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Abstract

Diet is a major aspect of glycaemic control in type 2 diabetes, particularly among the elderly. The objective of this study was to describe the food habits of elderly diabetic subjects compared with non-diabetic ones and to examine the difference between their nutritional behavior and nutritional recommendations. This study was based on the Three City (3C) community-based cohort. The food habits of 1336 participants aged 65 or over, including 149 diabetic subjects, were evaluated using a food frequency questionnaire and a 24-hour recall of food consumption. For both sexes, intake of carbohydrates was lower for diabetic compared to non diabetic subjects, essentially due to lower intake of mono-/disaccharides. For ddiabetic men, this was compensated for by a higher intake of protein whereas women had a lower energy intake overall. Fibre intake was also higher in diabetic men. There was no absolute increase in fats intake, neither for men nor for women and distribution of subtypes of fats (saturated, mono-unsaturated, and poly-unsaturated) did not differ between diabetic and non-diabetic subjects. In mean, carbohydrates provided 40.5% of energy intake in diabetic men and 43.9% in diabetic women. Contrary to nutritional recommendations for diabetic subjects, for approximately two thirds of the diabetic subjects carbohydrates represented less than 45% of daily calories. Although food habits of elderly diabetic subjects differed from those of non-diabetic ones these habits are not totally in line with nutritional recommendations. These results should be taken into account to adapt nutritional advice given to the diabetic population.

Author Keywords Type 2 diabetes ; Diet ; Elderly ; epidemiology

MESH Keywords Aged ; Cohort Studies ; Diabetes Mellitus, Type 2 ; diet therapy ; psychology ; Diabetic Diet ; standards ; Dietary Carbohydrates ; administration & dosage ; Dietary Fats ; administration & dosage ; Dietary Proteins ; administration & dosage ; Energy Intake ; Female ; Food Habits ; France ; Humans ; Male ; Nutrition Assessment ; Sex Factors

INTRODUCTION

Type 2 diabetes is a highly prevalent disease among the elderly1 –4 and the incidence of clinical diabetic complications in this population has been associated with glycemia.5 Although the impact of diabetes control is less well known in the elderly population, it can be postulated that, like younger subjects, older diabetics could benefit from efficient control of their diabetes. Diet is the cornerstone of diabetes management. In type 2 diabetes, diet without additional therapeutic is recommended as long as patients are meeting treatment goals, that is to say an HbAlc inferior to 7%.6 In a recent study in the UK, approximately one third of patients with type 2 diabetes were managed by diet alone.7 This proportion could be even greater in the elderly population.

One of the objectives of diet is to assure an adequate ratio between carbohydrates and lipids, which contributes to improve insulin sensitivity, a major factor in type 2 diabetes care. Diet also has to ensure an adequate and sufficient energy intake, which is of paramount importance in elderly people. Even when anti-diabetic drugs are required, diet is still a major contributor to glycaemic control. Thus, analysis of diet among elderly diabetic subjects is of particular interest since increasing our knowledge of the nutritional behaviour of the elderly diabetic population should make it possible to adapt the nutritional advice given to this population. Some studies have evaluated to what extent diabetic persons in the population follow dietary recommendations.8 –13 However, although most studies considered both insulin dependent and non-insulin dependent diabetes,8 ,9 ,11 –13 very few focused on the elderly population 11 ,12 and study samples were often quite small. Moreover, to our knowledge, previous studies have compared the diets of diabetic subjects with those of non-diabetic subjects. However, only one previous study has investigated the discrepancy between diet and nutritional recommendations in diabetics.12

We hypothesised that diet of elderly diabetic subjects differs from that of non diabetic ones but is not totally in line with nutritional recommendations for diabetic subjects. To test this hypothesis we compared nutritional behaviours of diabetic subjects, first with non diabetic subjects and then with nutritional recommendations for diabetics within the Three City Study (3C), a French population-based cohort study of subjects aged 65 years and over designed to study the main vascular and neurodegenerative pathologies related to ageing.

