Comparison of the diet of self-declared diabetics with non-diabetic patients in the SU.VI.MAX study: did the diabetics modify their nutritional behavior?

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SUMMARY

Objective: Dietary recommendations, a pillar in the treatment of diabetes, form part of official guidelines. However, it is not known how well these recommendations are followed in the diabetic population in France. The purpose of this study was to compare the habitual diet of self-declared diabetics with non-diabetics and to evaluate whether recommendations are being followed.

Methods: The intakes of several nutrients and foods of 67 self-declared diabetic patients were compared to those of 4658 non-diabetics in the SU.VI.MAX study (a primary prevention trial evaluating the impact of antioxidant supplementation on chronic disease). All patients (aged 45 to 60 years) who had completed at least five 24-hr dietary records over the first 18 months of the SU.VI.MAX study were included. We excluded patients who had not declared a diagnosis of diabetes and those whose fasting glucose levels were below 7 mmol/l.

Results: The diabetic patients who declared being diabetic reported lower carbohydrate intakes (185 ± 10.4 vs 219 ± 1.4 g/d for men [p = 0.001], 137 ± 9.6 vs 165 ± 1.0 g/d for women [0.005]), with a 50% reduction in consumption of oligosaccharides. Lipid intakes were unchanged for men, but reduced for women (61 ± 4.1 g/d vs 72 ± 0.4 g/d [p = 0.01]) with a 20% reduction in saturated fatty acids. Protein consumption was higher in the diabetic than in the non-diabetic men, but comparable for the women. Energy intakes were only lower in the diabetic women (1458 ± 81 vs 1665 ± 9 Kcal/d for women [p = 0.01]). Micronutrient intakes were similar to those of non-diabetics, but appeared to be inadequate, particularly for anti-oxidants. Diabetic men consumed more margarine and less alcohol than did the non-diabetics.

Conclusion: Diabetic patients who declared being diabetic did modify their nutritional behaviour, as they reduced their carbohydrate intake (both men and women), increased their protein intake (men only), and decreased their lipid and energy intakes (women only). However, carbohydrate intakes were unbalanced and there was excess protein intake. So patients who declared being diabetic are not as non-compliant in nutrition as commonly thought; they try to modify their diet, but often inappropriately. This may be explained by the fact that dietary advice stems from different sources and may be confusing.

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contradictory. A diabetic education program requires standardised training of health professionals and the provision of unequivocal information to the mass media and the general public.

Key-words: Diabetes · Dietary recommendations · Diet.

Diabetes represents a major public health problem, especially in view of the constant increase in prevalence, estimated at 2.5% in the French population [1]. Irrespective of the type of diabetes and the associated treatments, nutrition therapy is an essential component of successful control of blood glucose [2]. Numerous proposals have been put forward to determine the best-adapted diet [3]. In Europe, as in the USA, the nutritional recommendations for diabetic patients are regularly revised by medical commissions and diabetes societies such as the ALFEDIAM (Association de langue française pour l’étude du diabète et des maladies métaboliques) [4], the EASD (European Association for the Study of Diabetes) [2], and the ADA (American Diabetes Association) [5]. The latter recommends that the diet of a diabetic patient must cover energy requirements with an optimal distribution of macro and micro-nutrients, without increasing insulin-resistance, or risk of cardiovascular disease. Dietary recommendations may also attempt to minimise complications. As type 2 diabetic patients are frequently overweight, a caloric limitation of 15-30% of intakes is usually required to obtain a weight loss of 5-15%, which should be adequate to reduce blood glucose concentrations, dyslipidemia and blood pressure [6]. At present, the nutritional recommendations for diabetic patients do not differ from those for normal non-diabetic individuals with respect to prevention of major chronic diseases. In the latest recommendations of the EASD, protein intake represents 10 to 20% of the total caloric intake, polyunsaturated fatty acids less than 10%, and saturated fatty acids 10% [2]. Of the remaining calories, 60 to 70% should be provided by a combination of carbohydrates and mono-unsaturated fatty acids. The proportion of carbohydrates lies between 40 and 50%, as a very high carbohydrate content (> 55%) leads to an elevation in triglycerides, a lowering of HDL, sometimes accompanied by an increase in postprandial glycaemia and insulinemia [7]. To limit carbohydrate intake, part of the carbohydrates should be replaced by mono-unsaturated fatty acids up to a quarter of the total diet [3]. There are no specific recommendations for diabetic patients with respect to micronutrients, but more antioxidants may be required due to the high oxidative stress of diabetic patients [8].

