Behavioural counselling to increase consumption of fruit and vegetables in low income adults: randomised trial

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Abstract

Objective To measure the effect of brief behavioural counselling in general practice on patients' consumption of fruit and vegetables in adults from a low income population.

Design Parallel group randomised controlled trial.

Setting Primary health centre in a deprived, ethnically mixed inner city area.

Participants 271 patients aged 18-70 years without serious illness.

Intervention Brief individual behavioural counselling based on the stage of change model; time matched nutrition education counselling.

Main outcome measures Self reported number of portions of fruit and vegetables eaten per day, plasma β carotene, α tocopherol, and ascorbic acid concentrations, and 24 hour urinary potassium excretion. Assessment at baseline, eight weeks, and 12 months.

Results Consumption of fruit and vegetables increased from baseline to 12 months by 1.5 and 0.9 portions per day in the behavioural and nutrition groups (mean difference 0.6 portions, 95% confidence interval 0.1 to 1.1). The proportion of participants eating five or more portions a day increased by 42% and 27% in the two groups (mean difference 15%, 3% to 28%). Plasma β carotene and α tocopherol concentrations increased in both groups, but the rise in β carotene was greater in the behavioural group (mean difference 0.16 µmol/l, 0.001 µmol/l to 1.34 µmol/l). There were no changes in plasma ascorbic acid concentrations or urinary potassium excretion. Differences were maintained when analysis was restricted to the 177 participants with incomes ≤ £400 (€596, $640) a week.

Conclusions Brief individual counselling in primary care can elicit sustained increases in consumption of fruit and vegetables in low income adults in the general population.

Introduction

Consumption of fruit and vegetables is thought to protect against cancer and cardiovascular disease,[1 2] and increasing this is a central objective of health promotion programmes worldwide. Fruit and vegetable intake is inversely related to socioeconomic position, and increasing consumption in low income sectors of the population may help to redress socioeconomic inequalities in health.[3] The Department of Health has established a "five a day" programme to improve access to, and increase consumption of, fruit and vegetables (see box 1).[4]

Previous research on increasing consumption has used individual, worksite, and community approaches to intervention.[5] Brief interventions can be effective,[6] but few studies have used intention to treat analysis, and biomarkers have seldom been included.[7] We tested the hypothesis that brief behavioural counselling by nurses in general practice would lead to increased consumption of fruit and vegetables and to associated increases in plasma and urinary biomarkers over a 12 month period in adults from a low income population compared with time matched counselling based on nutrition education.

Methods

Participants

This randomised parallel group trial compared brief nutrition counselling with behavioural dietary counselling. Recruitment, assessments, and interventions were carried out by research nurses in a primary healthcare setting.

We randomly recruited by letter patients aged 18-70 years registered at one primary health centre in a deprived inner city area with a Jarman score of 40.3. We excluded individuals with serious illness and women who were pregnant or who planned to become pregnant within the next 12 months. Only one person per household was eligible. We did not exclude individuals taking vitamin supplements but asked them to maintain a constant dose throughout the trial. After several months of recruitment, it became evident that many participants had relatively high incomes, suggesting that the study was attracting more affluent residents. Invitations were therefore modified to discourage people with a weekly income of more than £400 (€596, $640) from volunteering.

In total 459 patients expressed interest in the study. After exclusions the sample consisted of 166 women and 105 men (figure). From 25 June 1999 to 3 November 2001 a member of the research team who had no contact with participants individually randomised par-

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Box 1: What is the five a day message?

- Aim for at least five portions of a variety of fruit and vegetables each day
- Fresh, frozen, chilled, canned, 100% juice, and dried fruit and vegetables all count

How much is one portion of fruit?

One portion of fruit is—for example, a medium apple or a medium banana or two satsumas

A glass (150 ml) of 100% juice (fruit or vegetable juice) counts as only one portion, however much you drink. This is because it has very little fibre. Also, the juicing process "squashes" the natural sugars out of the cells that normally contain them, which means that drinking juice between meals isn't good for your teeth

One portion of dried fruit counts (for example, three dried apricots counts as one portion), but other types of fruit and vegetables should be eaten to meet the rest of the target.