MATERIALS AND METHODS

Design of the study

This study was part of the Three City (3C) study, a collaborative research program based on a longitudinal cohort of 9 294 subjects aged 65 years and over. The main objective of this cohort is to estimate the risk of dementia and cognitive impairment attributable to vascular factors and to define target groups for future preventive strategies.14

Participants were recruited between March 1999 and March 2001 in three French cities: Bordeaux (n=2 104 participants included), Dijon (n=4 931) and Montpellier (n=2 259). Details of the 3C study are reported elsewhere.14 To be eligible, people had: 1) to be aged 65 years or over, 2) to be living in one of the selected districts of the three cities and registered on the electoral rolls, and 3) not to be institutionalized. The study protocol was approved by the Ethical Committee of the Kremlin-Bicêtre University Hospital of. Data collection included measurements and examinations common to the three centers, principally related to the central objective of the 3C Study. Additional data have been collected for center-specific ancillary studies.

Population

The present paper is based on the data of the Bordeaux center collected at the two-year follow-up of the cohort. At this time, the Bordeaux center had planned specific dietary objectives and had collected additional data on nutritional habits. Among the 2 104 subjects initially included in the Bordeaux center, 1 761 (83.7%) were visited in 2001–2002. A total of 1 661 (94.3%) of them had a nutritional evaluation during this follow-up. After exclusion of three subjects with extremely low energy intake (less than 500 kcal) on the 24-hour recall, 1658 subjects were included in the present study.

Data collection

Data were collected during face-to-face interview using standardized questionnaire administered by trained psychologists. Data collection included sociodemographic variables, habits, personal medical history, current symptoms and diseases including diabetes, an inventory of all drugs used daily or regularly during the preceding month and anthropometric data (including height and weight). A fasting blood sampling, including fasting glucose level was performed at the inclusion of the cohort but not repeated at this follow-up. Dietary information was collected by specifically trained dietician who administered a food frequency questionnaire and a 24-hour dietary recall. The food frequency questionnaire was adapted from the questionnaire used for inclusion in the “SUpplémentation en VItamines et Mineraux AntioXydants” (SUVIMAX) randomised controlled study.15 This questionnaire asked for the usual frequency of consumption of broad categories of food and beverages at each meal and in intervals. During the 24-hour recall, the dietician registered all the meals and beverages consumed at any time during the previous day. Portions sizes were estimated by a picture booklet16 edited for the SUVIMAX study.15 Then estimation of the daily nutrient intake of each participant was obtained using BILNUT software© (release 4.0) which includes food composition tables for France. At the end of the interview, the dietician evaluated the reliability of the information provided by the subject based on the global coherence of the record and the cognitive abilities of the respondent. We excluded subjects for whom the report was judged as unreliable. For the same reason, we excluded demented participants from our sample. The validity of dietary questionnaires has been previously assessed by evaluating the association between total fat intake estimated from the 24 h recall and triacylglycerol assessed at baseline.18 In addition, fish consumption frequency evaluated by the food frequency questionnaire was also linked to the estimated EPA and DHA intake.18

Diabetes diagnostic procedure

The presence of diabetes was evaluated on self-reported diagnosis of diabetes and/or a consumption of insulin or oral hypoglycemic agents. In order to insure that the non-diabetic group did not include any diabetic subjects, results of the fasting glucose level obtained at the baseline phase of the cohort were also taken into account. Thus, subjects who did not report a diabetes but were classified as hyperglycemic (fasting glucose level between 6.1 (included) and 7 (excluded) mmol/L) or diabetic (fasting glucose level equal or over 7 mmol/L) on the blood sample at baseline were excluded;19 in addition, subjects who did not report a diabetes and had no blood sample at baseline were also excluded.

