB number 20033; 7.03 g of fat per 100 g; 1.05 g of fat per RACC; 25.7% of energy from fat) results in exceeding the DV for fat. Also, consuming 966.3 g of the dry oats or 948.5 g of the raw oat bran results in exceeding the NRV for fat, and these dry oats and raw oat bran are customarily consumed 900 g and 300 g per day in 20 eating occasions, respectively.

The FDA per serving and CAC per 100 g, in contrast to the proposed method, defined pasta with sliced franks as a food item containing an appropriate fat level. Consuming 20 RACCs of pasta with sliced franks (NDB number 22941; main dish product; 2.38 g of fat per 100 g; 6 g of fat per RACC; 24.6% of energy from fat) results in receiving 120 g of fat. However, the DV and NRV for fat in adults and children aged 4 yr and older are 77.78 g and 66.667 g, respectively.

Limitations of the study

One hundred ninety-four food items were excluded from the study due to the lack of density or RACC.

Conclusion

On the basis of the proposed method, calculating the fat content and determining appropriate fat levels in foods are performed by considering RACCs, small RACCs, the number of daily servings, and the percentage of energy from fat. Thus, making food choices based on the proposed method to limit fat intake did not exceed fat needs and the appropriate percentage of energy from fat. Moreover, foods that did not exceed fat needs were appropriate food choices based on the proposed method to limit fat intake.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflicts of interest

The authors declare no conflicts of interest.

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