The Nutritional Characteristics of a Contemporary Diet Based Upon Paleolithic Food Groups

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ABSTRACT

Purpose:

The intent of the present study was to examine the nutritional characteristics of a contemporary diet based upon Paleolithic food groups and to determine how these characteristics may impact the risk of chronic disease.

Methods:

Nutritional software was employed to ascertain the macro and trace nutrient characteristics of a diet composed of commonly available modern foods, but devoid of processed foods, dairy products and cereal grains. The relative contribution of plant and animal foods to the experimental diet was based upon average values previously determined in 229 hunter gatherer societies.

Results:

The analysis revealed that except for vitamin D, which would have been supplied by endogenous synthesis in hunter gatherers, it is entirely possible to consume a nutritionally balanced diet from contemporary foods that mimic the food groups and types available during the Paleolithic. Despite the elimination of two major food groups, the trace nutrient density of the experimental diet remained exceptionally high. The macronutrient content of the experimental diet (38 % protein, 39 % fat, 23 % carbohydrate by energy) varied considerably from current western values.

Conclusions:

Contemporary diets based upon Paleolithic food groups maintained both trace and macronutrient qualities known to reduce the risk of a variety of chronic diseases in western populations.

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INTRODUCTION:

There is a growing awareness among evolutionary biologists that humans like all species are genetically adapted to the environment of their ancestors–that is, to the environment that their ancestors survived in and the environment that consequently conditioned their genetic makeup.[1-3] At the same time, there is growing awareness that the profound changes in the environment (e.g. in diet and other lifestyle conditions) that began with the introduction of agriculture and animal husbandry 10,000 years ago occurred too recently on an evolutionary timescale for the human genome to adjust.[1-3] As a result of the mismatch between the contemporary human diet and our genetically determined physiology, many of the so-called diseases of civilization have emerged.[4-8] Previous studies have examined the dietary characteristics of humans living during the Paleolithic,[6,9,10] as well as of historically studied hunter-gatherer societies,[11,12] and their authors have suggested that the nutritional qualities of these diets may have therapeutic value in the treatment of chronic disease. Although it is no longer possible or practical for contemporary men and women in western, industrialized countries to adopt and follow the exact dietary patterns of humans living during the Paleolithic, it is certainly possible to emulate the essential characteristics of historically studied hunter-gatherer diets with common foods and food groups available in all supermarkets.

The intent of this study was to examine the nutritional qualities of a contemporary diet based upon Paleolithic food groups and to characterize how these qualities may impact health and well being.

METHODOLOGY

Formulation of a Contemporary Diet Based Upon Paleolithic Food Groups

In the United States and other western nations, foods generally are organized into one of five food groups: 1) bread, cereal, rice and pasta group, 2) fruit group, 3) vegetable group, 4) milk, yogurt and cheese group, and 5) meat, poultry, fish, dry beans, eggs & nuts group.[13] The formulation of a contemporary diet based upon Paleolithic foods groups necessarily excludes two of these major groups (grains and dairy) because these foods were rarely or never consumed by contemporary or Paleolithic hunter-gatherers.[9,11,14-15] Additionally, within food group #5, dry beans and legumes were not included in the analysis because, like cereal grains, these foods did not become dietary staples until Neolithic times.[16] Finally, all modern processed foods containing mixtures of grains, refined sugars and oils, salt, and food additives were likewise excluded from the model because these food mixtures became part of the human dietary repertoire only following the Agricultural and Industrial Revolutions.[9,11,14-15] Consequently, the present model utilized only the following contemporary food types: fruits, vegetables, meats, poultry, fish and nuts/seeds. For each food type, only the most commonly consumed foods in the U.S. diet were incorporated into the model. These were then randomly arranged into three meals and snacks utilizing dishes that were not dissimilar from those normally found in traditional western diets. The example diet was then analyzed for macro and trace nutrients using nutritional software (Nutritionist 5, First Data Bank, San Bruno, CA).

The 20 most commonly consumed fruits, vegetables, and fish in the United States were employed in the random meal selections (Table 1).[17] For the 20 most commonly consumed vegetable foods in the United States, two foods (potatoes and corn) were excluded from the model because corn is a cereal grain, and potatoes maintain nutrient properties (high glycemic and insulin responses)[18] uncharacteristic of traditional hunter-gatherer plant foods.[19] Consequently, the remaining 18 vegetable foods in Table 1 represent the food choices available in the model.