Other variables

Age, sex, marital status (married or living together, widowed, never-married and divorced or separated) and living conditions (alone or not) were considered. Educational level was evaluated on two levels, at least primary school level validated by a diploma, versus no diploma (low level). The Body Mass Index (BMI) was calculated (weight/size^2) in kilograms per squared meters.

Data analysis

The Statistical Analysis Systems statistical software package version 8.2 (SAS Institute, Cary, NC, USA) was used. Student’s t test (for quantitative) and Chi-square tests (for qualitative) were used to compare socio-demographic characteristics and food consumption by groups. Nutrient intake has been presented in absolute values and nutrient densities for diabetic and non-diabetic subjects. Because of differences in diet between men and women, at least in total energy intake, most of the results are presented separately for men and women.

To compare nutrient intake between diabetic and non-diabetic subject, linear regression models adjusted for age and educational level have been performed. Because of a significant interaction between gender and nutrient intake, these models have been performed separately for each sex. Statistical assumptions for these models have been verified graphically.

To evaluate the discrepancy between nutritional behaviour and nutritional recommendations in diabetic subjects, indicators of consumption were created for the three nutrient densities (carbohydrates, fats and protein), saturated fats and cholesterol. In France, nutritional recommendations for diabetic subjects in 2000 mention that consumption of carbohydrates should be between 45 to 50% of total energy intake, total fats between 25 to 35% and protein between 10 to 20%.20 As data in the 3C study were collected in 2001–2002, we chose to refer to these recommendations rather than more recent ones. At first, only consumption of carbohydrates was considered. Then, consumption of less than 300mg of cholesterol and less than 10% of daily energy intake was also evaluated. As French recommendations differed slightly from American and European recommendations,21 ,22 we also evaluated the proportion of subjects for whom consumption was not in compliance with those recommendations which advise more than 60% of daily energy intake as carbohydrates and monounsaturated fats.

RESULTS

The initial sample was constituted of 1 658 subjects who underwent the nutritional evaluation at the two-year follow-up of our cohort. Among them, we excluded 107 subjects for whom dietary information was judged to be unreliable, due to a diagnosis of dementia (n=75), or based on the judgment of the dietician (n=32). In order to avoid misclassification, we excluded 195 subjects who declared they were non-diabetic at this follow-up: 140 of them because they did not provide a blood sample at the baseline examination and 55 who had nevertheless hyperglycaemia in their blood sample at baseline. Finally, 20 subjects who were diagnosed as diabetic at the baseline phase of the study but who did not report diabetes at this follow-up were also excluded. Our final working sample was therefore constituted of 149 diabetic participants and 1187 non diabetic participants.

Characteristics of the diabetic and the non-diabetic sample according to gender are described in Table 1 . Diabetic subjects were more often men (54.4% of men among diabetics compared to 35.9% among non-diabetics, $p<0.0001$), but did not differ by age (76.0 years for diabetics and 75.9 for non-diabetics, $p=0.73$). Diabetic women had a lower level of education than non-diabetic women. As expected, BMI was greater among diabetic than non-diabetic subjects, especially for women, with a BMI 3.9 higher for diabetic women than for non-diabetic ones ($p<0.0001$).

Food consumption

Six non-diabetic subjects did not answer the food frequency questionnaire and the results for food consumption are thus based on 1330 subjects. The number of meals per day, including snacks, was lower for diabetic women compared to non-diabetic women, whereas no differences were observed in men (Table 2). Only two diabetic subjects declared having only two main meals instead of three (breakfast, lunch and dinner). In men, fruit consumption per week was slightly more frequent among diabetic than among non-diabetic as well as meat consumption. However in women, no differences in consumption of fruit, vegetable, meat, pork-meat and fish were observed between diabetic and non-diabetics. On average, 87.3% of the diabetic subjects ate at least one piece of fruit a day and diabetic subjects eat about three vegetables day. Non-diabetic subjects ate more often sweet foods than diabetic ones, particularly for breakfast and also as snacks between meals for men. About 36% of non-diabetic subjects reported nibbling sweets between meals regularly (ie. at least 5 times a week), compared to 21.5% of diabetic subjects ($p<0.0003$)). The use of artificial sweeteners was more frequent for diabetic subjects with more than half of them (51.0%) adding an artificial sweetener to their drink regularly at breakfast, compared to 13.0% of the non-diabetic subjects.

