The High–Monounsaturated Fat Diet as a Practical Alternative for NIDDM

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OBJECTIVE — To examine the dietary preferences of and metabolic effects in patients with non-insulin-dependent diabetes mellitus (NIDDM) of a home-prepared high–monounsaturated fat (HM) diet compared with the recommended high-carbohydrate (CHO) diet.

RESEARCH DESIGN AND METHODS — Ten men with mild NIDDM prepared HM and high-CHO diets at home alternately and in random order for 2 weeks each with a minimum 1-week washout. Before and after each diet, 24-h urine glucose, fasting lipids, fructosamine, and 6-h profiles of glucose, insulin, and triglycerides were measured. Dietary preferences were assessed by questionnaire.

RESULTS — In the HM diet, patients consumed 40% of energy intake as CHO and 38% as fat (21% monounsaturated) compared with 52 and 24%, respectively, in the high-CHO diet, with equal dietary fiber content. Body weight and total energy intake were similar in both. The HM diet resulted in significantly lower 24-h urinary glucose excretion, fasting triglyceride, and mean profile glucose levels. The fructosamine levels, the fasting total, low-density lipoprotein, and high-density lipoprotein cholesterol, and the prandial triglyceride concentrations did not differ significantly as a result of the diets. The two diets did not differ in ratings for overall acceptance, taste, cost, ease of preparation, variety, or satiety.

CONCLUSIONS — Prepared at home, the HM diet was, in the short-term, metabolically better in some aspects than the currently recommended diet for NIDDM. It also provided a palatable alternative.

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HM, high–monounsaturated fat; CHO, carbohydrate; NIDDM, non-insulin-dependent diabetes mellitus; HDL, high-density lipoprotein; LDL, low-density lipoprotein; BMI, body mass index; CV, coefficient of variation.

The dietary prescription for non-insulin-dependent diabetes mellitus (NIDDM) remains controversial. The currently recommended high-carbohydrate (CHO), low-fat diet can produce adverse lipid (1) and glycemic effects (2). Patients with mild (3) and more severe NIDDM experience deterioration of glycemic control and increased triglyceride and lowered high-density lipoprotein (HDL) cholesterol concentrations on high-CHO diets (2,4). Furthermore, we showed that long-term adherence to this diet in Australian patients is suboptimal (5), consistent with experiences in other Western populations (6).

The high–monounsaturated fat (HM) diet has been proposed as a palatable alternative, which is not metabolically detrimental compared with a high-CHO diet (3). Studies examining variations in dietary fat and carbohydrate often use prepared diets or liquid formula in metabolic wards, sometimes using unrealistic extremes of fat or carbohydrate (7). The reported metabolic benefits of HM diets have not yet been confirmed with patient-prepared meals. Similarly, questions of palatability and patient compliance are as yet unanswered.

The aims of this study were as follows: *1*) to develop suitable HM diet guidelines for patients to use at home; *2*) to compare the metabolic effects with the recommended CHO diet; *3*) to assess patients' dietary adherence and subsequent dietary preference.

RESEARCH DESIGN AND METHODS — Ten men with mild NIDDM gave informed consent to be studied. The study was approved by the St. Vincent's Hospital Ethics Committee. None had liver, renal, or thyroid disease or took antihyperlipidemic medication. One had a prior myocardial infarction. The average age was 55 ± 2.7 years (range 41–68 years), body mass index (BMI) was 26.5 ± 1.2 kg/m^2 (range

Table 1—*The mean composition of the prescribed high-CHO and HM*

	High-CHO diet	HM diet
Carbohydrate (%)	55	40
Sugars	10	10
Starch	45	30
Fat (total) (%)	22	37
Saturated	7	7
Polyunsaturated	7	8
Monounsaturated	8	22
Alcohol (%)	2	2
Fiber (g)	>30	>30
Cholesterol (mg/day)	<300	<300

Data are the percentage of total energy.

23.0–32.8 kg/m^2), and diabetes duration was 4.6 ± 1.9 years (range 0.3–20 years). One subject took one hypoglycemic tablet per day; the remainder followed diet alone.

Studies were conducted on an outpatient basis. Diets were prescribed in random crossover design for 2 weeks each, with a minimum 1-week washout.