For the meat food group, the four most commonly consumed meats in the United States (beef, chicken, pork and turkey)[20] represented the meats of choice in the analysis. Only very lean cuts of meat (turkey and chicken breasts without skin, pork loin trimmed of fat, beef sirloin tip roast trimmed of fat) that averaged 20 % fat by energy–a mean value similar to that found in wild game meat[21]–were utilized in the model. For the nuts/seeds group, 10 nuts and seeds commonly consumed in the U.S. diet (almonds, walnuts, pecans, filberts, brazil nuts, pistachio nuts, macadamia nuts, coconut, sunflower seeds and pumpkin seeds) represented the available choices for this food type.

The primary consideration in the formulation of a "modern Paleolithic diet" is the relative contribution of each food group to total energy intake. Compiled ethnographic studies of 229 hunter-gatherer societies,[11] as well as 13 quantitative studies of hunter-gatherers[12] have demonstrated that animal foods contributed slightly more than half (55-65%) of the daily energy, whereas plant foods would have made up the remainder (35-45%) of the average daily caloric intake. Of the energy obtained from animal foods, historically-studied hunter-gatherers typically derived half of their energy from aquatic animals and the other half from terrestrial animals.[11] Animal food intake would have also been constrained by the physiologic protein ceiling, which has been shown to occur between 30 to 41% of total energy.[11]

In hunter-gatherer diets, the balance of total dietary energy (35-45%) derived from plant foods would have been quite erratic in how it would have been apportioned among the various plant food groups due to varying environmental and ecological considerations.[11] Hence, in the formulation of a modern diet based upon Paleolithic food groups, the plant food energy was arbitrarily divided equally among fruits, vegetables and nuts/seeds. Figure 1 displays the food type energy weightings assigned to the example "Modern Paleolithic" diet. Using these energy weightings for each of the five food types, the diet outlined in Table 2 was formulated.

Figure 1. Apportionment of daily energy to the five food types in a contemporary diet based upon Paleolithic food groups.

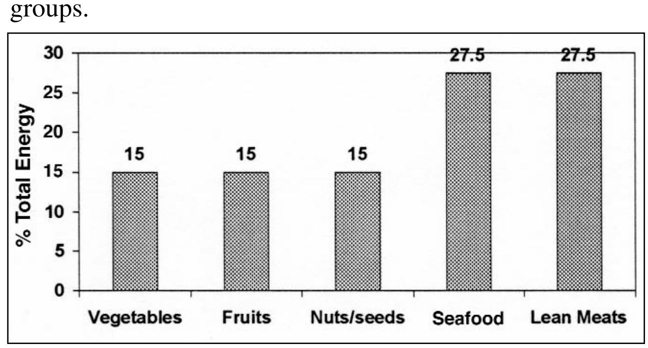

Table 1. Top 20 most common fruits, vegetables and fish sold in the United States.[17]

Top 20 Fruits	Top 20 Vegetables	Top 20 Fish
Banana	Potato	Shrimp
Apple	Iceberg lettuce	Cod
Watermelon	Tomato	Pollock
Orange	Onion	Catfish
Cantaloupe	Carrot	Scallop
Grape	Celery	Atlantic/Coho salmon
Grapefruit	Sweet corn	Flounder
Strawberry	Broccoli	Sole
Peach	Green cabbage	Oyster
Pear	Cucumber	Orange roughy
Nectarine	Bell pepper	Mackerel
Honeydew melon	Cauliflower	Ocean perch
Plum	Leaf lettuce	Rockfish
Avocado	Sweet potato	Whiting
Lemon	Mushroom	Clam
Pineapple	Green onion	Haddock
Tangerine	Green bean	Blue crab
Sweet cherry	Radish	Rainbow trout
Kiwi fruit	Summer squash	Halibut
Lime	Asparagus	Lobster

Table 2. Sample 1-day menu for a modern diet based upon Paleolithic food groups for females (25 yrs, 2200 kcal daily energy intake).

