The effect of long-term high-fibre diets in diabetic outpatients

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Summary

Diets containing large amounts of dietary fibre have been shown to be beneficial in improving diabetic control. We investigated the practical aspects of administering a high-fibre diet to diabetic outpatients in Cape Town, using readily available, low-cost foodstuffs with a high dietary fibre content.

Ten patients were followed up over a period of 9 months, for 3 months of which a high-fibre diet was prescribed. Although only 3 patients approached the projected dietary fibre intake, significant negative correlations were found between the mean plasma glucose changes and the dietary fibre increments ($r = -0,704$; $P < 0,05$) and between the mean serum triglyceride changes and the dietary fibre increments ($r = -0,741$; $P < 0,05$).

These findings suggest that, were it not for poor dietary compliance, a high-fibre diet might result in significant improvement in diabetic control, and that education and motivation are of prime importance when making major changes to patients' eating habits.

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The addition of unabsorbable carbohydrate to the meals of diabetic patients in order to reduce the rise of postprandial blood glucose levels in the short term and to improve diabetic control in the long term has been the subject of much interest recently.[1] Jenkins *et al.*[2] found that guar gum and pectin decreased postprandial hyperglycaemia after a test meal in non-insulin-dependent diabetics during a week in which their diets were supplemented with guar gum. Miranda and Horwitz[3] have demonstrated an improvement of diabetic control when patients consumed a high-fibre diet supplemented mainly by cellulose fibres (high-fibre bread) for 20 days, while Anderson and Ward[4] have clearly shown the benefit of a high-carbohydrate, high-fibre diet in insulin-dependent diabetic men. In another study, Anderson and Ward[5] followed up 10 patients on a high-carbohydrate, high-fibre diet for an average of 15 months and showed an improvement in diabetic control as well as a reduction in serum cholesterol and triglyceride values.

Although these studies show unequivocal results, they may not necessarily be applicable to the long-term outpatient management of diabetics in South Africa. Also, the gel fibres, guar gum and pectin used by Jenkins *et al.*[2] are somewhat unpalatable because of their viscosity, and may not be suitable for long-term use for this reason. We therefore designed this

TABLE I. PATIENT DETAILS

Patient	Sex	Age	Duration of DM (yrs)	Therapy	% Average body wt*	Comments
1	M	54	5	Diet	103,7	Left study because of work problems
2	M	65	20	Oral	87,7	Too well controlled to demonstrate improvement
3	F	46	4	Oral	153,3	Completed study
4	F	52	8	Oral	94,4	Completed study
5	F	46	1	Oral	113,1	Completed study
6	F	22	3	Insulin	93,5	Left study for personal reasons
7	M	62	10	Oral	89,5	Completed study
8	F	50	3	Oral	117,4	Completed study
9	M	59	5	Oral	111,0	Left study because of work problems
10	M	53	10	Oral	74,7	Left study because of septic foot
11	F	57	10	Oral	104,2	Completed study
12	F	52	10	Insulin	77,5	Dropped: found to be psychologically unstable
13	M	68	19	Insulin	75,0	Completed study
14	M	38	4	Insulin	73,1	Completed study
15	F	42	10	Oral	93,4	Dropped: non-compliant
16	F	31	6	Insulin	116,4	Dropped: found to be psychologically unstable
17	F	51	2	Oral	101,6	Completed study
18	M	41	4	Oral	98,9	Completed study

*Geigy *Scientific Tables*, 7th ed., 1970.
DM = diabetes mellitus.

study to investigate the practical aspects of administering a high-fibre diet to diabetic outpatients in Cape Town, using readily available, low-cost foodstuffs with a high dietary fibre content.

Patients and methods

Eighteen patients from the Diabetes Clinic at Groote Schuur Hospital volunteered to take part in this study, and details are given in Table I. Of these patients 8 did not complete the study, for reasons stated in the table.

Study protocol

The study was divided into three periods, each lasting 12 weeks. For the duration of the study, patients were visited at the same time of day at 2-week intervals, either at home or at work, where they were weighed and venous blood was taken for assay of glucose, glycosylated haemoglobin A_1 (Hb A_1) serum triglycerides, total cholesterol and high-density lipoprotein (HDL) cholesterol. In the first period no adjustment was made to the patient's usual diet, in order to exclude a possible placebo effect of frequent visits. During this period, termed the 'uncontrolled diet' period, each patient kept a detailed food record for 1 week, and this was later analysed for intake of energy, protein, carbohydrate, fat and dietary fibre.

During the second period each patient was prescribed a standard diabetic diet, with the energy intake tailored to individual requirements. A dietary analysis for the three periods is shown in Table II. The second was considered the 'low-fibre' period. Again, detailed food records were kept and analysed as before. During the third period, the patients' low-fibre diets were modified by increasing the intake of dietary fibre to 25 g per 4 200 kJ while adjusting the carbohydrates to maintain an equivalent energy intake. The foods selected were commonly available foodstuffs which had been donated by various manufacturers and contained varying proportions of dietary fibre (Table III). The dietary fibre was predominantly of the non-cellulose polysaccharide type and therefore consisted chiefly of peptic substances and hemicelluloses.