Composition of diets

Initially and during each diet, subjects completed a 4-day food record (including 2 weekend days). Each subject was individually trained by a dietitian in accurate food recording (9). Each subject's diet was based on his initial nutritional analysis to supply diets isocaloric with the usual one, differing only in fat and starch. Prescribed composition of the diets is shown in Table 1. Alcohol intake (<30 g/day) and exercise were maintained.

Diet prescription

To instruct patients in preparing HM diets at home, we suggested simple substitutions for the patient's usual diet (practical suggestions in Appendix 1). Appendix 2 shows the 24-h intake for one individual for each diet.

Biochemical analysis

After a 10-h fast, patients had a representative breakfast, morning snack, and lunch on the last day of both diets. Blood was sampled fasting and every 30 min for plasma glucose, insulin, and triglyceride measurements during the 6-h study. The 24-h urinary glucose was measured initially and at the end of each diet. Fasting plasma glucose, insulin, and lipids were measured initially and at the end of each diet and the washout. Serum fructosamine was measured before the study and after each diet on an autoanalyzer (Hitachi 717, Boehringer Mannheim, Indianapolis, IN). Blood and urine glucose were measured by the glucose oxidase method (YSI 23 AM, Yellow Springs, OH); serum insulin by radioimmunoassay (11) (intra-assay coefficient of variation [CV] 6%, 30 pM) and C-peptide by radioimmunoassay (12) (intra-assay CV 6%, 0.33 nM). Each individual's samples, except for blood glucose, were analyzed in the same assay. Cholesterol and triglycerides were measured by automated enzymatic methods (13,14) (intra-assay CV 2 and 5%, respectively). HDL cholesterol was determined after precipitation of other lipoprotein classes by phosphotungstic acid-magnesium chloride (15) (intra-assay CV 1.5%). Low-density lipoprotein (LDL) cholesterol was determined by the formula: LDL cholesterol = total cholesterol − (0.458 triglycerides + HDL cholesterol).

Dietary preferences and compliance

After the study, patients completed a visual analogue questionnaire about dietary preferences. The 4-day dietary records were analyzed using the Diet 3 computer program (Xyris Software, Queensland, Australia) based on the NUTTAB Food Composition Data Base (10) and compared with the composition of the prescribed diets as an estimate of compliance. Foods not included were added or coded as very similar foods.

Statistical analysis

Comparisons were made using the paired Student's *t* test (with urinary glucose, after log transformation of raw data); Statview 512 plus statistical package (Abacus Concepts, Berkeley, CA). Mean glucose, triglyceride, and insulin responses during the 6-h profile were calculated from the area under the curve. All data are expressed as means ± SE.

RESULTS

Dietary composition

The initial diet and the composition of the two study diets consumed are shown in Table 2. Using 4-day food records, dietary compliance appeared excellent, as no significant differences were found between actual nutrient intake and that prescribed. Body weight did not change with either diet. The baseline and post-diet weights and metabolic data are shown in Table 3.

Glycemic control and insulin profiles

Half the group ate the HM diet first; the order of the diets did not affect the following metabolic results. The responses in glucose, insulin, and triglyceride levels to the respective test meals is shown in Figure 1. Although fasting plasma glucose did not differ, mean prandial glucose concentration was significantly lower during the 6-h profile on the HM diet (high-CHO vs. HM diet: 11.7 ± 1.3 vs. 10.4 ± 1.0 mM, $P = 0.028$). This is consistent with the significantly lower 24-h urinary glucose at the end of the HM diet vs. the high-CHO diet (6.1 vs. 10.6 mmol/day). Fructosamine levels did not differ between the two diets (high-CHO vs. HM diet: 303 ± 25 vs. 299 ± 25 μM, $P > 0.05$).

No difference was found between diets in fasting or prandial insulins. One subject had very high insulin (fasting >240 pM) and C-peptide (fasting >1.3 nM) levels; the differences between diets were nonsignificant (parametric and nonparametric tests) whether or not his data were included.

