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(Article begins on next page)



Eating habits in elderly diabetic subjects: Assessment in the InCHIANTI Study

E. Mannucci ^{a,*}, B. Bartali ^b, R. Molino Lova ^c, M. Papucci ^c,
F. Lauretani ^d, M.L. Luisi ^c, A. Pietrobelli ^e, C. Macchi ^c

^a Section of Diabetology, Geriatric Unit, University of Florence, Via delle Oblate 4, 50134 Florence, Italy

^b Division of Nutritional Sciences, Cornell University, Ithaca, NY, USA

^c Don Gnocchi Foundation, Florence, Italy

^d Laboratory of Clinical Epidemiology, Geriatric Department, Florence, Italy

^e Pediatric Unit, Verona University Medical School, Verona, Italy

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Abstract *Background and aims:* Nutritional therapy is a cornerstone of the treatment of type 2 diabetes. The aim of this study was to assess differences in dietary habits between subjects with and without known type 2 diabetes.

Methods and Results: In a sample of 1242 predominantly elderly subjects enrolled in the InCHIANTI study, total energy and macronutrient intake was assessed cross-sectionally using the EPIC self-reported questionnaire. Results were compared in subjects with ($N = 109$) and without known diabetes, and differences were adjusted for age, sex, and reported comorbidities. Subjects with known diabetes reported a significantly lower ($p < 0.001$) total energy and soluble carbohydrate intake in comparison with the rest of the sample (1793 ± 481 vs 2040 ± 624 kCal/day, and 66.9 ± 22.3 vs. 93.5 ± 34.9 g/day, respectively). Conversely, consumption of total and saturated fats, dietary fibres and proteins was not significantly different. *Conclusion:* Known diabetes is associated with a reduction of soluble carbohydrate consumption and total energy intake without any further modification of dietary habits. These data suggest that the diagnosis of diabetes could induce some changes in nutritional style. However, corrections in dietary habits do not appear to be consistent with current guidelines and recommendations.

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* Corresponding author. Tel.: +39 055 427 9430; fax: +39 0574 31 895.

E-mail address: edmannu@tin.it (E. Mannucci).

Introduction

Dietary management has a central role in the long-term treatment of type 2 diabetes [1]. Current nutritional guidelines include reduction of energy intake, limitation of dietary cholesterol and saturated fat and increased consumption of dietary fibre [2]. Restriction of soluble carbohydrate intake is no longer the cornerstone of dietary treatment of type 2 diabetes since the total amount, rather than the type, of carbohydrates seems to play a greater role in the regulation of glycemic response [2], and moderate amounts of simple sugars have little effect on blood glucose levels in diabetic patients [3].

The aim of this study was to investigate the impact of awareness of being affected by diabetes on eating habits in a predominantly elderly population-based cohort enrolled in the InCHIANTI Study in order to verify whether elderly subjects are able to modify their eating habits once they receive the diagnosis of diabetes and whether such changes are consistent with current nutritional guidelines.

Methods

The population studied was enrolled in the InCHIANTI Study, a prospective cohort investigation on factors affecting loss of mobility in late life [4]. Briefly, 1453 predominantly elderly subjects randomly selected from the population of Greve in Chianti and Bagno a Ripoli, two towns in the Tuscany countryside, were studied. Data collected at baseline included a detailed medical history, anthropometric measurements and assessment of dietary habits. Clinical visits and assessments were performed by trained geriatricians and were preceded by an interview conducted at the participants' home. Trained interviewers administered a structured questionnaire providing general information on health, socio-economic and functional status, including physical activity and education. Physical activity was classed into a five level ordinal score (0 = Sedentary or light physical activity <1 h/week; 1 = Light physical activity 2–4 h/week; 2 = Light physical activity >4 h/week or Moderate physical activity 1–2 h/week; 3 = Moderate physical activity ≥ 3 h/week; 4 = Intense physical activity several times a week) and education into a three level ordinal score (1 = No formal education or elementary school, 2 = Intermediate, 3 = University or equivalent). Assessment of current dietary intake was performed using the Italian version of the food frequency questionnaire developed and validated

in the context of the European Prospective Investigation into Cancer and Nutrition (EPIC) [5–7].

For the purpose of this cross-sectional analysis, diagnosis of diabetes was considered as derived from self-reporting by the participants. Subjects with previously undiagnosed diabetes were included in the non-diabetic group, as the awareness of having diabetes, rather than the disease *per se*, was considered potentially capable of interfering with eating habits. Similarly, only self-reported diagnoses of comorbidities, such as hypertension, dyslipidemia, coronary artery disease, cerebrovascular disease, peripheral arterial obstructive disease, chronic liver disease and chronic renal failure were considered as potential covariates.