Energy and nutrient intake

Table 3 shows the absolute values of nutrient intake, assessed with the 24-hour recall, for both sexes according to the diabetic status. Comparisons between diabetic and non-diabetic subjects have been performed using linear regression models separately for each sex. Adjusted for age and educational level, energy intake the day before significantly differed between diabetic and non-diabetic subjects only for women, with a lower energy intake for diabetic women.

Compared to non-diabetic men, diabetic men had a lower intake of carbohydrates, essentially due to a lower intake of mono- and disaccharides, and a higher intake of protein (Table 3) Fibre intake was also higher in diabetic men. As for men, intake of carbohydrates was also lower for diabetics women, but not accompanied by an increase in another nutrient with thus a lower energy intake overall. The lower intake of carbohydrates in diabetic women was essentially due to a lower intake of mono- and disaccharides. Regarding intake of polysaccharides, there was no significant difference between diabetics and non-diabetics, neither for women nor for men. Alcohol intake was also lower in diabetic women.

Similarly, the comparison of nutrient densities evidenced a fewer carbohydrates intake for diabetic subjects, and notably a fewer mono- and disaccharides intake whatever the sex (Table 4). This reduction in carbohydrates intake was done simultaneously with a slightly higher intake of protein and fats. However, distribution of subtypes of fats (saturated, mono-unsaturated and poly-unsaturated) was similar for diabetic and non-diabetic subjects for both sexes.

Comparison with nutritional recommendations

Proportions for nutrient densities for diabetics' men and women are displayed in table 4 . About 84% of the diabetic subjects did not consume between 45 to 50% of their daily energy intake as carbohydrates as recommended, with about two thirds (63.8%) consuming less than 45%). Even with less restrictive criteria, 43.0% of our diabetic subjects consumed less than 40% of their daily energy intake as carbohydrates. In addition, although 61.1% of the diabetic subjects consumed less than 300mg of cholesterol, only 20.8% consumed less than 10% of daily energy intake as saturated fats. When all the criteria were combined, only one diabetic subject was totally in compliance with the nutritional recommendations. In addition, regarding the American and European recommendations, 77.2% of the diabetic subjects consumed less than 60% of daily energy intake as carbohydrates and mono-unsaturated fats.

DISCUSSION

This study on the food habits of elderly subjects showed that food behavior differed between diabetic and non-diabetic subjects, particularly with a lower intake of carbohydrates, essentially due to a lower intake of mono- and disaccharides. However, food behaviors of diabetic subjects did not seemed to be appropriate since consumption of carbohydrates was too low in these elderly diabetic subjects and about two thirds of them were not in line with the recommendation and consumed less than 45% of daily energy intake as carbohydrates. Moreover, protein intake was high in diabetic men.

Compared to nutritional recommendations, total energy intake appears to be relatively low in our results, particularly among women. However, total energy intake reported in our study was similar[11 ,23 ,24] or only slightly lower[8 ,12 ,13 ,25] compared to previous evaluations in diabetic subjects or healthy elderly. When lower, these differences could be partly explained by the fact that our population was older. Although our results were comparable to previous ones, under-report of intake cannot totally be ruled out. Indeed, in our population, although total energy intake appears to be relatively low, BMI is high among diabetic subjects. Even if nutritional assessment was performed in the same way in diabetic and non-diabetic subjects and was part of an epidemiological study which primary objective was not nutrition, a selective under reporting of restricted foods among diabetic subjects cannot be ruled out. However, previous studies with similar report of energy intake consistently found a high BMI among diabetic subjects.[8 ,9 ,11 –13]