How much is one portion of vegetables?

- One portion of vegetables is—for example, three tablespoons of cooked carrots or peas or sweetcorn or one cereal bowl of mixed salad
- Beans and other pulse vegetables—such as kidney beans, lentils and chick peas—count only once a day, however much you eat. While pulses contain fibre, they don't give the same mixture of vitamins, minerals, and other nutrients as fruit and vegetables
- Potatoes don't count because they are considered a "starchy" food (starchy foods are foods like potatoes, rice, and pasta) However, starchy foods are also an important part of a balanced diet

These portion sizes are for adults. Children should also eat at least five portions each day, but the portion sizes may be smaller.

Do processed foods count?

The fruit and vegetables contained in processed foods—such as ready meals, pasta sauces, soups, and puddings—can contribute to the five a day target. But processed foods, which are high in added fat, salt, and sugars, should be eaten in moderation, so it is important always to check the nutrition information on food labels.

ticipants into one of two counselling conditions. We used a minimisation procedure[8] to ensure balance between the groups in terms of age, sex, ethnic distribution, and smoking. There were 136 in the behavioural counselling group and 135 in the nutrition group.

Counselling methods

Each intervention was a 15 minute individual consultation, carried out immediately after the baseline assessment. We prepared written information to support the consultations, and participants attended a second 15 minute consultation two weeks later. Eleven participants (eight behavioural, three nutrition) did not attend the second session. The target was to increase intake of fruit and vegetables from baseline levels.

The nutrition counselling group received education about the importance of increasing consumption of fruit and vegetables, emphasising beneficial nutritional constituents and the way these act biologically to maintain health. The bioactive constituents of fruit and vegetables were described in lay terms, together with the range of effects that they have on bodily processes. The nurses emphasised the five a day message. Behavioural counselling was founded on social learning theory and the stage of change model (box 2), which posits that the most appropriate methods of encouraging change in behaviour vary with the motivational readiness of the individual.[9] Interventions were tailored to the individual, with personalised specific advice, and setting of short and long term goals. The counselling interventions were carried out by two research nurses, both of whom conducted nutritional and behavioural counselling. Sessions were audiotaped to monitor the quality of interventions and to ensure that the two types of counselling remained distinct.

Methods of assessment

The main measure of consumption was a two item frequency questionnaire adapted from previous research.[10 11] We asked participants how many pieces of fruit and how many portions of vegetables they ate on a typical day and gave them detailed information about portion sizes.[4] Potatoes were excluded, and one serving of fruit juice was allowed. Patients also completed the dietary instrument for nutrition education (DINE), a weighted food frequency questionnaire that accounts for most fat and fibre in the typical UK diet.[12] Blood pressure was measured after the participant had been sitting for 10 minutes. We used the average of three consecutive readings with a digital sphygmomanometer (Omron HEM705CP).

We assessed biomarkers of fruit and vegetable intake to determine whether counselling interventions had effects not only on reported consumption but also on potential biological mediators of health effects. Non-fasting blood samples were stored at −70°C until the end of the trial and analysed for plasma ascorbic acid (vitamin C), α tocopherol (vitamin E), and β carotene. Ascorbic acid assays were carried out at the University of Cambridge with a fluorimetric assay,[13] and analyses of α tocopherol and β carotene were conducted with normal phase high performance liquid chromatography (AASC, Hampshire). We collected 24 hour urine samples for the measurement of potassium excretion. Participants were given oral and written instructions on how to collect the specimens, and the completeness of the collection was checked by direct

Box 2: Stage of change model

People vary in their readiness to make healthy changes such as eating more fruit and vegetables, stopping smoking, or increasing leisure time physical activity. Five stages of change have been described:

Precontemplation—The person has no intention of changing behaviour in the foreseeable future (for example, they were not thinking of increasing fruit and vegetable consumption)