In the 1980s in the USA, the Nurses’ Health Study suggested that diabetic women consumed less energy from carbohydrates, especially from sucrose, and more energy from protein and fat than did non-diabetic women. A longitudinal study including only women indicated that patients do modify their diet as a result of the diagnosis of diabetes [9]. In Europe, the EURODIAB IDDM Complications study found that only 14%, 14% and 15% of patients complied with recommendations from the EASD for total fat, saturated fatty acids and carbohydrates, respectively [10]. No patients with type 2 diabetes were included in this study. In the Monic project in France, the dietary intake of diabetic men differed markedly from that of the general population (fat intake higher and carbohydrate intakes lower) and furthermore did not correspond to international dietary guidelines [11]. This study only considered men from three specific regions in France, which are unrepresentative of the general population.

The implementation of dietary recommendations in diabetic populations has been little studied, especially in France, where habitual diets differ from those in Anglo-Saxon countries. The aim of our study was, therefore, to compare the habitual diet of self-declared diabetic patients (essentially type 2) to that of non-diabetic patients in a French population of 45-60-year-old men and women, and to determine whether their diet was in line with nutritional recommendations.

Subjects and methods

Subjects

Subjects were participants in the SU.VI.MAX study, an on-going randomised double-blind placebo-controlled primary prevention trial designed to evaluate the effect of daily antioxidant supplementation (vitamin C, vitamin E, β-carotene, selenium and zinc) at nutritional doses on the incidence of cancer and ischemic heart disease. The cohort consisted of women initially aged between 35 to 60 years and men aged between 45 to 60 years. They were invited to participate by a multimedia campaign throughout France. Candidates received detailed information on the study and performed a self-test of acceptability of the daily supplement. In total
12735 subjects were included at baseline in 1994 and are being followed up for eight years. The patients were volunteers; they are generally interested in nutritional behaviour and health; they were included for simple observation of their nutritional behaviour rather for any dietary modification. If they had a nutritional disease (diabetes, dyslipemia, etc.) they were followed-up as usual by their own practitioners. Details on recruitment and study design have been described elsewhere [12]. For the present analyses only those subjects who completed at least five 24-hr food records during the first 18 months of the SU.VI.MAX study, were included. In order to have a sample of men and women of the same age, only women aged between 45 to 60 years were included (same age range as the men). Furthermore, all individuals with a fasting plasma glucose concentration over 7.00 mmol/l, not declaring themselves diabetic, were excluded. The general characteristics of the subpopulation of 4955 subjects we studied here did not differ from that of the total study population (data not shown).

For the present study, patients were defined as self-declared diabetics if they declared being diabetic during the first interview on entering the SU.VI.MAX study or if they stated they were taking oral anti-diabetic drugs or insulin. Due to the absence of accurate medical data, we were unable to distinguish type 1 from type 2 diabetic patients, so all diabetics, including those treated with insulin, were considered as a single group.

The SU.VI.MAX study has been approved by the ethical committee for studies on human patients (CCPPRB no. 706) of Paris-Cochin Hospital, and the Comité National Informations et Libertés (CNIL no. 334641), which advocates that all medical information is confidential and anonymous.

Data collection

Subjects kept a 24-hour record every two months, for a total of six records per year. They kept the record randomly for two weekend days and four weekdays per year, so that each day of the week was covered in all seasons for the mean intake of all participants. Information was collected using the Minitel Telematic Network. The Minitel is a small terminal widely used in France as an adjunct to the telephone. At the beginning of the study, participants received free of charge a miniature central processing unit specifically developed for the study and loaded with specialised software that allowed patients to fill out the computerised dietary records off-line and to transmit data during brief telephone connections. Conversational facilities in the software and an instruction manual for codification of foods guided the participants in completion of the records. The manual contained photographs showing portions in three sizes. Subjects could choose a portion size indicated exactly by one of the three pictures or an intermediate size (between the first and the second, or between the second and the third picture), or less than the first picture, or more than the last picture, so that seven choices were available to indicate the consumed portion. Photos of portion sizes had been validated on 780 subjects in a pilot study [13]. Data on variables such as cooking methods, seasoning, types of foods (fresh, frozen, canned, etc.) and place and time of consumption were also collected.

Weight and height, were measured with participants in underwear, and body mass index was calculated by dividing weight by the square of height (kg/m²).

Data analyses

Intakes of energy, proteins, carbohydrates, total, saturated, monounsaturated and polyunsaturated fat, fibre, alcohol, vitamins and minerals were calculated from food consumption data using the French computerised food composition table CIQUAL [14] completed by McCance and Widdowson’s food composition table [15].