Our results were based only on one 24-hour recall of food consumption. Thus, for an individual, it does not reflect his/her regular food habits, since diet varies from day to day. However, it represents mean values for the groups of diabetic and non-diabetic subjects.[26] One limitation in this method is that the within person variation is such that the median tends to be correct, but the variance is increased.[27 ,28] In our study, the 24-hour recall was assessed using food photographs which generally have a positive influence on the relative validity for absolute food group intake.[29] In addition, although validity has not been evaluated for each nutrient, dietary assessment methods have been previously validated for fat intake[18 ,30] and the mean energy intake was positively associated with the intensity of physical activity in our study.[18]

Nevertheless, our results are very close to previous results in a younger French population.[13] This replication of results, in similar population but of different age, limits the risk of methodological bias. For many diabetic subjects in our population, nutritional behavior appears to be different to the French nutritional recommendations for diabetic persons. Indeed, many diabetic subjects in our population consumed fewer carbohydrates than recommended. Yet, this population has a modified diet compared to non-diabetic population. The decrease of mono-/disaccharide consumption, of alcohol consumption for women and the increase of artificial sweetener consumption bear witness to these modifications, but they seem partly inadequate. This is probably due to the fact that the current belief for diabetes is that people need to avoid sugar and many diabetic people are not aware of the necessity of high carbohydrate consumption and an adequate carbohydrate/lipid ratio. Thus, nutritional information should clearly underline the main messages.

In France, dietary recommendations directed towards subjects with type 2 diabetes did not specifically include the consumption of mono-unsaturated fats, except for subjects with abdominal obesity, hypertriglyceridemy, and low HDL-cholesterol.[20] These cases apart, the main recommendation is that carbohydrates should provide about half the total energy intake.[21] When considering this recommendation, only one third of the diabetic subjects consumed enough of them. Moreover, because of increased within person variation due to use of the 24 hour recall, the actual percentage of people who habitually eat less than 45% of energy from carbohydrates is probably greater than the estimated value. The proportion of subjects in line with nutritional recommendations has rarely been provided directly in previous published data. Even if results cannot be compared directly since recommendations differ across countries, our result appears to be in contradiction with previous data in a Spanish population, where more than 80% of the patients complied with the

recommendation of consuming more than 60% of daily energy intake as carbohydrates and mono-unsaturated fats.12 However, consumption of carbohydrates was relatively low in this Spanish population, about 38% of total energy; the high compliance with recommendations was explained by a very high consumption of fats (almost 40%, including about 56% of mono-unsaturated fats), which appears rather to be a common nutritional habit in Spain than respect of nutritional recommendations in this diabetic population. In other studies, the mean consumption of carbohydrates and mono-unsaturated fats was lower than 60% in two of the three countries in the Seven Countries Study11 and also in France.13

The low intake of carbohydrates in our diabetic population leads to an imbalance between carbohydrates and lipids, which hampers the action of insulin. Thus, this nutritional behaviour of reducing carbohydrate intake is deleterious for the management of these diabetic patients, making it more difficult to obtain glycemic control and probably increasing the vascular risk associated with diabetes.

Beyond the low intake of carbohydrates in our diabetic population, the difference between diabetic men and women in nutritional behaviour is of particularly interest. Indeed, diabetic women decrease their nutritional intake whereas diabetic men increase their protein consumption. Both of these are risk behaviours. The decrease in energy intake can lead to malnutrition in women. Thus, although high BMI is problematic, nutritional recommendations for this population should be cautious and not too restrictive. In men, the high intake of protein constitutes a risk for renal function, particularly in case of nephropathy, which may be frequent in this population.