Plasma lipid responses

Fasting plasma triglycerides were significantly lower at the end of the HM diet (HM

Table 2—*Composition of diets consumed by subjects during study*

Nutrient	Baseline	High-CHO diet	HM diet
Energy (MJ/day)	8.3 ± 0.6	8.5 ± 0.5	8.8 ± 0.7
Carbohydrate (% of energy)	46 ± 2	52 ± 2	39 ± 2
Starch	30 ± 2	33 ± 3	24 ± 2
Sugars	15 ± 1	18 ± 2	15 ± 1
Total fat (% of energy)	27 ± 2	24 ± 2	38 ± 1
Polyunsaturated	6 ± 1	7 ± 1	8 ± 0.4
Monounsaturated	11 ± 1	9 ± 1	21 ± 1
Saturated	10 ± 1	8 ± 1	8 ± 1
P:M:S ratio	0.7:1.1:1.0	0.9:1.1:1.0	1.0:2.6:1.0
Cholesterol (mg/day)	276 ± 32	183 ± 16	190 ± 20
Protein (% of energy)	23 ± 0.3	21 ± 1	20 ± 1
Alcohol (% of energy)	5 ± 2	3 ± 2	3 ± 1
Dietary fiber (g/day)	31 ± 4	40 ± 3	37 ± 4

Data are means ± SE. P:M:S ratio refers to the ratio of polyunsaturated fat:monounsaturated fat:saturated fat.

vs. high-CHO diet: 1.1 ± 0.2 vs. 1.4 ± 0.2 mM, $P = 0.01$). The meal profile triglycerides were not significantly different (high-CHO vs. HM diet: 2.0 ± 0.3 vs. 1.9 ± 0.3 mM, $P > 0.05$) despite the greater fat intake on the HM-diet test meals. Fasting total cholesterol and HDL-cholesterol concentrations were not significantly different between the diets (total cholesterol, high-CHO vs. HM diet: 4.7 ± 0.3 vs. 4.3 ± 0.3 mM; HDL cholesterol, high-CHO vs. HM diet 0.8 ± 0.1 vs. 0.8 ± 0.1 mM, $P > 0.05$). Neither the LDL-cholesterol level (high-CHO vs. HM diet: 3.2 ± 0.3 vs. 3.0 ± 0.3 mM, $P > 0.05$) nor the total:HDL-cholesterol ratio differed significantly.

Dietary preferences

No significant differences were noted in the ratings of the two diets in overall score of acceptability, ease of preparation, expense, taste, satiety, or variety (Fig. 2).

CONCLUSIONS

Judging from our patients' dietary records, satisfactory compliance was achieved in all components of the two prescribed diets. Use of the HM diet was associated with a significant decrease in urinary glucose excretion, a significantly lower rise in prandial glucose in the meal profile, and significantly lower fasting triglycerides. This confirms that such diets can have metabolically beneficial effects in some people with NIDDM.

The ideal diabetic diet remains controversial. Its composition should promote good glycemic control while minimizing future atheroma. The major controversy arises as to the nutrient with which to replace saturated fat. It is of concern that the currently universally accepted high-CHO diet has been shown to elevate triglycerides, reduce HDL cholesterol, and worsen glycemic control in some subjects. The common assumption that high-CHO diets improve insulin sensitivity in humans is based on extreme variations in diet (18) and has been shown not to occur with diets tolerable for human consumption in normal (19) or diabetic subjects (7,17).

To claim that a high-fiber diet is

Table 3—*Baseline and post-diet weights and metabolic data*

	Baseline	High-CHO diet	HM diet	*P* value
Weight (kg)	76.7 ± 4.2	76.1 ± 4.2	76.1 ± 4.2	0.98
Fasting plasma glucose (mM)	8.4 ± 0.8	8.7 ± 1.0	8.5 ± 0.9	0.36
Mean prandial glucose (mM)	—	11.7 ± 1.3	10.4 ± 1.0	0.015*
Urinary glucose excretion (mmol/day)	9.0 (1.1–28.7)	10.6 (1.1–21.7)	6.1 (1.1–23.7)	0.007*
Plasma fructosamine (μM)	342 ± 28	303 ± 25	299 ± 25	0.16
Fasting serum insulin (pM)	46 ± 6	38 ± 6	35 ± 6	0.25
Mean prandial insulin (pM)	—	190 ± 25	160 ± 28	0.13
C-peptide (nM)	—	0.54 ± 0.03	0.40 ± 0.03	0.004*
Fasting plasma triglyceride (mM)	1.4 ± 0.2	1.4 ± 0.02	1.1 ± 0.2	0.013*
Mean prandial triglyceride (mM)	—	2.0 ± 0.3	1.9 ± 0.3	0.66
Fasting plasma total cholesterol (mM)	5.1 ± 0.2	4.7 ± 0.3	4.3 ± 0.3	0.06
Fasting plasma HDL cholesterol (mM)	0.8 ± 0.1	0.8 ± 0.1	0.8 ± 0.1	0.95
Fasting plasma LDL cholesterol (mM)	3.7 ± 0.2	3.2 ± 0.3	3.0 ± 0.3	0.25
Total cholesterol:HDL cholesterol ratio	7.0 ± 0.6	6.1 ± 0.5	5.7 ± 0.6	0.21