Only participants who had completed the nutritional assessment procedure described above, and for whom all data were available, were included in the present analysis. The final sample consisted of 1242 subjects, 563 men and 679 women; of those, 109 subjects (8.8%), 53 men (9.4%) and 56 (8.2%) women, reported to be affected by diabetes.

Statistical analysis was performed using the SPSS 10.0 software. Parametric data are reported as mean ± SD and non-parametric data are reported as percentages. Comparisons between diabetic and non-diabetic participants were performed using the unpaired two-tailed Student's *t*-test or the two-tailed Pearson's χ^2 test, whenever appropriate. Differences in nutritional intake between diabetic and non-diabetic subjects were analysed using a three-step strategy. Univariate regression-based analyses were first used to identify differences in specific nutritional intake. Then, age, sex, physical activity, education and self-reported comorbidities were entered in a step-wise linear regression model, with each parameter of dietary intake as the dependent variable of a separate analysis (Model A). Finally, in order to test possible differences in relative contribution to total energy intake of any single energy-providing macronutrient, total energy intake was added to the covariate set (Model B).

Results

Table 1 shows characteristics of the study population according to self-reported diabetes.

When compared with the rest of the sample, participants reporting to be affected by diabetes were older ($p < 0.001$) and showed lower educational degree ($p < 0.01$) and higher prevalence of comorbidities such as hypertension ($p < 0.01$), coronary artery disease ($p < 0.001$) and cerebro-vascular disease ($p < 0.005$). No significant difference ($p > 0.10$) was

Table 1 Characteristics of the study population according to self-reported diabetes

| | Diabetes n. 109 | No diabetes n. 1133 | p value |
|---|--------------------|------------------------|---------|
| Age (years) (mean \pm SD) | 73.4 \pm 8.8 | 67.8 \pm 15.9 | <0.001 |
| Sex (% Female) | 51.4 | 55.0 | NS |
| Physical activity: | | | |
| – Sedentary OR Light physical activity <1 h/week (%) | 20.2 | 16.0 | NS |
| – Light physical activity 2–4 h/week (%) | 47.7 | 39.8 | |
| – Light physical activity >4 h/week OR Moderate physical activity 1–2 h/week (%) | 26.6 | 35.8 | |
| – Moderate physical activity \geq 3 h/week (%) | 3.7 | 6.2 | |
| – Intense physical activity several times a week (%) | 1.8 | 2.3 | |
| Education: | | | |
| – No formal education or elementary school (%) | 81.7 | 68.0 | <0.01 |
| – Intermediate (%) | 17.4 | 28.3 | |
| – University or equivalent (%) | 0.9 | 3.7 | |
| Self-reported comorbidities: | | | |
| – Hypertension (%) | 50.5 | 37.2 | <0.01 |
| – Dyslipidemia (%) | 28.4 | 26.2 | NS |
| – Coronary artery disease (%) | 14.7 | 5.6 | <0.001 |
| – Cerebro-vascular disease (%) | 10.1 | 4.1 | <0.005 |
| – Peripheral arterial obstructive disease (%) | 4.6 | 2.6 | NS |
| – Chronic liver diseases (%) | 0.9 | 0.7 | NS |
| – Chronic renal failure (%) | 2.8 | 1.2 | NS |

Means are compared using unpaired two-tailed Student's *t*-test. Percentages are compared using two-tailed Pearson's χ^2 test.

found for sex, physical activity and other self-reported comorbidities (dyslipidemia, peripheral arterial obstructive disease, chronic liver disease and chronic renal failure).

Table 2 shows daily total energy and macronutrients intake according to self-reported diabetes and results of univariate and multivariate analyses, Models A and B.

At univariate analysis participants aware of being affected by diabetes showed lower intake of total energy ($p < 0.001$), total carbohydrates ($p < 0.001$), starches ($p < 0.05$), soluble carbohydrates ($p < 0.001$), total lipids ($p < 0.01$), monounsaturated fats ($p < 0.05$), saturated fats ($p < 0.001$) and alcohol ($p < 0.005$). No significant difference was found for polyunsaturated fats, cholesterol, proteins and dietary fibres.

After adjusting for potential covariates, such as age, sex, physical activity, education and self-reported comorbidities (Model A), participants aware of being affected by diabetes showed lower intake of total energy ($p < 0.001$), total carbohydrates ($p < 0.001$) and soluble carbohydrates ($p < 0.001$). No significant difference was found for starches, total lipids, monounsaturated fats, polyunsaturated fats, saturated fats, cholesterol, proteins, alcohol and dietary fibres.

Finally, after adding total energy intake to the covariate set (Model B), participants aware of being affected by diabetes showed relatively lower contribution to total energy intake of total and soluble carbohydrates ($p < 0.001$ for both), and relatively higher contribution of total lipids ($p < 0.01$), monounsaturated fats ($p < 0.05$), polyunsaturated fats ($p < 0.001$) and proteins ($p < 0.001$). No significant difference was found for starches, saturated fats and alcohol.