The high-fibre foods were supplied to the patients in order to exclude financial considerations as a cause of non-compliance. A dietary record was also kept for 1 week during this period and analysed as before. At each visit, the patients' compliance with the diet was checked and they were encouraged to adhere to their diets.

The patients' antidiabetic medications were not altered during this study except for patient 14, who required a reduction in insulin dosage during the high-fibre diet period because of hypoglycaemic episodes.

Laboratory methods

Blood for glucose and Hb A_1 estimation was collected in a fluoride tube, and plasma glucose was measured by the glucose oxidase method on a Technicon Autoanalyzer. Hb A_1 levels were estimated using short-column ion-exchange chromatography.

Serum triglyceride levels were measured using the fully enzymatic UV method (Boehringer Mannheim kit) on the Technicon Autoanalyzer, and total cholesterol and HDL cholesterol levels were measured spectrophotometrically using the Liebermann-Buchard reagent.

Statistical methods

Results were analysed using Student's *t* test for unpaired samples.

TABLE II. FOOD INTAKE

	Uncontrolled period					Low-fibre period					High-fibre period					
Patient	kJ	Prot. (g)	Fat (g)	CHO (g)	Fibre (g/4 200 kJ)	kJ	Prot. (g)	Fat (g)	CHO (g)	Fibre (g/4 200 kJ)	kJ	Prot. (g)	Fat (g)	CHO (g)	Fibre (g/4 200 kJ)	% incr
3	6 926	76,6	82,4	158,7	7,8	5 610	64,7	80,1	95,6	5,9	6 720	58,0	33,7	125,0	15,4	161,0
4	8 145	89,6	102,4	173,5	7,3	7 101	70,9	83,6	175,2	9,0	6 988	84,5	87,8	162,2	16,2	80,0
5	7 524	79,3	108,9	210,3	7,9	6 524	79,8	87,3	116,6	5,2	6 496	93,4	72,4	214,4	16,2	211,6
7	7 671	91,1	85,0	184,2	9,2	6 074	77,2	73,9	121,4	9,1	5 822	69,0	60,4	132,5	14,6	60,4
8	10 126	100,9	124,4	227,8	9,0	6 802	82,9	82,3	145,8	8,9	5 719	72,4	66,6	125,7	16,3	83,1
11	5 672	61,2	63,2	153,3	13,8	5 320	58,9	69,9	121,2	8,5	5 467	58,1	57,7	147,0	22,6	165,9
13	9 177	123,6	127,0	142,8	4,3	8 015	113,8	99,7	145,9	7,7	7 310	90,4	65,3	228,7	18,8	144,2
14	9 981	117,7	123,0	215,6	8,5	11 612	119,6	118,1	294,9	9,2	10 771	125,1	125,3	213,2	17,9	94,6
17	8 624	85,1	109,4	195,5	10,0	6 375	53,9	91,7	127,8	7,7	6 943	70,2	75,6	184,0	22,3	189,6
18	8 463	97,3	122,3	145,6	7,0	8 048	97,3	115,4	130,8	5,4	6 951	81,5	86,0	148,2	20,3	275,9

CHO = carbohydrate.

TABLE III. PERCENTAGE OF DIETARY FIBRE IN FOODSTUFFS USED

Type of food	% DF[6]
Weetbix	**12,7**
Bran	**44,0**
Baked beans	**7,3**
Peas, canned	**6,3**
Prunes	**16,1**
Wholewheat bread	**8,5**

DF = dietary fibre.

Results

The analysis of the diet records kept by the 10 patients who completed the study is shown in Table II. Although several patients showed an apparently large percentage increase of fibre intake from the low-fibre diet to the high-fibre diet periods, only 3 patients (Nos 11, 17 and 18) approached the projected fibre intake of 25 g/4 200 kJ per day, and not one attained it. Four patients showed a significant reduction in body weight from the uncontrolled diet to the low-fibre period, while only 1 lost weight between the low-fibre and high-fibre periods.

The mean plasma glucose values are shown in Table IV. There was no significant overall improvement in these values although there were some individual changes. The mean Hb A_1 values did not change significantly. Despite small individual changes in the mean serum triglyceride levels, these did not reach statistical significance except in 2 patients (Table V).

TABLE IV. PLASMA GLUCOSE (mmol/l) (MEAN ± SD)

Patient	Uncontrolled diet	Low-fibre diet	High-fibre diet
3	**13,7 ± 5,8**	**16,7 ± 3,4**	**15,1 ± 3,6**
4	**10,8 ± 2,1**	**9,7 ± 2,2**	**8,4 ± 3,1**
5	**9,8 ± 1,4**	**11,3 ± 1,9**	**9,6 ± 1,7**
7	**16,8 ± 2,8**	**12,8 ± 2,3***	**15,6 ± 1,3‡**
8	**17,3 ± 8,2**	**17,6 ± 2,5**	**22,1 ± 3,0‡**
11	**14,7 ± 3,1**	**17,0 ± 3,4**	**17,4 ± 3,2**
13	**12,5 ± 6,0**	**15,7 ± 6,9**	**15,5 ± 3,1**
14	**10,9 ± 4,6**	**14,6 ± 4,3**	**16,9 ± 7,7**
17	**21,6 ± 5,0**	**19,3 ± 2,9**	**20,8 ± 4,5**
18	**11,5 ± 2,8**	**8,4 ± 3,3**	**5,1 ± 2,0†**

Significantly lower than uncontrolled diet: * $P < 0,025$; † $P < 0,01$.
Significantly higher than low-fibre diet: ‡ $P < 0,025$.