Data are means ± SE except for 24-h urinary glucose excretion, which is expressed as the geometric mean (range). For insulin and C-peptide data, $n = 9$; one subject was excluded because of extreme values for insulin and C-peptide (see METHODS).
*$P < 0.05$ for comparison between the high-CHO and HM diet periods.

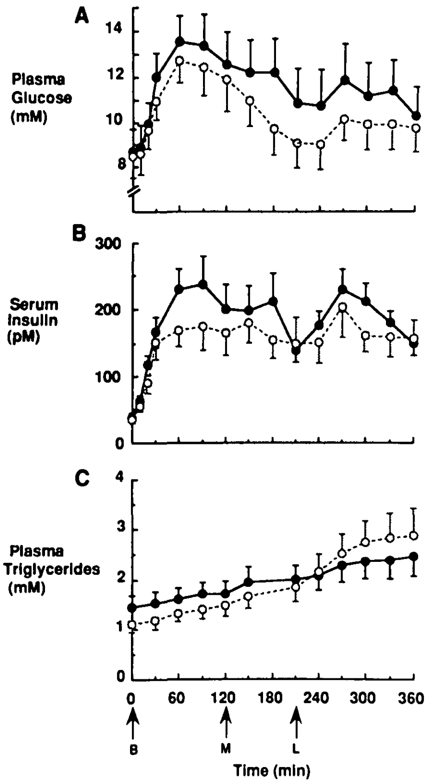

Figure 1—*Plasma glucose (A), serum insulin (B), and plasma triglyceride (C) concentrations (mean ± SE) during 6-h meal profile studies in subjects with NIDDM after 3 weeks on a high-CHO (●——●) or an HM (O----O) diet. For plasma glucose and triglyceride levels* n = *10, and for serum insulin* n = *9 (see* METHODS*). Meals consumed were representative of the diet periods, and meal times are indicated by arrows: breakfast (B), midmorning snack (M), and lunch (L).*

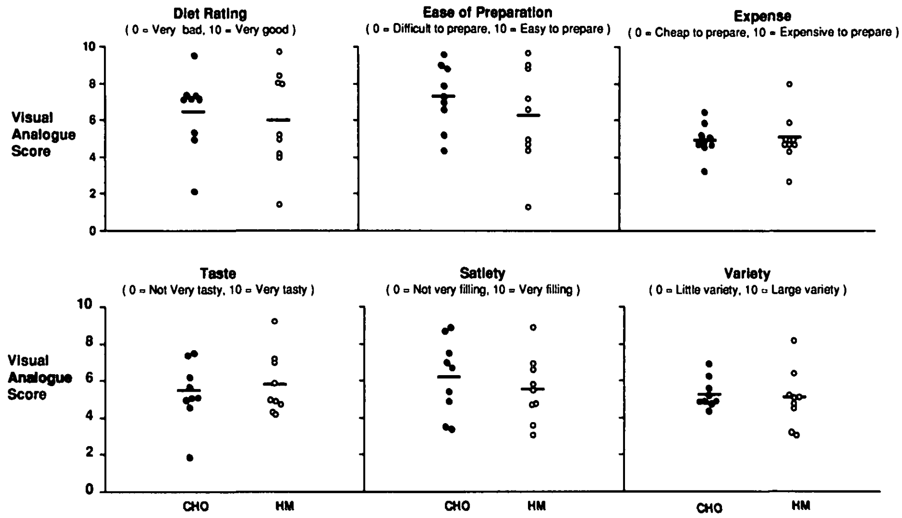

Figure 2—*Visual analogue scores for questions in the diet evaluation questionnaire completed at the end of the study (*n = *9). Scores indicate the distance along the visual analogue scale from 0 to 10 for the high-CHO and HM diets. Individual subjects are indicated by the symbols and the mean score by the horizontal lines.*

the optimum diabetic diet is misleading when the beneficial glycemic effects are only present when the amount of fiber to be ingested is above tolerable levels for most patients (16). Also, no large population is known to have consumed a high–polyunsaturated fat diet for long periods with documented safety; and use of large amounts is not recommended (16).