Breakfast	**Food Quantity (g)**	**Energy (kcal)**
Cantaloupe	276	97
Atlantic salmon (broiled)	333	605
Lunch		
Vegetable salad with walnuts		
Shredded Romaine lettuce	68	10
Sliced carrot	61	26
Sliced cucumber	78	10
Quartered tomatoes	246	52
Lemon juice dressing	31	8
Walnuts	11	70
Broiled lean pork loin	86	205
Dinner		
Vegetable avocado/almond salad		
Shredded mixed greens	112	16
Tomato	123	26
Avocado	85	150
Slivered almonds	45	260
Sliced red onion	29	11
Lemon juice dressing	31	8
Steamed broccoli	468	131
Lean beef sirloin tip roast	235	400
Dessert – Strawberries	130	39
Snacks		
Orange	66	30
Carrot sticks	81	35
Celery sticks	90	14

Table 3. Macronutrient and other dietary characteristics in a contemporary diet based on Paleolithic food groups for females (25 yrs, 2200 kcal daily energy intake).

Protein (g)	217
Protein (% energy)	38
Carbohydrate (g)	129
Carbohydrate (% energy)	23
Total sugars (g)	76.5
Fiber (g)	42.5
Fat (g)	100.3
Fat (% total energy)	39.0
Saturated fat (g)	18.0
Saturated fat (% total energy)	7.0
Monounsaturated fat (g)	44.3
Polyunsaturated fat (g)	26.7
Omega 3 fat (g)	9.6
Omega 6 fat (g)	14.2
Cholesterol (mg)	461
Sodium (mg)	726
Potassium (mg)	9062

RESULTS

Nutritional Characteristics of a Contemporary Paleolithic Diet

Table 3 presents the macronutrient intake and other qualities of the example diet analyzed from foods listed in Table 2. The macronutrient characteristics of the example diet, protein (38% energy), carbohydrate (23% energy), fat (39% energy) are similar to values demonstrated in historically studied hunter-gatherer societies but different from values (16% protein, 49% carbohydrate, 34% fat) in traditional western diets.[11] Despite its relatively low carbohydrate content (23% energy), the contemporary Paleolithic diet contained 42.5 g of plant fiber.

The contemporary Paleolithic diet contains more fat (39% energy) than average values (34% energy) found in western diets,[11] however this extra fat occurs entirely as a consequence of a greater intake of both polyunsaturated (PUFA) and monounsaturated (MUFA) fats. Although more than 50% of the energy in the contemporary Paleolithic diet is derived from animal foods, the saturated fat content (7.0% energy) falls within recommended healthful limits ($\leq$ 10% energy).[13] The contemporary Paleolithic diet is characterized by a high intake of total omega 3 (n3) fatty acids (9.6 g) and a relatively low intake of omega 6 (n6) fatty acids, which in turn yield a total dietary n6/n3 of 1.5 to 1. The cholesterol content of the contemporary Paleolithic diet is higher (461 mg) than recommended values (300 mg).[13] The contemporary Paleolithic diet contains 12.5 times more potassium than sodium. Except for calcium, all trace nutrients occur in considerably greater quantities than the recommended daily allowances (RDAs) (Table 4).

DISCUSSION

The results of this analysis demonstrate that it is entirely possible to consume a nutritionally balanced diet from commonly available contemporary foods that emulate the food types available to Paleolithic hunter gatherers. Despite the elimination of two major food groups (dairy and cereals), the trace nutrient density of the diet remains exceptionally high. Moreover, the diet maintains numerous nutritional characteristics that have been demonstrated to reduce the risk of a variety of chronic diseases.