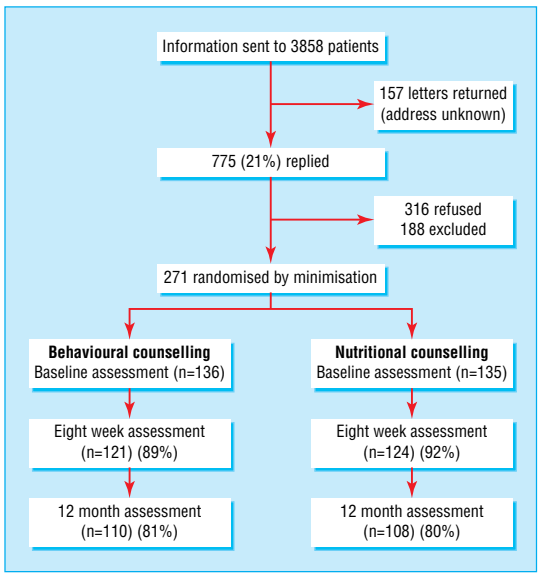
Contemplation—The person is aware of the problem and is seriously thinking about changing but has not yet made a commitment to take action and is not confident of being able to sustain a behaviour change (for example, they were thinking about increasing intake but were either not intending to do so within the next month or were not confident of being able to stick to the plan)

Preparation—The person is seriously planning to take action in the next month and is confident of success (for example, they were thinking about increasing intake, were planning to do so within the next month, and were confident of success)

Action—The person has successfully modified behaviour within the past six months

Maintenance—The person has maintained the behaviour change for at least six months

It is thought that the most suitable methods of encouraging and sustaining behaviour changes vary across stages



Recruitment of participants

inquiry and by the evaluation of creatinine concentrations and volume outputs. Potassium excretion was expressed both as absolute daily excretion and as ratio to creatinine output.

We devised a stage of change questionnaire that gauged participants' readiness to increase consumption at the start of the study, irrespective of whether they had made changes in the past. They were classified as precontemplators, as contemplators, or as in the preparation stage (see box 2).

Our primary end points were changes in self reported intake of fruit and vegetables (number of portions per day and the proportion of individuals who increased intake to five a day) and changes in biomarkers (plasma β carotene, α tocopherol, and ascorbic acid concentrations, and 24 hour urinary excretion of potassium and urinary potassium:creatinine ratio). The secondary end points were changes in body weight, body mass index, blood pressure, total plasma cholesterol concentration, and DINE measures.

Assessment of income

We intended to investigate only low income adults, but some higher income volunteers also took part. We therefore separately carried out analyses on the complete sample and on the lower income category. The criterion for the definition of lower income was ≤£400 a week. This is somewhat below the national average gross income of £480 (€706, $762) a week in 1999-2000, as estimated from the family expenditure survey,[14] and close to the average for lower socioeconomic status groups. Of the 271 participants, 177 fell into the lower income category.

The sample of 270 provided 95% power (α=0.05) to detect an average difference of 0.75 portions of fruit and vegetables per day between the two groups. The power to detect a 25% difference in β carotene and plasma vitamin C was 85%. The power to detect similar differences in the subsample of 177 low income adults was 85% for fruit and vegetables and over 70% for the biomarkers (Query Advisor, release 4.0, Software Solutions, Cork, Ireland).

Statistical methods

One hundred and ten people (81%) in the behavioural counselling and 108 (80%) in the nutrition counselling groups completed the 12 month follow up (figure). The trial was analysed on an intention to treat basis. Baseline values were brought forward for participants with data missing at 12 months (imputing no change).

We calculated scores indicating the change between 12 months and baseline, so a positive value indicates a beneficial change in fruit and vegetable consumption and in biomarkers. We have presented these scores with 95% confidence intervals adjusted for possible confounders. Sex, age, ethnicity, income, smoking, and baseline stage of change were confounders for fruit and vegetable analyses. Sex, age, ethnicity, income, smoking, body mass index, and baseline concentration were confounders for β carotene and α tocopherol, while the use of vitamin supplements was a covariate in the analyses of ascorbic acid and potassium excretion. Analysis of covariance was used for these comparisons.

We had data on consumption from all 271 participants, plasma β carotene from 268, α tocopherol from 266, and vitamin C from 265. Data for β carotene were skewed, so we log transformed values before analysis and have presented geometric means with confidence intervals. Urine samples were obtained from 225 participants, but four individuals did not collect the full amount for the 24 hour period.