Use of monounsaturated fat, in contrast with starch, as a replacement for saturated fat has been reported not to adversely affect glycemic control or insulin sensitivity and to be significantly better for HDL-cholesterol and triglyceride concentrations (17). The favorable studies were performed with formula diets or preprepared food. Before the major step of recommending an alternative choice to the current diet for NIDDM, a feasibility study was needed to help answer the practical questions of ease of preparation of the HM diet, its metabolic impact when prepared in the home, and its palatability and acceptance to NIDDM subjects.

In our study, NIDDM patients complied equally well with the diets and rated them similarly in all aspects of palatability, cost, and ease of preparation. Patients could therefore appreciate the option of choice in their diet, perhaps improving long-term compliance. To offer an alternative diet to the universally accepted high-CHO diet for NIDDM, it must also be shown that the diet, while equally palatable, is not worse in metabolic aspects. The HM diet in our study was, in fact, significantly superior to the high-CHO diet in some aspects: 24-h glycosuria, postprandial glycemia, and fasting triglycerides. The HM diet tested in this study contains a moderate amount of fiber and is consistent with the Mediterranean diet whose acceptability and palatability is proven by centuries of consumption in a population known for favorable cardiovascular outcome (20).

Theoretical arguments remain regarding the long-term benefit of a low-fat diet on weight loss. However, extremes of high-fat and high-CHO were not different in 24-h energy expenditure over 2 months in a metabolic ward (7). The long-term effects of high-CHO vs. HM diets in NIDDM are not yet known.

Our results suggest that the HM diet is a realistic alternative to the high-CHO diet. It can be prepared at home as efficiently, is equally palatable, and in the short-term at least, demonstrated significantly better effects on some aspects of glycemic control and circulating lipids. Lengthy studies are needed to answer the question whether the HM diet is metabolically better than the current high-CHO one when eaten long-term by people with NIDDM.

APPENDIX 1— PRACTICAL TIPS ON IMPLEMENTING A DIET HIGH IN MONOUNSATURATED FAT

Principles

- Reduce the carbohydrate component of the diet by moderately reducing starchy foods.
- Increase the intake of monounsaturated fat from fats, oils, nuts, avocados, and protein foods.
- Do not change protein, polyunsaturated fat, saturated fat, or alcohol content (keep as currently recommended).

Practical tips

- Avoid saturated fat spreads and oils such as butter, coconut, and palm oils.
- Replace polyunsaturated margarine and oils with monounsaturated margarine (canola) and monounsaturated oils (olive, canola). Canola is a monounsaturated cooking oil or margarine based on rapeseed oil. In comparison with polyunsaturated margarine (in brackets) it contains (per 100 g fat): total fat = 82 g (82 g); saturated fat = 12 g (16 g); cis-monounsaturated fatty acids = 41 g (20 g); cis-methylene interrupted polyunsaturated fatty acids 16 g (33 g); trans fatty acids 12 g (13 g). Courtesy of Meadow Lea, Australia.
- Use measured amounts of monounsaturated margarine and oils in cooking (e.g., stir fry dishes and marinades), in salad dressings, spread on bread (e.g., sandwiches), and added to cooked vegetables.
- Choose lean mean, poultry, and fish products, particularly those that are higher in monounsaturated fats, e.g., pork, duck, chicken, red salmon, veal, beef, kippers, herring, and gemfish.
- Use only low-fat dairy products or fat-modified products, e.g., low-fat milk with canola oil added (available commercially).
- Use avocados, which are high in monounsaturated fat, in measured amounts for sandwich spreads, dips, and sauces. Where too expensive for frequent use, use more monounsaturated cooking oils and margarines; use white meats such as pork, veal, and chicken in place of red; use fish with high monounsaturates such as gemfish, red salmon, and ocean perch.
- Use nuts in measured amounts, particularly the following (high in monounsaturated fats): macadamias, pecans, almonds, hazelnuts, cashews, peanuts, and pistachios. Nuts can be used in cooking (e.g., meat and vegetable dishes), in salads, as a midmeal snack, and as a spread (peanut butter/paste). Where some nuts are expensive, use more peanuts and peanut paste, a relatively cheap source of protein.
- Use generous amounts of nonstarchy vegetables to ensure a high-fiber intake is maintained. Nuts also will provide additional fiber.
- Reduce moderately the amount of bread, pasta, rice, potato, and breakfast cereals and replace energy with nuts, avocados, and monounsaturated oil/ margarine. For example, a diet providing 8,400 kJ (2,000 kcal) with 55% of energy from carbohydrate and 25% from fat would need 15% of kJ from carbohydrate (79 g carbohydrate) to be replaced with 34 g monounsaturated fat to increase the proportion of fat to 40%.