Potential Nutritional Shortcomings of the Contemporary Paleolithic Diet

Calcium

Table 4 shows that the calcium intake (691 mg) would be considerably lower than the RDA (1000 mg), while the protein intake (217 g) would be more than 4 times recommended values (50 g). Because increased dietary protein increases obligatory loss of urinary calcium, it has been suggested that a calcium (mg)/protein (g) ratio of $\geq$20:1 may protect against bone loss.[22] The calcium/protein ratio of the contemporary Paleolithic diet (3.2 :1) is considerably lower than that in the average U.S. diet (10.7:1)[23] and therefore might be expected to increase the risk for bone demineralization, osteoporosis, and osteopenia. However, analyses of the skeletons of ancestral humans living during the Paleolithic [24,25] as well as more recently studied hunter-gatherers[26] have shown these people maintained robust, fracture-resistant bones, free from signs and symptoms of osteoporosis despite consuming no dairy products. Their robust bones may be due in part to greater activity levels (bone loading)[24] and greater sunlight exposure (increased vitamin D synthesis, hence increased calcium absorption). However, more importantly it is likely that Paleolithic hunter gatherers would have been in positive calcium balance despite a relatively low calcium intake because the calciuretic effects of a high meat diet were countered by high fruit and vegetable intake.[11,12]

Ingestion of meat protein induces calciuresis because the oxidation of sulfur-containing amino acids presents a net acid load to the kidney, which in turn must buffer the acid load from base that ultimately is derived from calcium-containing bone mineral salts.[27] Previous studies have demonstrated that ingestion of an alkalinizing agent prevented the calciurea which normally accompanies high protein diets,[28] and that when base is administered at a dose sufficient to neutralize endogenous acid production, calcium balance is improved, bone resorption is reduced, and bone formation is increased.[29] In western diets, meats,

Table 4. Trace nutrients in a modern diet based on Paleolithic food groups for females (25 yrs, 2200 kcal daily energy intake).

	Total	% RDA
Vitamin A (RE)	6386	798
Vitamin B_1 (mg)	3.4	309
Vitamin B_2 (mg)	4.2	355
Vitamin B_3 (mg)	60	428
Vitamin B_6 (mg)	6.7	515
Folate (µg)	891	223
Vitamin B_{12} (µg)	17.6	733
Vitamin C (mg)	748	1247
Vitamin E (IU)	19.5	244
Calcium (mg)	691	69
Phosphorus (mg)	2546	364
Magnesium (mg)	643	207
Iron (mg)	24.3	162
Zinc (mg)	27.4	228

Table 5. The potential renal acid load (PRAL) in the example diet. Values for PRAL were adapted from Remer and Manz's database.[30] (+) values are acid-producing,(-)values are base-producing.

Alkaline-Yielding Foods	Weight (g)	PRAL/100 g	Net PRAL
Cantaloupe	276	-3.5	-9.7
Lettuce	68	-2.5	-1.7
Carrot	142	-4.9	-7.0
Cucumber	78	-0.8	-0.6
Tomatoes	331	-3.1	-10.3
Lemon juice	62	-2.5	-1.6
Salad greens	112	-2.5	-2.8
Avocado	85	-3.5	-3.0
Almonds	45	-2.8	-1.3
Onion	29	-1.5	-0.4
Broccoli	468	-1.2	-5.6
Strawberries	130	-2.2	-2.9
Orange	66	-2.7	-1.8
Celery	90	-5.2	-4.7
Total			**-53.2**
Acid-Yielding Foods			
Salmon	333	7.9	26.3
Pork	86	7.9	6.8
Beef	235	7.8	18.3
Walnuts	11	6.8	0.7
Total			**51.4**

cheeses, and cereal grains yield high potential renal acid loads[30] and hence may promote osteoporosis by producing a net metabolic acidosis.[27] In contrast, fruits and vegetables yield a net alkaline renal load,[30] and high fruit and vegetable diets have been shown to reduce urinary calcium excretion rates.[31] Accordingly, in hunter-gatherer populations consuming high protein diets, a concomitant consumption of high levels of fruits and vegetables may have countered the calciuretic effects of a high protein diet.

In the present model, the net renal ionic load was slightly alkaline with base producing foods (-53.2) outweighing acid producing foods (51.4) (Table 5). Consequently the high protein intake of the example diet would not have caused an increased calciuresis, and subjects consuming a similar diet likely would remain in calcium balance despite a calcium intake lower than the RDA.

Vitamin D

The contemporary Paleolithic diet provides no dietary vitamin D. Except for the livers of certain marine mammals and fish, there are relatively few sources of vitamin D in the normal food supply. In most hunter-gatherers, vitamin D would have been obtained via the body's synthesis of this hormone from ultraviolet irradiation (sunlight exposure) of cholesterol in the skin. Only with the fortification of margarine and milk, beginning in the mid 20th century, has vitamin D been widely available in the food supply.