Results

Table 1 gives the baseline characteristics of participants in the two groups. The average age was 43 years; 68% were in the low income category; over a third were receiving benefits, and less than a half owned their own homes. The sample was ethnically mixed. A third were cigarette smokers, and nearly one third were taking vitamin supplements. As expected, many (55%) participants were in the preparation stage of change; a quar-

Table 1 Baseline characteristics of participants

	Behavioural counselling (n=136)	Nutrition counselling (n=135)
Women	82	84
Weekly household income:		
Less than £400	91	86
More than £400	40	44
Mean (SD) age (years)	43.3 (13.8)	43.2 (14.0)
Ethnicity:		
White	94	96
Black	37	32
Asian	3	5
Home ownership	69	59
In receipt of benefits	50	43
Mean (SD) body weight (kg)	71.2 (15.5)	73.0 (16.6)
Mean (SD) body mass index	25.5 (4.9)	26.3 (5.8)
Current smokers	47	44
Mean (SD) plasma cholesterol (mmol/l)	4.90 (0.97)	5.03 (1.0)
Mean (SD) systolic/diastolic blood pressure (mm Hg)	123.0 (17.8)/ 78.6 (10.7)	123.0 (17.6)/ 77.8 (10.4)
Taking vitamin supplements	40	38
Stage of readiness for change:		
Precontemplation	38	31
Contemplation	25	29
Preparation	73	75

Table 2 Effect of counselling on intake of fruit and vegetables and biomarkers (complete sample)

Group (n)	Baseline (SD)	Unadjusted change over 12 months (95% CI)	Adjusted change over 12 months (95% CI)	Adjusted difference in change (95% CI)	P value for adjusted difference
Portions/day					
Nutritional (135)	3.67 (2.00)	0.99 (0.63 to 1.34)	0.87 (0.50 to 1.25)	0.62 (0.09 to 1.13)	0.021
Behavioural (136)	3.60 (1.81)	1.44 (1.09 to 1.80)	1.49 (1.12 to 1.86)*		
Five a day (%)					
Nutritional (135)	26.7%	28.7% (19.9 to 37.6)	26.8% (17.6 to 36.0)	15.4% (2.52 to 28.3)	0.019
Behavioural (136)	21.3%	40.2% (31.3 to 49.0)	42.2% (33.1 to 51.2)*		
β Carotene (μmol/l)					
Nutritional (134)	0.92 (0.68)	1.06 (0.94 to 1.21)	1.04 (0.94 to 1.15)	0.16 (0.001 to 1.34)	0.05
Behavioural (134)	0.90 (0.62)	1.22 (1.08 to 1.39)	1.20 (1.08 to 1.33)†		
α Tocopherol (μmol/l)					
Nutritional (132)	27.4 (10.9)	7.28 (5.25 to 9.31)	7.30 (5.58 to 9.02)	1.52 (–0.91 to 3.95)	0.22
Behavioural (134)	25.6 (11.3)	8.87 (6.85 to 10.9)	8.81 (7.12 to 10.5)†		
Ascorbic acid (μmol/l)					
Nutritional (131)	78.0 (33.0)	0.12 (–4.89 to 5.12)	0.51 (–4.00 to 5.01)	–4.57 (–10.9 to 1.80)	0.16
Behavioural (133)	75.6 (33.3)	–2.80 (–7.76 to 2.17)	–4.06 (8.52 to 0.41)‡		
Potassium excretion (mmol/24h)					
Nutritional (114)	75.0 (27.6)	–0.63 (–4.04 to 2.77)	–0.27 (–3.52 to 2.98)	0.46 (–4.22 to 5.13)	0.85
Behavioural (107)	73.0 (26.0)	0.19 (–3.33 to 3.70)	0.19 (–3.14 to 3.52)‡		
Potassium/creatinine ratio					
Nutritional (114)	6.69 (2.32)	–0.24 (–0.53 to 0.03)	–0.20 (–0.48 to 0.07)	0.13 (–0.27 to .53)	0.52
Behavioural (107)	6.34 (2.26)	–0.05 (–0.34 to 0.24)	–0.07 (–0.35 to 0.21)‡		

*Adjusted for sex, age, ethnicity, income, smoking, and baseline stage of change.
†Adjusted for sex, age, ethnicity, income, smoking, body mass index, and baseline level.
‡Adjusted for sex, age, ethnicity, income, smoking, body mass index, baseline level, and vitamin supplements.

ter were precontemplators, and a fifth contemplators. The two groups did not differ in these background characteristics.