APPENDIX 2—SAMPLE MENU FOR HIGH-CHO AND HM DIETS

High-CHO diet	HM diet (HM)
Breakfast	Breakfast
51 g Weet-bix (3 wheat biscuits)	51 g Weet-bix (3 wheat biscuits)
46 g sultanas (3 tablespoons)	23 g sultanas (1 1/2 tablespoons)
150 ml reduced-fat fortified milk	150 ml reduced-fat fortified milk
60 g wholemeal bread, toasted (2 slices)	60 g wholemeal bread, toasted (2 slices)
10 g polyunsaturated margarine (2 teaspoons)	12 g canola margarine (1 1/2 teaspoons)
10 g meat or fish paste (2 teaspoons)	20 g peanut butter (1 tablespoon)
1 cup tea/coffee plus milk from allowance	1 cup tea/coffee plus milk from allowance
Morning snack	Morning snack
23 g rye crispbread (3 crispbread)	23 g rye crispbread (3 crispbread)
20 g reduced fat cheddar cheese (1 small slice)	12 g canola margarine (1 1/2 teaspoon)
40 g raw tomato (2 slices)	40 g raw tomato (2 slices)
150 g fresh pear (1 medium)	150 g fresh pear (1 medium)
200 ml tea/coffee plus milk from allowance	200 ml tea/coffee plus milk from allowance
Lunch	Lunch
120 g wholemeal bread (4 slices)	120 g wholemeal bread (4 slices)
20 g polyunsaturated margarine (4 teaspoons)	42 g avocado (1/2 very small avocado)
100 g lean leg ham (2 large slices)	100 g lean leg ham (2 large slices)
80 g raw tomato (4 slices)	80 g raw tomato (4 slices)
50 g lettuce (1 large leaf)	50 g lettuce (1 large leaf)
40 g raw carrot, grated (1/2 medium)	40 g raw carrot, grated (1/2 medium)
150 g peeled fresh orange (1 medium)	150 g peeled fresh orange (1 medium)
Low-joule soft drink	Low-joule soft drink

APPENDIX 2—*Continued*

Afternoon snack	Afternoon snack
140 g banana (1 medium)	140 g banana (1 medium)
30 g wholemeal bread (1 slice)	20 g almonds with skin (15 nuts)
5 g polyunsaturated margarine (1 teaspoon)	
5 g vegemite [yeast extract spread] (1/2 teaspoon)	
Evening meal	Evening meal
90 g lean grilled round steak	90 g lean grilled round steak
225 g boiled white pasta (1 1/2 cup)	150 g boiled white pasta (1 cup)
50 g steamed broccoli (1 flowerette)	50 g steamed broccoli (1 flowerette)
50 g steamed carrot (1/3 cup)	50 g steamed carrot (1/3 cup)
50 g steamed peas (1/3 cup)	50 g steamed peas (1/3 cup)
30 g wholemeal bread (1 slice)	15 g pecan nuts (9 half nuts)
5 g polyunsaturated margarine (1 teaspoon)	135 g fresh fruit salad (3/4 cup)
135 g fresh fruit salad (3/4 cup)	
Evening snack	Evening snack
17 g plain sweet biscuit/cookie (2 biscuits)	17 g plain sweet biscuit/cookie (2 biscuits)
150 g red apple (1 medium)	Tea/coffee plus milk from allowance
Tea/coffee plus milk from allowance	20 g hazelnuts (13 nuts)

The high-CHO diet provides the following: 10,760 kJ (2,570 kcal), 123 g protein (20%), 70 g fat (25% [8% polyunsaturated, 9% monounsaturated, and 8% saturated]), 364 g (55%), 61 g dietary fiber, and 167 mg cholesterol. The HM diet provides the following: 10,705 kJ (2,557 kcal), 120 g protein (19%), 103 g fat (36% [8% polyunsaturated, 21% monounsaturated, and 8% saturated]), 291 g carbohydrate (44%), 58 g dietary fiber, 145 mg cholesterol. The diets meet the recommended daily intake for all nutrients. Estimates in household measures are listed in parentheses; metric measures are used (1 cup = 250 ml and 1 tablespoon = 20 ml). Sultanas are dried grapes or raisins. Milk allowed for tea/coffee is 150 ml reduced-fat fortified milk per day.

