ORIGINAL ARTICLE

# Estimation of fruit and vegetable intake using a two-item dietary questionnaire: a potential tool for primary health care workers

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## Abstract

Background and Aim: *High fruit and vegetable intake is associated with health benefits for cancer and cardiovascular disease. An increase is therefore integral in recommendations for the prevention of chronic disease. However, measuring intake requires either extensive dietary assessment or the measurement of specific bio-markers which is neither cheap nor feasible for the routine assessment of an individual's diet in a community or primary care setting. Within the context of a study evaluating a dietary counselling programme to increase fruit and vegetable intake our aim was to assess the use of a simple tool to estimate fruit and vegetable intake.*

Methods and Results: *We studied associations between bio-markers [plasma ascorbic acid, β-carotene and α-tocopherol 24-hour urinary potassium excretion] and a two-item fruit and vegetable consumption questionnaire in 271 subjects (105 men and 166 women), aged 18 to 70 years. After controlling for age, sex, vitamin supplement use, smoking and body mass, those reporting a daily intake of ≥5 portions of fruit and vegetables had higher potassium excretion (difference 15.6 [95% confidence interval: 6.2 to 25.0] mmol/24h), urinary potassium/creatinine ratio (1.2 [0.5 to 2.0]) and plasma vitamin C (10.0 [-0.9 to 20.8] µmol/L) than those reporting ≤2.5 portions per day. β-carotene (*p=0.04*), vitamin C (*p=0.01*) and potassium excretion (*p<0.001*) were associated with fruit rather than vegetable intake. The two-item questionnaire had high specificity; over 3/4 of participants who reported low intake also had bio-markers below the upper third of the distribution.*

Conclusion: *Self report of fruit and vegetable intake through a simple questionnaire is confirmed by bio-markers for those eating less than five portions of fruit and vegetables a day. Although the tool is amenable to improvements for the detection of vegetable portions, it may prove useful for monitoring dietary preventive approaches in primary care without the use of invasive and costly biochemical measurements.*
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*Key words.* Diet, fruit and vegetables, bio-markers, primary care.

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## Introduction

High fruit and vegetable intake is associated with health benefits for cancer (1, 2) and cardiovascular prevention (3-8). A high fruit and vegetable intake provides high potassium and high anti-oxidants. These are therefore considered reasonable bio-markers of fruit and vegetables intake (9-12). High levels of these nutrients are associated with lower coronary heart disease (8, 13), stroke (14, 15), hypertension (16-18) and overall cardiovascular disease (19). An increase in fruit and vegetable consumption is integral in national and international recommendations for the prevention of cardiovascular disease and cancer (1, 20). It has also become a priority in national public health programmes such as the five-a-day programme in England (for more information see http://www.doh.gov.uk/fiveaday). Measuring food intake is difficult and requires either extensive dietary assessment or the measurement of specific bio-markers (9-13, 19, 21). These methods are neither cheap nor feasible for the day-to-day monitoring of dietary changes in a community setting or in primary care. The National Health Service Plan makes a commitment to the development of a national programme to increase fruit and vegetable consumption, particularly in low-income groups (22) who eat much less fruit and vegetables (23). As part of this programme, action includes evaluation and monitoring.

In the context of a study evaluating a behaviourally-oriented dietary counselling programme designed to increase fruit and vegetable intake, we took the opportunity to assess a simple dietary questionnaire to estimate fruit and vegetable intake in an inner city primary care setting.

## Methods

Data were collected in the context of a randomised parallel-group controlled comparison of behaviourally orientated dietary counselling and informational counselling in primary care (24). The study is based in one general practice in South London. Details of the study participants and their recruitment are given elsewhere (24). This paper reports on the characteristics of the 271 participants who took part in the trial.

There were 105 men and 166 women, 192 were white, 71 of black African origin and eight of other ethnic groups. Only six (2%) of them were on thiazide diuretics. All subjects underwent a baseline assessment, a general questionnaire and a blood test as early in the morning as possible to minimise diurnal variation in bio-markers. They were also asked to provide a 24-hour urine collection. Physical assessment included body weight (bare footed in light indoor clothing on electric scales), height, waist and hip measurements so that body mass index (BMI) and waist/hip ratio (WHR) could be calculated. Blood pressure was measured after 10 minutes in the sitting position with three consecutive readings using an automated device.