Discussion

We investigated the impact of awareness of being affected by diabetes on eating habits in a predominantly elderly population cohort in order to verify whether elderly subjects are able to modify their eating habits once they receive the diagnosis of diabetes and whether such changes are consistent with current nutritional guidelines that suggest, for type 2 diabetes, a reduction of energy intake, limitation of dietary cholesterol and saturated fats and increased consumption of dietary fibre [2].

In synthesis, our results show that among participants enrolled in the InCHIANTI Study the diagnosis of diabetes was associated with a relevant

Table 2 Daily total energy and macro-nutrient intake according to self-reported diabetes

| | Diabetes | | No diabetes | | Univariate analyses | | Multivariate analyses model A (*) | | Multivariate analyses model B (**) | |
|----------------------------|-----------------|-----------------|-----------------|-----------------|------------------------|---------|-----------------------------------|---------|------------------------------------|---------|
| | n = 109 | n = 481 | n = 1133 | n = 624 | $\beta \pm SE (\beta)$ | p value | $\beta \pm SE (\beta)$ | p value | $\beta \pm SE (\beta)$ | p value |
| Total energy intake (kcal) | 1793 \pm 481 | 2040 \pm 624 | 2040 \pm 624 | 2040 \pm 624 | -246 \pm 61.5 | <0.001 | -173 \pm 53.4 | <0.001 | — | — |
| Total carbohydrates (g) | 223 \pm 70.1 | 264 \pm 87.7 | 264 \pm 87.7 | 264 \pm 87.7 | -41.0 \pm 8.7 | <0.001 | -34.8 \pm 7.9 | <0.001 | -11.8 \pm 3.5 | <0.001 |
| Starches (g) | 156 \pm 60.5 | 170 \pm 70.1 | 170 \pm 70.1 | 170 \pm 70.1 | -14.3 \pm 6.9 | <0.05 | -10.2 \pm 6.2 | NS | 5.9 \pm 3.8 | NS |
| Soluble carbohydrates (g) | 66.9 \pm 22.3 | 93.5 \pm 34.9 | 93.5 \pm 34.9 | 93.5 \pm 34.9 | -26.6 \pm 3.4 | <0.001 | -24.4 \pm 3.4 | <0.001 | -17.6 \pm 2.7 | <0.001 |
| Total lipids (g) | 63.4 \pm 18.3 | 69.6 \pm 23.4 | 69.6 \pm 23.4 | 69.6 \pm 23.4 | -6.2 \pm 2.3 | <0.01 | -2.5 \pm 2.1 | NS | 3.2 \pm 1.2 | <0.01 |
| Monounsaturated fats (g) | 32.1 \pm 10.5 | 34.8 \pm 12.3 | 34.8 \pm 12.3 | 34.8 \pm 12.3 | -2.7 \pm 1.2 | <0.05 | -0.9 \pm 1.1 | NS | 1.8 \pm 0.7 | <0.05 |
| Polyunsaturated fats (g) | 7.2 \pm 2.0 | 7.5 \pm 2.5 | 7.5 \pm 2.5 | 7.5 \pm 2.5 | -0.3 \pm 0.2 | NS | 0.0 \pm 0.2 | NS | 0.6 \pm 0.1 | <0.001 |
| Saturated fats (g) | 20.8 \pm 6.4 | 23.6 \pm 8.9 | 23.6 \pm 8.9 | 23.6 \pm 8.9 | -1.5 \pm 0.8 | <0.001 | -1.5 \pm 0.8 | NS | 0.6 \pm 0.5 | NS |
| Cholesterol (mg) | 268 \pm 80.1 | 285 \pm 108 | 285 \pm 108 | 285 \pm 108 | -16.5 \pm 10.7 | NS | -3.3 \pm 10.2 | NS | — | — |
| Proteins (g) | 77.3 \pm 19.3 | 78.7 \pm 23.1 | 78.7 \pm 23.1 | 78.7 \pm 23.1 | -1.4 \pm 2.3 | NS | 1.0 \pm 2.1 | NS | 6.9 \pm 1.0 | <0.001 |
| Alcohol (g) | 10.9 \pm 15.3 | 15.2 \pm 20.4 | 15.2 \pm 20.4 | 15.2 \pm 20.4 | -4.4 \pm 2.0 | <0.05 | -3.5 \pm 1.8 | NS | -1.7 \pm 1.7 | NS |
| Dietary fibres (g) | 19.5 \pm 5.8 | 20.0 \pm 5.9 | 20.0 \pm 5.9 | 20.0 \pm 5.9 | -0.6 \pm 0.6 | NS | -0.2 \pm 0.7 | NS | — | — |

Values are expressed as means \pm SD. Univariate and multivariate analyses results are expressed as $\beta \pm SE (\beta)$ and p-value. (*) Model A includes age, sex, physical activity, education and self-reported comorbidities as covariates. (**) Model B also includes total energy intake limited to energy-providing macro-nutrients.

reduction of total energy intake and soluble carbohydrate consumption, without any significant difference in intake of starches, saturated fats, cholesterol, alcohol and dietary fibres. Our results also show a relative increase of the contribution of lipids (total, mono- and polyunsaturated fats) and proteins to total energy intake in diabetic patients.