References

1. Coulston AM, Hollenbeck CB, Swislocki ALM, Reaven GM: Persistence of hypertriglyceridemic effect of low-fat, high-carbohydrate diets in NIDDM patients. *Diabetes Care* 12:94–101, 1989
2. Reaven GM: How high the carbohydrate? *Diabetologia* 19:409–13, 1980
3. Garg A, Grundy SM, Unger RH: Comparison of effects of high- and low-carbohydrate diets on plasma lipoproteins and insulin sensitivity in patients with mild NIDDM. *Diabetes* 41:1278–85, 1992
4. Garg A, Bonanome A, Grundy SM, Zhang Z-J, Unger RH: Comparison of a high-carbohydrate diet with a high-monounsaturated fat diet in patients with non-insulin-dependent diabetes mellitus. *N Engl J Med* 319:829–34, 1988
5. Campbell LV, Barth R, Gosper J: Unsatisfactory nutritional parameters in established non-insulin-dependent diabetes mellitus. *Med J Austr* 151:146–50, 1989
6. West KM: Diet therapy of diabetes: an analysis of failure. *Ann Intern Med* 79: 425–34, 1973
7. Howard BV, Abbott WGH, Swinburn BA: Evaluation of metabolic effects of substitution of complex carbohydrates for saturated fat in individuals with obesity and NIDDM. *Diabetes Care* 14:786–95, 1991
8. Bantle JP: Thoughts on the dietary treatment of diabetes mellitus. *Diabetes Care* 15:1821–23, 1992
9. Gosper J, Barth R, Campbell LV: Practice guidelines: satisfactory food records—a new method of instruction. *Austr J Nut Diet* 46:46–47, 1987
10. Lewis J, English R: *90 Nutrient Data Tables for Use in Australia*. Canberra, Australia, Commonwealth Government Printer, 1990
11. Morgan CR, Lazarow A: Immunoassay of insulin: two antibody system: plasma insulin levels of normal, subdiabetic, diabetic rats. *Diabetes* 12:115–26, 1963
12. Heding LG: Radioimmunological determinations of human C-peptide in serum. *Diabetologia* 11:541–48, 1975
13. Allaine GC, Poon LC, Chan CSG: Enzymatic determination of total serum cholesterol. *Clin Chem* 20:470–75, 1974
14. Bucolo G, David H: Quantitative determination of serum triglycerides by the use of enzymes. *Clin Chem* 19:476–82, 1973
15. Burstein M, Scholnik H, Morfin R: Rapid method for the isolation of lipoproteins from human serum by precipitation with polyanions. *J Lipid Res* 11:583–95, 1970
16. Riccardi G, Rivellese A, Pacioni D, Genovese S, Mastranzo P, Mancini M: Separate influence of dietary carbohydrate and fiber on the metabolic control in diabetes. *Diabetologia* 26:116–21, 1984
17. Garg A, Grundy SM, Koffler M: Effect of high carbohydrate intake on hyperglycaemia, islet function, and plasma lipoproteins in NIDDM. *Diabetes Care* 15: 1572–80, 1992
18. Himsworth HP: The dietetic factors determining the glucose tolerance and sensitivity to insulin of healthy men. *Clin Sci* 2:67–94, 1935
19. Borkman M, Campbell LV, Chisholm DJ, Storlien L: High-carbohydrate low-fat diets do not enhance insulin sensitivity in normal subjects. *J Clin Endocrinol Metab* 72:432–37, 1991
20. Keys A, Menotti A, Karvonen MJ, Aravanis C, Blackburn H, Buzina R, Djordjevic B, Dontas AS, Fidanza F, Kyes MH, Kromhout D, Nedeljkovic S, Punsar S, Seccareccia F, Toshima H: The diet and 15-year death rate in the seven countries study. *Am J Epidemiol* 124:903–15, 1986