Usual fruit and vegetable consumption was assessed by a two-item food-frequency questionnaire originally devised by Wardle *et al* (25). This was sent to all participants prior to the visit for self-completion at home. The questions used to assess the amount of fruit and vegetable consumption were: How many pieces of fruit, of any sort, do you eat on a typical day? How many portions of vegetables, excluding potatoes, do you eat on a typical day? Portion size was defined using The British Dietetic Association guidelines ('Give me Five'; Fact sheet 5, 1998 http://www.bda.uk.com/) with examples given (*eg* an apple or banana, a small bowl of strawberries, three tablespoons of tinned pears). When necessary, the nurse clarified the meaning of portion size for specific items. Fruit juice was included in 'pieces of fruit' if it was at least a glass of fresh juice in a day. Even if more than one glass per day was reported, they would only count as one portion of fruit per day. Potatoes did not count towards the portions of vegetables. Portions of fruit and vegetables were then pooled and the combined variable was used for the main analysis both as a continuous variable and after classification in tertiles.

The general questionnaire provided information about smoking and regular use of vitamin supplements (26), used in the analysis as potential confounders.

Non-fasting venous blood samples were taken and analysed to determine plasma ascorbic acid (vitamin C), α-tocopherol (vitamin E) and β-carotene. For vitamin C determination, blood was collected in citrate, protected from light, cold spun and plasma added to 10% metaphosphoric acid (MPA). Samples were stored at -70°C until analysis. Plasma vitamin C was estimated using a fluorimetric assay (27). Vitamin E and β-carotene were measured concurrently by normal phase high performance liquid chromatography (HPLC) (28).

Twenty-four-hour urinary potassium excretion has been used as a measure of dietary potassium intake, the vast majority of which comes from fruit and vegetables (16, 29). Participants were given oral and written instructions on how to collect a complete 24-hour urine specimen. The completeness of the collection was then checked by direct enquiry and by the evaluation of creatinine and volume outputs. Two-hundred and twenty-one (or 82%) samples were deemed complete and were used in the analysis. Sodium, potassium, calcium and creatinine were measured by standard methods. Excretion was expressed both as absolute daily excretion and as ratio to creatinine output.

The study was approved by the local Ethics Committee and each participant gave written informed consent to take part. Data are reported as mean, standard error or 95% confidence intervals. Associations between variables were measured by Spearman's rank correlation and by analysis of co-variance (ANCOVA) for linear trends and by multiple regression analysis for each bio-marker, with assessment of fruit and/or vegetable intake as the independent variable(s), and potential confounders as covariates. A $p$ value less than 0.05 was considered statistically significant. The analyses were not different when excluding six participants on thiazide diuretics.

## Results

*Characteristics of the participants*

Men were older than women (48.4 [SD 13.4] *vs* 40.0 [13.2] years, $p<0.001$) so that further comparisons are age-adjusted

| | Women (n=166) | Men (n=105) | *p* |
|---|---|---|---|
| Height (cm) | 162.4 (0 5) | 174 2 (0.6) | <0.001 |
| Weight (Kg) | 67.4 (1.2) | 79.2 (1.5) | <0 001 |
| Body mass index (Kg/m$^2$) | 25.6 (0 4) | 26 0 (0 5) | 0.54 |
| Waist circumference (cm) | 79 6 (0.9) | 89.4 (1 1) | <0.001 |
| Hip circumference (cm) | 102 1 (0.8) | 101.6 (1.0) | 0.73 |
| Waist/hip ratio | 0.783 (0.006) | 0 885 (0.008) | <0 001 |
| | | | |
| Cigarette smokers (%) | 29 (22 to 36) | 43 (34 to 53) | 0 025 |
| Vitamin supplement takers (%) | 34 (26 to 42) | 30 (21 to 40) | 0 58 |

Results are mean (SE) or % (95%CI) adjusted for age

**TABLE 1**
Characteristics of the participants.

(Table 1). Men had BMI comparable to women (difference: 0.4 [95% CI: -0.9 to 1.7] kg/m$^2$, $p$=0.54), and higher WHR (difference 0.103 [0.008 to 0.123], $p$<0.001). Men were more likely to smoke (Table 1). Gender did not affect reported intake of fruit and vegetables (Table 2) and this was reflected in comparable plasma levels of vitamin C, vitamin E and β-carotene. However, urinary bio-markers indicate higher levels of sodium and potassium excretion in men than women, so further analyses were carried out also after adjustment for sex.