The mean number of portions of fruit and vegetables eaten daily (excluding potatoes) was 3.6 at baseline, and a quarter of the participants were eating at least five portions a day (table 2). Both groups increased the number of portions consumed a day. After adjustment for covariates, the increase was greater in the behavioural counselling than in the nutrition counselling group (mean difference 0.62 portions, 95% confidence interval 0.09 to 1.13). The increase in the number eating five or more portions a day was also greater in the behavioural group (difference 15%, 3% to 28%). Plasma β carotene and α tocopherol concentrations increased in both groups, with no changes in plasma ascorbic acid concentration or potassium excretion. The increase in β carotene was greater in the behavioural group (difference 0.16 μmol/l, 0.001 μmol/l to 1.34 μmol/l). We carried out separate analyses of biomarkers on non-smokers and on participants who were not taking vitamin supplements either at baseline or at 12 month follow up, and the pattern of results was the same.

Results were largely replicated when we restricted the analysis to the lower income participants (table 3). The increase in the number of portions was twice as great in the behavioural than in the nutrition groups, and the behavioural group also showed larger increases in plasma β carotene concentration (difference 0.18 μmol/l, 0.02 μmol/l to 0.37 μmol/l). In addition, there was also a more positive change in potassium:creatinine ratio in the behavioural group (difference 0.48, 0.01 to 0.95).

There were no changes in body weight, body mass index, blood pressure, or serum cholesterol, either in the complete sample or the lower income participants (table 4). DINE scores for fat consumption fell in both groups, while fibre intake increased in the behavioural group only, but there were no differences between the groups in these measures.

Discussion

Brief counselling carried out by nurses in primary care can result in marked increases in reported fruit and vegetable consumption in an ethnically mixed sample. The average increase in the group assigned to behavioural counselling (1.49 portions per day) was similar to the increase seen in a six month study in more affluent participants (1.4 portions).[7] We did not expect such a large increase in the nutrition counselling group, but the mean rise of 0.87 portions per day was similar to that observed in studies with more active interventions.[6] This indicates that the nutrition counselling programme was not an inactive control procedure but itself had substantive effects. General advice about the benefits to health of eating fruit and vegetables may lead to favourable changes if it is provided in an individualised supportive fashion. However, we do not know whether changes would have taken place in the absence of any professional advice because we did not have a control group in which no counselling took place.

The observed changes in consumption were similar when we restricted analysis to participants with lower incomes. The implication is that individual counselling in primary care may be an effective means of increasing consumption in less affluent adults, so targeting low income groups may help redress social inequalities in health.

The beneficial effects of brief counselling were endorsed by positive changes in β carotene and α tocopherol concentrations. Plasma concentrations of β carotene were more than doubled in both groups, while the increases in α tocopherol were 33% and 28% in the behavioural and nutrition group, respectively. The rise in β carotene was greater in the behavioural

Table 3 Effect of counselling on intake of fruit and vegetables and biomarkers (lower income sample)