For non-diabetics, in comparison with the French recommendations for elderly, proteins intake was slightly higher and mean carbohydrates lower. However, despite a mean increase of protein intake, a previous paper on the same population evidenced that 44% of the elderly consumed lower than 1g of proteins/kg/day, suggesting that some protein-energy malnutrition occurs in the oldest persons, putting them at higher risk of sarcopenia.18 Despite an adequate intake of total fat, non-diabetics had an excessive intake of saturated fat compared to the current French recommendations, concomitant to a low monounsaturated fat intake. This latter result confirms that the French people diet is not perfect despite a relatively low incidence of heart diseases.

These results offer several clues on how to improve nutritional recommendations for the elderly population. Although diet of diabetic subjects differs from the one of non-diabetic ones, it is not totally in line with nutritional recommendations. The message is probably poorly understood or distorted. Thus, nutritional advice should focus on the main messages such as the need for a large quantity of carbohydrates and moderate protein consumption of as well as the need to avoid mal-nutrition in the diabetic population.

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Table 1

Principal characteristics according to the sex and the diagnosis of diabetes. 3C study, 2001–2003

	Men		Women	
	Diabetics (n=81)	**Non diabetics (n=426)**	**Diabetics (n=68)**	**Non diabetics (n=761)**
Age (y):				
mean (SD)	75.1 (5.0)	75.5 (4.7)	77.1 (5.0)	76.2 (5.0)
range	68.3–88.4	68.0–90.0	69.3–94.9	67.7–93.5
Education (% low)	7.4	5.4	23.9***	9.3
Living alone (%)	17.3	17.4	58.8	54.4
Marital status (%)				
- married/together	77.8	78.6	33.8	40.5
- widowed	11.1	14.6	51.5	39.8
- never-married	6.2	2.1	5.9	9.6
- divorced/separated	4.9	4.7	8.8	10.1
BMI (%)				
<21	0.0	3.8	3.2*** †	10.7
[21–27[	49.4	54.2	28.6	54.6
[27 – 30[	29.3	27.2	25.4	18.7
>=30	21.0	14.8	42.9	15.9
BMI: mean (SD)	27.6 (3.4)*	26.7 (3.5)	29.8 (5.0)***	25.9 (4.3)

* p<0.05,

** p<0.01,

*** p<0.001: p-values for the differences between diabetic and non-diabetic subjects for each sex using Student's t test for quantitative variables and Chi-square tests for qualitative variables

† global p-value for the BMI categories

Table 2

Food frequency consumption according to the sex and the diagnosis of diabetes. 3C study, 2001–2003

	Men		Women	
	Diabetics (n=81)	**Non diabetics (n=423)**	**Diabetics (n=68)**	**Non diabetics (n=758)**
Number of meals per day: mean (SD)	4.0 (1.1)	4.0 (1.1)	4.0 (1.0)*	4.3 (1.1)
Fruit consumption: mean per week excluding fruit juice (SD)	12.9 (5.0)*	11.2 (5.8)	12.5 (6.0)	11.7 (5.8)
Vegetable consumption: mean per week (for raw and cooked vegetables (SD)	20.4 (8.7)	19.8 (7.4)	19.0 (7.0)	19.3 (7.3)
Meat meals: mean per week (SD)	7.6 (2.5)***	6.7 (2.6)	6.8 (2.7)	6.2 (2.5)
Pork-meat meals: mean per week (SD)	2.6 (3.0)	2.4 (2.7)	1.6 (1.9)	1.2 (1.8)
Fish meals: mean per week (SD)	2.5 (1.8)	2.3 (1.4)	2.0 (1.6)	2.3 (1.4)
Sweets for breakfast: mean per week (SD)	8.7 (5.1)***	3.5 (5.5)	7.6 (5.0)***	2.2 (3.2)
Snacking on sweets: mean per week (SD)	2.2 (4.6)*	3.7 (5.0)	3.1 (6.1)	4.5 (5.9)

* p-values for the differences between diabetic and non-diabetic subjects using Student's t test
* p<0.05,
** p<0.01,
*** p<0.001

Table 3

Nutrient intake in absolute values assessed with the 24-hour recall among diabetic and non diabetic subjects according to sex. 3C study, 2001–2003.