*Factors associated with fruit and vegetable intake and bio-markers*

Compared to non-smokers, smokers reported less fruit and vegetable intake (age and sex-adjusted difference: 0.9 [0.4 to 1.3] portions per day, $p$=0.001) and had significantly

| | Women (n=166) | Men (n=105) | *p* |
|---|---|---|---|
| **Portions per day of** | | | |
| Fruit intake | 1.8 (0 1) | 1.8 (0 1) | 0 95 |
| Vegetable intake | 1.8 (0.1) | 1.9 (0.1) | 0 38 |
| Fruit and vegetable intake | 3.6 (0.1) | 3.7 (0 2) | 0.62 |
| **Plasma** | | | |
| Vitamin C (µmol/L) | 79 9 (2 8) | 72 9 (3 4) | 0.13 |
| Vitamin E (µmol/L) | 26.7 (0.9) | 26 1 (1 1) | 0 69 |
| β-carotene (µmol/L) | 1.18 (0.06) | 1.01 (0.08) | 0.10 |
| **Urine** | *(n=130)* | *(n=91)* | |
| Volume (ml) | 1734 (82) | 1955 (98) | 0.09 |
| Sodium (mmol/24h) | 138 (5) | 164 (6) | 0.003 |
| Potassium (mmol/24h) | 67 (2) | 83 (3) | <0.001 |
| Calcium (mmol/24h) | 3.9 (0.2) | 4.2 (0.3) | 0.44 |
| Creatinine (mmol/24h) | 9 8 (0.3) | 15.0 (0.4) | <0.001 |
| Sodium:creatinine | 14.3 (0 4) | 11.3 (0.5) | <0.001 |
| Potassium:creatinine | 7.1 (0.2) | 5 7 (0 2) | <0.001 |
| Calcium:creatinine | 0 43 (0.02) | 0 29 (0.02) | <0.001 |

Results are mean (SE) adjusted for age

**TABLE 2**
Fruit and vegetable intake, plasma and urinary bio-markers in women and men.

**TABLE 3**
Characteristics of smokers and non-smokers.

| | Smokers (n=91) | Non-Smokers (n=179) | *p* |
|---|---|---|---|
| Height (cm) | 167.0 (0.7) | 167 0 (0.5) | 0 96 |
| Weight (Kg) | 70 3 (1 5) | 72.9 (1 1) | 0.18 |
| Body mass index (Kg/m$^2$) | 25.2 (0.5) | 26 1 (0.4) | 0 21 |
| Waist circumference (cm) | 82.4 (1.2) | 83.9 (0 8) | 0.32 |
| Hip circumference (cm) | 100 9 (1 0) | 102.4 (0.7) | 0.22 |
| Waist/hip ratio | 0.833 (0.008) | 0 817 (0.006) | 0.13 |
| Vitamin supplement takers (%) | 25 (15 to 34) | 34 (26 to 41) | 0 15 |
| Portions per day of | | | |
| Fruit and vegetable intake | 3.1 (0 2) | 3.9 (0.1) | 0.001 |
| **Plasma** | | | |
| Vitamin C (µmol/L) | 69.0 (3.5) | 82.3 (2.5) | 0 002 |
| Vitamin E (µmol/L) | 29 0 (1.1) | 25 0 (0.8) | 0.004 |
| β-carotene (µmol/L) | 0 98 (0.08) | 1 17 (0.06) | 0.054 |
| **Urine** | *(n=71)* | *(n=150)* | |
| Volume (ml) | 1760 (109) | 1855 (75) | 0.48 |
| Sodium (mmol/24h) | 140 (7) | 153 (5) | 0.14 |
| Potassium (mmol/24h) | 67 (3) | 77 (2) | 0 006 |
| Calcium (mmol/24h) | 4.0 (0 3) | 4 1 (0 2) | 0.83 |
| Creatinine (mmol/24h) | 10 8 (0.4) | 12.5 (0.3) | 0.001 |
| Sodium:creatinine | 13 5 (0.5) | 12 9 (0.4) | 0 33 |
| Potassium:creatinine | 6.5 (0 3) | 6.6 (0.2) | 0 82 |
| Calcium:creatinine | 0.40 (0.03) | 0 36 (0 02) | 0.25 |

Results are mean (SE) or % (95% CI) adjusted for age and sex One missing value

lower levels of plasma vitamin C (13.3 [4.7 to 21.8] µmol/L, $p$=0.002), vitamin E (3.9 [1.2 to 6.6] µmol/L, $p$=0.004), β-carotene (0.19 [0 to 0.38] µmol/L, $p$=0.05), and urinary potassium (10 [3 to 17] mmol/day, $p$=0.006), but not urinary sodium (13 [-4 to 30] mmol/day, $p$=0.14) excretion (Table 3). Participants who made regular use of vitamin supplements (n=77) had significantly higher levels of both plasma vitamin C (age and sex-adjusted difference: 9.7 [0.9 to 18.6] µmol/L, $p$=0.03) and vitamin E (2.8 [-5.7 to 9.4] µmol/L, $p$=0.06), but not β-carotene (1.4 [-0.2 to 0.2] µmol/L, $p$=0.99) or urinary potassium excretion (5 [-3 to 13] mmol/day, $p$=0.17).