TABLE V. SERUM TRIGLYCERIDE (nmol/l) (MEAN ± SD)

Patient	Uncontrolled diet	Low-fibre diet	High-fibre diet
3	**1,60 ± 0,36**	**2,02 ± 0,49**	**2,00 ± 0,08**
4	**1,59 ± 0,50**	**1,75 ± 0,39**	**2,41 ± 0,56**
5	**1,06 ± 0,26**	**1,00 ± 0,28**	**0,82 ± 0,26**
7	**1,24 ± 0,30**	**0,71 ± 0,17***	**0,95 ± 0,06†**
8	**3,33 ± 1,06**	**2,78 ± 0,79**	**2,71 ± 0,17**
11	**1,62 ± 0,53**	**1,68 ± 0,31**	**2,02 ± 0,45**
13	**0,81 ± 0,22**	**0,84 ± 0,21**	**0,71 ± 0,10**
14	**0,98 ± 0,36**	**0,94 ± 0,09**	**0,77 ± 0,23**
17	**—**	**1,27 ± 0,30**	**1,08 ± 0,34**
18	**3,02 ± 1,06**	**3,93 ± 0,20**	**1,68 ± 0,41‡**

Significantly different from uncontrolled diet: * $P < 0,025$.
Significantly different from low-fibre diet: † $P < 0,05$; ‡ $P < 0,001$.

The serum total cholesterol level also changed in only 2 patients, and there was no significant overall trend. The serum HDL cholesterol levels changed in 4 patients, but the pattern was too variable to detect a trend. When the low-fibre and high-fibre periods were compared, there were significant negative correlations between the mean plasma glucose change and the dietary fibre increment ($r = -0,704$; $P < 0,05$) (Fig. 1) and between the mean serum triglyceride change and the dietary fibre increment ($r = -0,741$; $P < 0,05$). However, no correlation could be demonstrated between the increment in dietary fibre intake and any of the following: HB A_1, serum cholesterol and HDL cholesterol. There was also no correlation between the difference in energy intake and the mean body weight change between the low- and high-fibre periods.

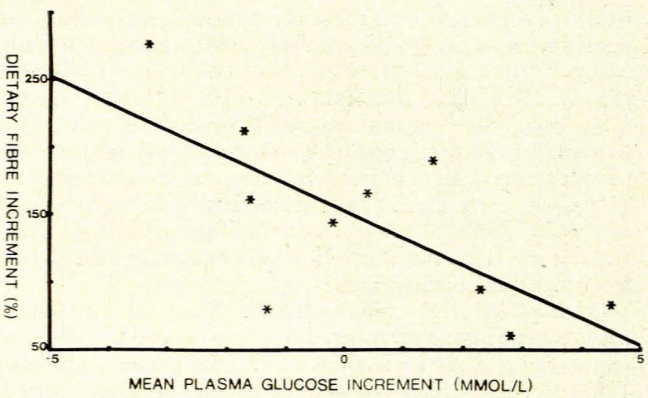

Fig. 1. Correlation between dietary fibre increment and mean plasma glucose levels ($r = 0,704$; $P < 0,05$).

Discussion

Although we were unable to demonstrate a significant lowering of the mean plasma glucose and triglyceride levels in the high-fibre period, there were individual changes which correlated significantly with the changes in dietary fibre intake. This indicates that the patients who increased their fibre intake most showed the greatest decrement in mean plasma glucose and triglyceride levels. This implies that by increasing the dietary fibre intake, one could expect to lower the plasma glucose and triglyceride levels significantly. The almost consistently negative findings in this study are probably related to the majority of the patients not attaining the desired level of dietary fibre intake, despite very close surveillance and the supply of high-fibre foods gratis. Possible explanations for this lack of compliance might be lack of understanding of the purpose of the trial and of the need to achieve good diabetic control. We did not attempt to educate the patients except to correct their diets, so as not to introduce further variables into the study. It would appear that without adequate education and motivation most people would not be prepared to make drastic alterations to their basic eating patterns.

We therefore conclude that although this study supports the current concept that increasing the dietary fibre intake improves diabetic control and possibly also lowers serum triglyceride levels,[5] the practical implementation of suitable high-fibre diets is difficult for our ordinary unselected clinic patients lacking suitable education and motivation. Should further studies of this nature be attempted, or should one try to introduce high-fibre diets into the routine management of diabetic patients, a comprehensive education programme will probably need to be instituted before one can hope to achieve success.

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