A covariance analysis was used to compare macro and micronutrients intakes between the diabetics and non-diabetics. Macro and micronutrients were expressed as means, standard deviations, with p-values for the two-tailed Fisher’s test for comparison between groups. Because of the skewed distributions, alcohol consumption was square transformed and fibres, retinol, vitamin B12, vitamin D and magnesium intakes were logarithmically transformed, for which geometric means and 95% confidence intervals are presented. The intakes of the various types of food were compared using a median test.

As the habitual diet may differ between men and women, we analysed their results separately and all values were adjusted for age in the statistical analysis.

Mean intakes were compared with those recommended by the EASD for macronutrients [2] and the ANC (Apports Nutritionnels Conseillés, recommended dietary intakes for the French population) [16] for micronutrients.

Results

The population we studied comprised 41 self-declared diabetic men, 2437 non-diabetic men, 26 self-declared diabetic women and 2221 non-diabetic women (Tab I) aged from 45 to 60 years. At inclusion there were more diabetic patients (70 self-declared diabetic men and 49 women), but not all patients completed at least 24 h records during the first 18 months; moreover 216 men and 97 women were diagnosed as diabetic at inclusion, but they were not aware of their diabetes or did not declared being diabetic during the first interview on entry the SU.VI.MAX study and so were not included in the study.

Diabetic patients had a higher BMI than did the non-diabetics (28 vs 24.9 [p = 0.0001] for men, and 27.8 vs 22.9 [p = 0.0001] for women. Compared to the non-diabetic group (Tab I), the height over hips ratio of the diabetics was elevated (0.98 vs 0.92; p = 0.0001 for men, and 0.84 vs 0.77; p = 0.0001 for women) they were also older. No difference in educational level was noted between the two groups.
Results are shown in table II; the main findings of our study were:

- a net reduction in carbohydrate intakes for diabetic patients (men and women): 185 g/d vs 219 g/d for men (p = 0.001), and 137 g/d vs 165 g/d among women (p = 0.005).
- an increased intake of proteins, primarily of animal origin; 102 g/d vs 96 g/d (p = 0.05) (corresponding to about 40 g of extra meat) for male diabetic patients, but not in women (73 g/d vs 74 g/d);
- a decrease in lipid intakes in the diabetic women, 61 g/d vs 72 g/d (p = 0.01), primarily involving saturated fatty acids (25 g/d vs 31 g/d; p = 0.007).
- a reduction in alcohol intake in the diabetic men (13 g/d vs 19 g/d for controls; p = 0.04).
- a lower caloric intake for diabetic women only.

Compared to non-diabetics, diabetic patients consumed 50% less sweetened products (Fig. 1 and 2). Diabetic men, but not diabetic women, ate 20% more meat and meat products. Diabetic men also consumed more margarine. No differences were noted between the groups for any of the other types of food.

Results of micronutrient intakes are listed in table III both diabetic and non-diabetic patients had lower intakes of micronutrients than recommended. In both diabetic and non-diabetic women more than 90% had iron intakes below the recommended level.

**Discussion**

Our population consisted of volunteers in a large longitudinal epidemiological intervention study, who tend to be concerned about their health and thus more likely to be aware of dietary recommendations than is the general population. The group of diabetics in the present study comprised individuals who were aware of their diagnosis, as the criterion of inclusion was a self-declaration of diabetes. This was designed to evaluate voluntary changes in the diet due to a presumed diagnosis of diabetes; so the results we reported cannot be extrapolated to all diabetic patients, but only to those who are aware of their disease. The nutritional intakes were based on 24-hour food records with a minimum of five records for each participant over a period of more than one year and thus eliminated seasonal variations. To our knowledge, this is the first study to take this into account. The number of diabetics was consequently small, due to the exclusion of undiagnosed diabetics (313 patients) and patients who did not provide at least five food reports during the first 18 month of the study (52 patients). However, the numbers appeared to be sufficient to find statistically significant differences in several nutrients between the diabetics and non-diabetics; both type 1 and type 2 diabetics were included (although probably most were type 2 considering the age range of our population).