Cholesterol

Table 3 shows that the cholesterol intake (461 mg) for the model diet is more than 50% higher than recommended values (300 mg).[13] However, it should be noted that dietary cholesterol has a relatively minor impact on serum cholesterol levels.[32] The recently developed Howell *et al.* equation[33] [Δ serum cholesterol (mg/dL) = 1.918 x Δ SFA – 0.900 x Δ PUFA + 0.0222 x Δ cholesterol; where SFA = % saturated fat energy, PUFA = % polyunsaturated fat energy, and cholesterol = dietary cholesterol (mg)] reveals that a reduction in dietary cholesterol from 461 mg (the value in the example diet) to 300 mg (recommended value) would only lower serum cholesterol levels by 3.5 mg/dL. Additionally, in the example diet the ratio of polyunsaturated fatty acids to saturated fatty acids (P/S) is 1.5.

Schonfeld and colleagues[34] have shown that when the P/S was = 0.8, the addition of 750 mg of dietary cholesterol did not elevate serum LDL cholesterol concentrations in healthy, normal men. Consequently, the high P/S in the contemporary Paleolithic diet likely would counter any elevations in serum cholesterol that potentially could have occurred from increased dietary cholesterol.

Potential Nutritional Benefits of the Modern Paleolithic Diet

Dietary Protein

Perhaps the most striking difference between the typical western diet and the current model diet lies in the much higher protein intake. Although a high protein ingestion can increase the rate of progression in renal dysfunction,[35] a recent clinical trial has demonstrated that a high protein diet (26% energy) had no adverse effects upon renal function in subjects with no pre-existing kidney disease.[36] Because protein has more than three times the thermic effect of either fat or carbohydrate[37] and because it has a greater satiety value than fat or carbohydrate,[37,38] increased dietary protein may represent an effective weight loss strategy for the overweight or obese. Recent clinical trials have demonstrated that calorie-restricted high protein diets are more effective than calorie-restricted high carbohydrate diets in eliciting weight loss in overweight subjects.[39,40]

There is an increasing body of evidence that suggests high protein diets may improve blood lipid profiles[41-45] and thereby lessen the risk for cardiovascular disease (CVD). Wolfe and colleagues have shown that the isocaloric substitution of protein (23% energy) for carbohydrate in moderately hypercholesterolemic subjects resulted in significant decreases in total, LDL and VLDL cholesterol, and TG while HDL cholesterol increased.[43] Similar blood lipid changes have been observed in type II diabetic patients in conjunction with improvements in glucose and insulin metabolism.[41,42] Further, high protein diets have been shown to improve metabolic control in type II diabetes patients.[41,42,46] In obese women, hypo-caloric high protein diets improved insulin sensitivity and prevented muscle loss, whereas hypocaloric high carbohydrate diets worsened insulin sensitivity and caused reductions in the fat free mass.[47]

Epidemiological evidence supports the clinical data showing a cardiovascular protective effect of dietary protein. Increased protein intake has been shown to be inversely related to CVD in a cohort of 80,082 women.[48] Dietary protein is also inversely related to serum homocysteine concentration,[49] an independent risk factor for CVD. Meat eating populations have been shown to maintain lower plasma homocysteine concentrations than non-meat eaters.[50,51] In numerous population studies, summarized by Obarzanek *et al.*,[52] higher blood pressure was associated with lower intake of protein. Recently, a four-week dietary intervention of hypertensive subjects demonstrated that a high protein diet (25% energy) was effective in significantly lowering blood pressure.[53] Further, a number of population studies have established that stroke mortality is inversely related to protein intake.[54,55]

Dietary Carbohydrate and Fiber

Table 3 reveals that the carbohydrate content (23% energy) of the example diet is considerably lower than average values (49% energy) in the U.S. diet,[11] or suggested healthful ranges (55-60% energy).[13,56] Although current advice to reduce the risk of CVD is, in general, to replace saturated fats with complex carbohydrate,[13,56] there is mounting evidence to indicate that low fat, high carbohydrate diets may elicit undesirable blood lipid changes, including reductions in HDL cholesterol and apolipoprotein A-1, while concurrently elevating TG, VLDL cholesterol and small dense LDL cholesterol.[57-60] Collectively, these blood lipid changes are associated with an increased risk for CVD and other Syndrome X diseases.[61]