Group	Baseline (SD)	Unadjusted change over 12 months (95% CI)	Adjusted change over 12 months (95% CI)	Adjusted difference in change (95% CI)	P value for adjusted difference
Portions/day					
Nutritional (86)	3.76 (2.11)	0.87 (0.41 to 1.32)	0.78 (0.31 to 1.24)	0.89 (0.25 to 1.54)	0.007
Behavioural (91)	3.34 (1.67)	1.64 (1.20 to 2.08)	1.67 (1.22 to 2.11)*		
Five a day (%)					
Nutritional (86)	27.9%	29.9% (18.3 to 41.5)	28.0% (16.2 to 39.9)	13.0 (–3.41 to 29.4)	0.12
Behavioural (91)	16.5%	40.5% (29.4 to 51.7)	41.0% (29.7 to 52.4)*		
β Carotene (μmol/l)					
Nutritional (86)	0.89 (0.59)	1.02 (0.88 to 1.18)	1.05 (0.89 to 1.13)	0.18 (0.02 to 0.37)	0.023
Behavioural (89)	0.94 (0.67)	1.22 (1.05 to 1.41)	1.23 (1.09 to 1.39)†		
α Tocopherol (μmol/l)					
Nutritional (84)	27.2 (10.8)	6.57 (4.01 to 9.14)	6.40 (4.31 to 8.48)	1.67 (–1.25 to 4.59)	0.26
Behavioural (89)	26.4 (11.2)	8.10 (5.62 to 10.6)	8.07 (6.05 to 10.1)†		
Ascorbic acid (μmol/l)					
Nutritional (85)	75.8 (33.0)	–0.88 (–6.92 to 5.14)	0.33 (–5.30 to 6.00)	–4.52 (–12.4 to 3.36)	0.26
Behavioural (89)	71.2 (34.7)	–2.87 (–8.75 to 3.02)	–4.20 (–9.67 to 1.27)‡		
Potassium excretion (mmol/24h)					
Nutritional (70)	72.3 (28.9)	–2.26 (–6.59 to 2.08)	–2.30 (–6.29 to 1.70)	4.94 (–0.76 to 10.6)	0.089
Behavioural (69)	70.2 (24.7)	2.25 (–2.12 to 6.61)	2.65 (–1.37 to 6.66)‡		
Potassium /creatinine ratio					
Nutritional (70)	6.71 (2.33)	–0.42 (–0.76 to –0.07)	–0.39 (–0.72 to –0.06)	0.48 (0.01 to 0.95)	0.046
Behavioural (69)	6.37 (2.19)	–0.09 (–0.26 to 0.44)	0.09 (–0.24 to 0.43)‡		

*Adjusted for sex, age, ethnicity, income, smoking, and baseline stage of change.
†Adjusted for sex, age, ethnicity, income, smoking, body mass index, and baseline level.
‡Adjusted for sex, age, ethnicity, income, smoking, body mass index, baseline level, and vitamin supplements.

than in nutrition group, in line with the self reported data on consumption.

Representativeness of the sample

We recruited participants from a primary care centre in a low income neighbourhood, but only a small proportion (12%) responded to our invitations. We had no information about the eating habits or income of non-participants. Most were presumably not interested in the study, but an unknown proportion would have realised they were ineligible because of their incomes. The demands of the study were onerous, involving three blood samples and three 24 hour urine collections, and this may have discouraged potential participants.

The average fruit and vegetable intake of 3.64 portions a day is comparable with the mean intake of 3.85 in the 1999 national food survey.[15] About 24% reported eating at least five portions a day, compared with 26% in the 2000 consumer attitudes survey.[16] Participants were not therefore remarkable with respect to fruit and vegetable intake before the study. The study was not restricted to people actively considering dietary change as half the participants were in the pre-contemplation or contemplation stages. The concen-

Table 4 Effect of counselling on secondary end points (complete sample)