The main results of our study show that patients declaring themselves diabetic modified their habitual diet when compared to non-diabetics. They declared a lower consumption of carbohydrates than did the non-diabetics, mainly due to less sweetened products; similar data were obtained in other studies (9, 11, 17); they also had a lower consumption of complex carbohydrates as it was found in diabetic patients from Finland (21.2 energy %) and the Netherlands (22.8 energy %). Thus in common with other authors, we found that when patients are aware of the diagnosis of diabetes they try to modify their food intake by reducing intake of simple and some complex carbohydrates. This leads to a low proportion of carbohydrate, which is not in line with international recommendations. As our diabetic patients had higher BMI than controls, our results might have been due to the difference in BMI. However, we studied a group of 70 non-diabetic patients matched with diabetics for BMI and we did not find any difference with controls in carbohydrate and energy intakes (data not shown). We therefore concluded that the lower carbohydrate intake was due to the diagnosis of diabetes and not to their excess BMI. However, compared to the recommendations of EASD, diabetic patients had an inadequate carbohydrate and an excess fat intake, especially in saturated fatty acids, which incidentally was also too high in the non-diabetics. This diet can increase both insulino-resistance and the risk of cardiovascular disease.

We also found a higher protein intake in our male diabetic patients. Similar results were observed in the Seven Countries survey [18], the Nurses’ study [9] for both diabetic men and women as well as in the MONICA study for men [11], whereas no difference was observed for the women in our study. It is possible that men, who have
higher energy needs than women, compensate for the reduction in simple carbohydrate intakes by a higher consumption of meat rather than complex carbohydrates. This high consumption of meat may represent an excess intake with respect to renal function and is not in line with recommendations.

With respect to fat intake, the studies mentioned above [9, 11, 18] noted either no difference or a higher fat intake in diabetic patients. In the two European studies however, only men were included, whereas we observed a lower fat intake in our diabetic women but not in the men. The diabetic women in our study reduced their consumption of butter the diabetic men did not decrease their total fat intakes, although they doubled their margarine intake. There may have been an under-reporting for fat, but this seems unlikely in view of the reported increase in margarine consumption. Another explanation for the difference in fat intake with the MONICA and the Seven Countries Studies probably stems from the fact that our population comprised volunteers in a large intervention trial, who were likely to be more health conscious and more motivated to change their diet. Moreover, the Seven Countries

![Graph](https://example.com/graph.png)

**Figure 1** Intakes of various foods (median) in diabetic and non-diabetic women.
Study included proven diabetic patients, whereas we only included self-declared diabetic patients.

Only diabetic women reduced their overall energy intakes. We did not observe any difference in energy intake between the diabetic and control men. However, the energy intakes noted in this study seem lower than expected in both control and diabetic groups and lower than reported in other studies of diabetic patients [19]. This may have been due to methodological differences, but the comparisons between the two groups remain valid as the energy intakes of both diabetics and controls were lower than in other reports.

In our study the self-declared diabetic men considerably reduced their consumption of alcoholic drinks, further evidence for compliance with recommendations. This was consistent with the findings in the male population of type 2 diabetics in the Netherlands and Italy (Seven Countries study) [18]. No difference was noted in the diabetics studied by Parker [17], but the men and women were not analysed separately.

Certain micronutrients play a significant role in the prevention of cardiovascular diseases, which has been attributed to their antioxidant properties [20]. Vitamin E and C are both antioxidant vitamins; vitamin C intakes were lower than the ANC in our diabetics and non-diabetics with a significantly smaller difference for the female diabetics. This raises the issue of antioxidant requirements in view of the greater oxidative stress in diabetic patients [8]; vitamin E intakes were below the ANC only for women. Our findings are in agreement with the study of Bischof [21] in which only 60% of the individuals consumed quantities of vitamins E and C in non-diabetics.

Table III

Vitamin and mineral intakes in diabetic and non-diabetic subjects.