Table 6 shows both the glycemic index and glycemic load (glycemic index x carbohydrate content in food portion) in selected grain products, sugars/sweets, dairy foods, fruits, and vegetables.[62] High glycemic loads represent a nearly universal characteristic of the typical western diet because of a high reliance upon refined sugars and cereal grains. Added sugars represent 16.1% of the energy consumed in the average U.S. diet, whereas refined grain products comprise 85.3% of all the grains consumed in the U.S.[23] Table 6 reveals that dairy products maintain low glycemic indices and loads, but paradoxically these foods are highly insulinotrophic with insulin indices similar to white bread.[63] Consequently, the elimination of refined sugars, grains and dairy products in the example diet produces a low-carbohydrate diet (23% energy) in which all of the carbohydrates are derived from fruits, vegetables, and seeds/nuts with their universally low glycemic loads. High glycemic load diets have been implicated in the development of obesity,[64] and observational studies suggest that foods with a high glycemic load increase the risk for type II diabetes[65,66] and CVD.[67]

The fiber content (42.5 g) of the example diet is considerably higher than values in the U.S. diet (15.1 g) and higher than recommended values (25-30 g).[56] Soluble fibers modestly reduce LDL and total cholesterol concentrations beyond those achieved by a diet low in saturated fat, and fiber, by slowing gastric emptying, may reduce appetite and help to control caloric intake.[68]

Table 6. Glycemic indices and glycemic loads of various food groups. Glycemic load = (glycemic index x carbohydrate content in 10g portions). The glycemic reference is glucose with a glycemic index of 100. Data adapted from Foster-Powell *et al.*[62]

	Glycemic Index	Glycemic Load		Glycemic Index	Glycemic Load
Grain Products			Vegetables		
Rice krispie cereal	88	77.3	Parsnips	97	19.5
Cornflakes	84	72.7	Sweet potato	54	13.1
Rice cakes	82	66.9	Yam	51	11.5
Shredded wheat cereal	69	57.0	Carrots	71	7.2
Graham crackers	74	56.8	Beets	64	6.3
Cheerio cereal	74	54.2	Rutabaga	72	6.3
Rye crisp bread	65	53.4	Fruits		
Vanilla wafers	77	49.7	Banana	53	12.1
Corn chips	73	46.3	Pineapple	66	8.2
Wheat thins	67	41.9	Grapes	43	7.7
Granola bar	61	39.3	Kiwi fruit	52	7.4
Bagel	72	38.4	Apple	39	6.0
Doughnuts	76	37.8	Pear	36	5.4
White bread	70	34.7	Watermelon	72	5.2
All bran cereal	42	32.5	Orange	43	5.1
Whole wheat bread	69	31.8	Dairy foods		
Sugar, sweets			Ice cream	61	14.4
Jelly beans	80	74.5	Yogurt	33	6.5
Lifesavers	70	67.9	Skim milk	32	1.6
Table sugar (sucrose)	65	64.9	Whole Milk	27	1.3
Mars bar	68	42.2			

Dietary Fat

The total fat content (39% energy) of the example diet is 30% higher than recommended intakes.[13,56] However, it should be noted that the overall dietary lipid profile is health-promoting and anti-atherogenic.

There is now substantial evidence to indicate that the absolute amount of dietary fat is less important in lowering blood lipid levels and reducing the risk for CVD than is the relative concentrations of specific dietary fatty acids.[69-72] Low (22% energy) and high (39% energy) fat diets which had identical (polyunsaturated/saturated) (n3/n6) and (monounsaturated/total fat) fatty acid ratios produced no significant differences in total or LDL cholesterol following a 50 day trial.[72] Hypercholesterolemic fatty acids include 12:0, 14:0, 16:0, and trans-9 18:1,[73] whereas monounsaturated (MUFA)[70,74] and polyunsaturated (PUFA)[73] fatty acids are hypocholesterolemic, and 18:0 is neutral.[74] Omega 3 PUFA have wide-ranging cardiovascular protective capacities including lowering of plasma VLDL cholesterol and triacylglycerol (TG) concentrations.[69] Consequently, it is entirely possible to consume relatively high fat diets that do not necessarily produce a plasma lipid profile that promotes CVD[72,75] given sufficient MUFA,[70] PUFA,[60] and an appropriate n6/n3 PUFA ratio[69] relative to the hypercholesterolemic fatty acids.