Group	Baseline (SD)	Unadjusted change over 12 months (95% CI)	Adjusted change over 12 months (95% CI)	Adjusted difference in change (95% CI)	P value for adjusted difference
Body weight (kg)					
Nutritional (135)	73.0 (16.6)	–0.17 (–0.69 to 0.36)	–0.27 (–0.81 to 0.26)	0.24 (–0.51 to 1.00)	0.53
Behavioural (136)	71.3 (15.6)	–0.11 (–0.63 to 0.41)	–0.03 (–0.56 to 0.50)*		
Body mass index					
Nutritional (135)	26.2 (5.8)	–0.03 (–0.20 to 0.20)	–0.04 (–0.24 to 0.17)	0.04 (–0.25 to 0.33)	0.77
Behavioural (136)	25.5 (4.9)	–0.03 (–0.23 to 0.17)	0.01 (–0.20 to 0.21)*		
Systolic blood pressure (mm Hg)					
Nutritional (133)	123.0 (17.6)	–0.54 (–2.76 to 1.68)	–0.56 (–2.88 to 1.76)	–0.24 (–3.50 to 3.02)	0.88
Behavioural (136)	123.0 (17.8)	–0.86 (–3.06 to 1.34)	–0.80 (–3.08 to 1.48)*		
Diastolic blood pressure (mm Hg)					
Nutritional (134)	77.8 (10.4)	0.05 (–1.43 to 1.54)	0.03 (–1.54 to 1.59)	–0.16 (–2.36 to 2.05)	0.89
Behavioural (136)	78.6 (10.7)	–0.07 (–1.54 to 1.41)	–0.13 (–1.68 to 1.42)*		
Total cholesterol (mmol/l)					
Nutritional (132)	5.03 (1.0)	–0.07 (–0.17 to 0.03)	–0.07 (–0.17 to 0.04)	–0.02 (–0.17 to 0.12)	0.77
Behavioural (134)	4.90 (1.0)	–0.08 (–0.18 to 0.02)	–0.09 (–0.19 to 0.01)*		
DINE fibre intake					
Nutritional (135)	13.8 (6.0)	0.08 (0.01 to 0.15)	0.07 (–0.01 to 0.15)	0.04 (–0.08 to 0.15)	0.55
Behavioural (136)	15.0 (6.8)	0.08 (0.01 to 0.16)	0.11 (0.03 to 0.19)†		
DINE fat intake					
Nutritional (135)	27.1 (13.9)	–2.92 (–4.59 to –1.26)	–2.09 (–3.91 to –0.24)	–2.01 (–4.60 to 0.58)	0.13
Behavioural (136)	28.5 (13.4)	–4.06 (–5.71 to –2.40)	–4.10 (–5.93 to –2.28)†		

*Adjusted for sex, age, ethnicity, income, smoking, and body mass index.
†Adjusted for sex, age, ethnicity, income, smoking, and baseline stage of change.

trations of plasma ascorbic acid were within the range described in the EPIC-Norfolk cohort,[17] but slightly higher than those reported in a local population based cross sectional study.[18] The concentrations of plasma α tocopherol and β carotene were comparable with those reported for men and women in the Whitehall II study.[19]

Variations in biomarker response

We did not record any changes in plasma ascorbic acid concentration. The explanation is not clear. The recent study in Oxford reported small increases in ascorbic acid in their intervention group at six months but from baseline concentrations that were much lower (34.4 μmol) than those of the present study (75 μmol/l).[7] The results for potassium excretion were also disappointing. Although there was a difference between groups in changes in potassium:creatinine ratio in the low income sample, analyses of the complete sample showed no overall effects.

The pattern of biomarker responses could have various explanations. β Carotene and α tocopherol may be more labile than ascorbic acid or potassium and therefore more likely to respond to relatively modest changes in dietary consumption. The difference could also be due to the types of fruit and vegetables eaten as nutritional constituents vary. For example, the potassium content of a banana is 10 times that of a serving of lettuce, but lettuce contains substantially more β carotene; grapefruit contains more vitamin C than an apple does, but apples contain 50% more α tocopherol.[20] The pattern of changes in biomarkers may therefore have arisen from the specific food choices made by participants.

Limitations of the study

Although we complied with the CONSORT recommendations for parallel group randomised trials, we could not blind researchers to group assignment. Quality control of counselling sessions was built into the study. Nevertheless, it would have been preferable (had resources allowed) if the nurses administering the intervention had not been involved in assessments.

Implications for health promotion

Our findings show that brief individual counselling in primary care can elicit sustained increases in consumption of fruit and vegetables, corroborated by biomarkers. Both nutrition and behavioural counselling stimulated increases in consumption, but the changes were greater with behaviourally oriented methods. Our techniques would be feasible in primary care, and they could be adapted for group administration. However, we do not know how effective they would be if applied by practice nurses outside the research setting.

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What is already known on this topic

Brief interventions can be effective in increasing consumption of fruit and vegetables

Biomarkers and intention to treat analyses have seldom been used in such interventions, and few studies have targeted low income populations

What this study adds

Compared with nutritional counselling, brief behavioural counselling carried out by nurses in primary care led to greater increases in fruit and vegetable intake and in plasma β carotene concentration

Favourable effects were observed in low income adults living in a deprived inner city area

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