<table>
<thead>
<tr>
<th></th>
<th>ANC 2000(^{17})</th>
<th>MEN</th>
<th>WOMEN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>W</td>
<td>Non-diabetics</td>
</tr>
<tr>
<td>Retinol ((\mu g/d))</td>
<td>800</td>
<td>600</td>
<td>735.8</td>
</tr>
<tr>
<td></td>
<td>[716.2-877.3]</td>
<td>[579.2-877.3]</td>
<td></td>
</tr>
<tr>
<td>% with intakes &lt; ANC</td>
<td>60.0</td>
<td>65.9</td>
<td>0.45</td>
</tr>
<tr>
<td>Vitamin B1 (mg/d) *</td>
<td>1.3</td>
<td>1.1</td>
<td>1.78 (0.01)</td>
</tr>
<tr>
<td>% with intakes &lt; ANC</td>
<td>23.1</td>
<td>22.0</td>
<td>0.12</td>
</tr>
<tr>
<td>Vitamin B6 (mg/d) *</td>
<td>1.8</td>
<td>1.5</td>
<td>1.98 (0.01)</td>
</tr>
<tr>
<td>% with intakes &lt; ANC</td>
<td>38.6</td>
<td>26.8</td>
<td>0.12</td>
</tr>
<tr>
<td>Folate ((\mu g/d))</td>
<td>330</td>
<td>300</td>
<td>304.3 (1.8)</td>
</tr>
<tr>
<td>% with intakes &lt; ANC</td>
<td>63.7</td>
<td>61.0</td>
<td>0.72</td>
</tr>
<tr>
<td>Vitamin B12 (ng/d) **</td>
<td>2.4</td>
<td>2.4</td>
<td>6.82</td>
</tr>
<tr>
<td></td>
<td>[6.68-6.96]</td>
<td>[6.35-8.72]</td>
<td></td>
</tr>
<tr>
<td>% with intakes &lt; ANC</td>
<td>1.4</td>
<td>2.4</td>
<td>0.45</td>
</tr>
<tr>
<td>Vitamin C (mg/d) *</td>
<td>110</td>
<td>110</td>
<td>88.5 (0.9)</td>
</tr>
<tr>
<td>% with intakes &lt; ANC</td>
<td>73.1</td>
<td>63.4</td>
<td>0.17</td>
</tr>
<tr>
<td>Vitamin D (ng/d) **</td>
<td>5</td>
<td>5</td>
<td>2.59</td>
</tr>
<tr>
<td></td>
<td>[2.52-2.65]</td>
<td>[2.03-2.94]</td>
<td></td>
</tr>
<tr>
<td>% with intakes &lt; ANC</td>
<td>86.1</td>
<td>90.2</td>
<td>0.45</td>
</tr>
<tr>
<td>Vitamin E (mg/d) *</td>
<td>12</td>
<td>12</td>
<td>11.2 (0.1)</td>
</tr>
<tr>
<td>% with intakes &lt; ANC</td>
<td>64.3</td>
<td>61.0</td>
<td>0.68</td>
</tr>
<tr>
<td>Magnesium (mg/d) **</td>
<td>420</td>
<td>360</td>
<td>302.1</td>
</tr>
<tr>
<td></td>
<td>[298.6-305.6]</td>
<td>[279.4-334.4]</td>
<td></td>
</tr>
<tr>
<td>% with intakes &lt; ANC</td>
<td>88.4</td>
<td>85.4</td>
<td>0.47</td>
</tr>
<tr>
<td>Calcium (mg/d) *</td>
<td>900</td>
<td>900</td>
<td>921.4 (6.4)</td>
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<td>% with intakes &lt; ANC</td>
<td>52.3</td>
<td>48.8</td>
<td>0.65</td>
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<tr>
<td>Iron (mg/d) *</td>
<td>9</td>
<td>16</td>
<td>13.9 (0.1)</td>
</tr>
<tr>
<td>% with intakes &lt; ANC</td>
<td>7.8</td>
<td>12.2</td>
<td>0.25</td>
</tr>
<tr>
<td>Sodium(mg/d) *</td>
<td>3140.3</td>
<td>3227</td>
<td>3397 (175)</td>
</tr>
</tbody>
</table>

* mean (SD).
** mean (95% confidence interval).
accordance with recommendation. Increased consumption of fruits and vegetables thus seems an especially important recommendation for diabetics [8]. Vitamin B12 intake was higher than ANC in our diabetic and non-diabetics patients, but a diet rich in animal products (Western diet) provides a higher than ANC intake of vitamin B12.

The results of our study indicate that self-declared diabetic patients may be aware of the importance of diet in the management of their disease, and that they try to modify their dietary habits. This has been reported by other authors, and is not consistent with the widespread opinion of poor compliance of this population with dietary advice. Although their food behaviour was far removed from the official recommendations, our diabetics, who were aware of their condition, did attempt to adhere to recommendations.

However, not all their efforts were in the recommended direction. They had either not properly understood and followed the recommendations, or not received the correct advice. Diabetics often diminish their intake of complex carbohydrates in an attempt to both lose weight and control blood glucose concentrations, which is the opposite of what is recommended. Similarly, diabetic men who tried to reduce their caloric intake increased protein intake, which is not recommended in their condition. Nevertheless, they did reduce their alcoholic intake.

Currently, diabetic patients derive dietary advice from a variety of sources: health professionals, the media and social contacts. Nutritional educational needs to be co-ordinated by health professionals to correct erroneous opinions commonly held by the public. A better informed public would reinforce the efforts of diabetic patients to modify their diet in a more appropriate manner. This should then be evaluated in longitudinal studies on the impact of a better focused educational program. We were encouraged to note that diabetics do try to modify their dietary habits.

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