Although more than 50 % of the energy in the contemporary Paleolithic diet is derived from animal foods, the saturated fat content (7.0% energy) not only falls within recommended healthful limits ($\leq$ 10 % energy),[13,56] but also within limits ($\leq$7 %) for individuals with elevated LDL cholesterol concentrations or CVD.[76] The dominant fats in the example diet are cholesterol lowering MUFA (17.2 % energy) and PUFA (10.4 % energy). MUFA may also confer additional cardiovascular protective effects beyond lowering serum cholesterol by its ability to reduce LDL oxidizability, a key step in the atherosclerotic process.[77]

The example diet is rich in omega 3 fatty acids (9.6 g) compared to the average value (2.3 g) found in the U.S. diet.[78] Numerous studies have reported the beneficial effects of an increased omega 3 fatty acid intake in CVD patients.[79-82] A 20% reduction in overall mortality and a 45% reduction in sudden death after 3.5 years were reported in subjects with preexisting CVD when given 850 mg of omega 3 fatty acids (20:5n3 and 22:6n3) either with or without vitamin E.[82] Omega 3 fatty acids may operate to reduce CVD mortality via a number of mechanisms including reductions in serum VLDL and triacylglycerol concentrations, thrombic tendencies, and the incidence of ventricular arhythmias.[66]

Dietary Sodium and Potassium

Because no processed foods or added salt are included in the example diet, the sodium intake (726 mg) is appreciably lower than average U.S. values (3,271 mg)[23] or recommended values (2,400 mg).[56] Further, since potassium-rich fruits and vegetables comprise 30% of the daily energy, the potassium content (9,062 mg) of the example diet is nearly 3.5 times greater than average values (2,620 mg) in the U.S. diet.[23] Diets rich in potassium and low in sodium have been repeatedly demonstrated to be therapeutic for a variety of chronic conditions including: hypertension, stroke, kidney stones, and osteoporosis.[83,84]

Trace Nutrients

Table 4 demonstrates that, except for calcium, the example diet is exceedingly rich in the 14 vitamins and minerals most commonly deficient in the U.S. diet.[23] A meta-analysis investigating the relationship between CVD and serum homocysteine concentrations has demonstrated that as much as 10% of CVD risk was attributable to hyperhomocysteinemia.[85] The normal metabolism of homocysteine requires an adequate supply of folate, vitamin B_6, vitamin B_{12} and riboflavin. Lower serum folate concentrations and vitamin B_6 have been associated with increased CVD risk.[86] Because the fruits (15% energy) and vegetables (15% energy) in the example diet are rich sources of folate, the intake of this vitamin is quite high (891 µg or 223% RDA). Additionally, the fish (27.5% energy) and lean meats (27.5% energy) contained in the example diet are rich sources of vitamin B_6, and along with the fruits, vegetables and seeds/nuts, combine to yield a high intake (6.7 mg or 515 % RDA) of this vitamin.

SUMMARY

Despite a high reliance upon low fat animal foods (55% energy), the experimental diet would not have necessarily elicited unfavorable blood lipid profiles because of the hypolipidemic effects of high dietary protein (38 % energy) and the relatively low level of low glycemic index dietary carbohydrates (23%). Although total fat intake (39% energy) would have been higher than that found in western diets, total saturated fat (7.0% energy) fell well within healthful limits (10% energy). Important qualitative differences in fat intake, including relatively high levels of MUFA and PUFA and a lower n6/n3 fatty acid ratio, also would have served to reduce the risk for CVD. Other characteristics of the example diet, including a high intake of antioxidants, fiber, vitamins, and phytochemicals along with a low salt intake would further deter the risk of CVD and other chronic diseases.

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