	Men		Women	
Absolute values: mean (SD)	**Diabetics (n=81)**	**Non diabetics (n=426)**	**Diabetics (n=68)**	**Non diabetics (n=761)**
Total energy (kJ)	8294.1 (2219.2)	8603.7 (2260.7)	5715.1 (1622.7)**	6465.2 (1941.3)
Carbohydrates (g)	198.8 (64.1)***	233.1 (76.5)	149.4 (58.7)***	180.7 (62.2)
mono-/disaccharides (g)	76.1 (36.5)***	101.8 (46.0)	65.7 (35.8)***	87.2 (35.5)
polysaccharides (g)	122.7 (49.4)	131.3 (51.7)	83.7 (35.6)	93.5 (43.9)
Protein (g)	94.1 (31.9)**	85.2 (25.6)	69.5 (26.6)	69.8 (24.9)
Total fats (g)	74.9 (33.3)	70.0 (29.8)	51.3 (21.9)	54.5 (25.1)
saturated (g)	32.0 (16.0)	29.8 (13.8)	22.2 (10.8)	23.3 (12.0)
mono-unsaturated (g)	27.0 (12.6)	25.3 (12.5)	17.8 (8.1)	19.4 (9.8)
poly-unsaturated (g)	10.6 (7.4)	9.9 (6.7)	7.4 (3.7)	7.8 (5.9)
cholesterol (mg)	325.6 (168.8)	331.9 (189.8)	268.2 (151.5)	268.5 (172.3)
Fibre (g)	21.3 (9.2)*	19.2 (7.8)	14.3 (7.1)	15.7 (7.3)
Alcohol (g)	19.5 (19.9)	21.8 (20.1)	4.1 (6.7)*	7.5 (10.5)

* p<0.05,
** p<0.01,
*** p<0.001: p-value for the difference between diabetic and non-diabetic subjects for each sex analysed with linear regression models adjusted for age and educational level

Table 4

Nutrient intake in nutrient densities assessed with the 24-hour recall between diabetic and non diabetic subjects according to sex and comparisons with dietary recommendations. 3C study, 2001–2003.

		Men		Women	
Nutrient densities: % (SD)	**Nutritional recommendations for diabetic subjects†**	**Diabetics (n=81)**	**Non diabetics (n=426)**	**Diabetics (n=68)**	**Non diabetics (n=761)**
Carbohydrates: (% kJ)	45–50	40.5 (8.8)***	45.6 (9.7)	43.9 (10.6)*	47.1 (9.8)
mono-/disaccharides (% carbohydrates)	-	38.5 (14.4)**	43.5 (12.8)	43.5 (14.1)**	49.2 (14.3)
polysaccharides (% carbohydrates)	-	61.5 (14.4)**	56.5 (12.8)	56.5 (14.1)**	50.8 (14.3)
Protein (% kJ)	10–20	19.1 (4.9)***	16.9 (4.1)	20.4 (5.6)**	18.4 (5.0)
Total fats (% kJ)	25–35	33.3 (9.2)**	30.2 (8.5)	33.7 (10.1)*	31.2 (8.8)
saturated (% total fats)	-	42.3 (7.9)	42.3 (7.7)	42.9 (7.5)	42.6 (8.5)
mono-unsaturated (% total fats)	-	36.2 (6.4)	35.7 (5.9)	34.3 (6.0)	35.3 (6.0)
poly-unsaturated (% total fats)	-	14.2 (6.3)	14.6 (7.0)	15.0 (5.4)	14.6 (7.3)
Alcohol (% kJ)	-	7.1 (6.8)	7.4 (6.4)	2.1 (3.6)	3.3 (4.6)

* p<0.05,

** p<0.01,

*** p<0.001: p-value for the difference between diabetic and non-diabetic subjects for each sex analysed with linear regression models adjusted for age and educational level

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