With regard to modification of eating habits related to the diagnosis of diabetes, we have previously shown that overweight type 2 diabetic patients, after adjustment for age, show a higher level of cognitive dietary restriction when compared to non-diabetic subjects with similar body mass indexes and that patients with known diabetes seem to be aware of the need to modify their eating habits [8]. Our study confirms the notion that diabetic patients report dietary intakes somewhat differently when compared to non-diabetic subjects.

Reduction of total energy intake, which is strongly recommended for type 2 diabetes [2], was consistent with that actually observed in diabetic participants, even after correction for age, sex, physical activity, education and self-reported comorbidities. Yet, reduction of energy intake is only a part of the above mentioned nutritional guidelines and previous papers have shown that, although the prescription of a moderately hypocaloric diet improved short-term metabolic control [9], such a prescription did not slow down the progressive deterioration of glycemic control in type 2 diabetic patients [10].

Despite the fact that restriction of soluble carbohydrate intake is no longer the cornerstone of dietary treatment of diabetes [2], diabetic participants showed a significantly relevant reduction of simple sugar consumption, which is also responsible for the reduction of total carbohydrate intake. The observation that the effect of soluble carbohydrates on blood glucose is only marginally different from that of an isocaloric amount of starch [2,3] did not prevent diabetic patients from a specific restriction of simple sugars. Thus, simple sugars appeared to be the main focus of diabetic dietary treatment in our study population.

Similarly, despite current recommendations for the nutritional management of type 2 diabetes [2], in our study subjects aware of being affected by diabetes did not seem to refrain from saturated fat intake, which still represents over 10% of their total daily energy intake, and from cholesterol intake. Also the recommendation for increasing consumption of dietary fibres [2] appeared to be substantially ignored by our diabetic participants.

The observed relatively higher contribution of total lipids ($p < 0.01$), monounsaturated fats ($p < 0.05$), polyunsaturated fats ($p < 0.001$) and proteins

($p < 0.001$) to total energy intake was, probably, related to the relatively lower contribution of total and soluble carbohydrates ($p < 0.001$, for both).

This study shows four main limitations. The first one is that nutritional intake is based upon participants self-reporting. Previous studies have shown that obese subjects report lower food intake compared to lean individuals [11,12]. It has been speculated that retrospective self-reporting might produce a systematic underestimate of food intake. In fact, some subjects are not totally aware of what they eat, particularly during snacks [13]; memory deficits, not uncommon in the elderly, could also produce some errors in estimates. However, a previous study has suggested that nutritional data collected in the InCHIANTI study provide a good estimate of dietary intake [14]. In spite of this result, it can be speculated that diabetic patients, on the basis of their belief that simple sugars increase blood glucose, could have specifically under-reported their consumption of soluble carbohydrates. In fact, patients' reports could, at least partly, reflect their hopes and desires rather than their actual intakes. However, subjects enrolled in the study had been informed that nutritional data collected would not have been available to the clinicians in charge of their care, and this should have reduced the risk of intentional under-reporting. The second limitation is that the population studied is mostly composed of people in advanced age. Thus, taking into account differences in dietary intake that occur with aging [15], these results cannot be automatically extended to younger subjects. The third limitation is represented by the cross-sectional nature of the analysis; a prospective survey on modifications of dietary habits after the diagnosis of diabetes could have been more informative. Finally, the population studied was mostly enrolled in a rural area and the results cannot be automatically extended to the urban environment.

In conclusion, our results suggest that elderly participants enrolled in the InCHIANTI Study could still be capable of modifying their eating habits once they receive the diagnosis of diabetes, as shown by reduction of soluble carbohydrates intake. However, our diabetic participants appeared to focus their attention only on restriction of simple sugars, possibly due to the immediately comprehensible relationship between simple sugar intake and blood glucose levels, rather than attempting changes in their eating habits less immediately comprehensible but more relevant for long-term outcomes, such as reducing intake of saturated fats and cholesterol and increasing dietary fibres consumption.

Thus, our results strongly indicate the need for an improved nutritional education for diabetic patients who appear to be driven by incorrect or incomplete health beliefs. A greater educational effort is needed and future studies should investigate the best tools to hit the target.

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