*Relationship between fruit and vegetable intake and bio-markers*

There was a direct relationship between the reported daily intake of fruit and vegetable and urinary potassium excretion both expressed as total daily excretion (Spearman $r_s$=0.234, $p$<0.001) and as potassium/creatinine ratio ($r_s$=0.184, $p$=0.006). Also the level of fruit and vegetable intake was directly associated with plasma levels of vitamin C ($r_s$=0.133, $p$=0.029), but not vitamin E ($r_s$=0.018, $p$=0.77) or β-carotene ($r_s$=0.085, $p$=0.16). This relationship is shown in Table 4, after controlling for the confounding effects of age, sex, vitamin supplement, smoking and BMI. Increasing numbers of portions of fruit and vegetables consumed per day were significantly associated with higher levels of urinary potassium excretion and plasma levels of vitamin C. However, when the reported intakes of fruit and vegetable were analysed separately, fruit intake (but not vegetable intake) correlated with plasma levels of β-carotene ($p$=0.04), vitamin C ($p$=0.01), and with urinary potassium excretion ($p$<0.001) (Table 5).

*Specificity and sensitivity*

The questionnaire on fruit and vegetables had low sensitivity. Only 36% (27/76) of those who were in the upper tertile of reported fruit and vegetable intake (five or more por-

**TABLE 4**
Measure of fruit and vegetable intake. association between bio-markers and dietary questionnaire.

| Variable | Pieces of fruit (of any sort) & vegetables (excluding potatoes) per day | | | *p* value | Difference III *vs* I tertile |
|---|---|---|---|---|---|
| | ≤2 5 per day (n=82)* | 3 0-4.5 per day (n=105)* | ≥5 0 per day (n=58)* | | |
| Fruit and vegetables intake (portions per day) | 1 8 (0 1) | 3 6 (0.1) | 6 3 (0.1) | <0 001 | 4 5 (4.2 to 4.8) |
| **Plasma** | | | | | |
| Vitamin C (μmol/L) | 68 2 (3 5) | 81.3 (3.1) | 78 2 (4.2) | 0 036 | 10 0 (-0 9 to 21 0) |
| Vitamin E (μmol/L) | 26 7 (1 2) | 26.5 (1 0) | 26.3 (1.4) | 0 79 | -0 47 (-4 12 to 3 18) |
| β-carotene (μmol/L) | 1 12 (0 08) | 1 10 (0.07) | 1 16 (0 10) | 0 77 | 0.05 (-0 21 to 0.31) |
| **Urine** | *(n=68)* | *(n=91)* | *(n=49)* | | |
| Sodium (mmol/24h) | 151 7 (7 3) | 153.1 (6 4) | 140.2 (8.9) | 0.38 | -11 6 (-34 6 to 11 4) |
| Potassium (mmol/24h) | 67 9 (3 0) | 71.5 (2 6) | 83 5 (3 6) | 0 002 | 15.6 (6 2 to 25 0) |
| Calcium (mmol/24h) | 3 78 (0 29) | 4 23 (0 25) | 4 04 (0 35) | 0 47 | 0 26 (-0 64 to 1.17) |
| Creatinine (mmol/24h) | 11 7 (0 4) | 11 7 (0.3) | 12 3 (0 5) | 0 35 | 0.62 (-0.56 to 1 81) |
| Sodium creatinine | 13 4 (0.5) | 13 7 (0 5) | 12 2 (0 7) | 0 23 | -1.23 (-2.95 to 0 50) |
| Potassium:creatinine | 6 1 (0.2) | 6 4 (0.2) | 7 3 (0 3) | 0 003 | 1 25 (0 47 to 2.03) |
| Calcium:creatinine | 0.35 (0.03) | 0 40 (0 02) | 0 36 (0.03) | 0 65 | 0 01 (-0 07 to 0.09) |

Results are mean (SE) or mean difference (95% CI) adjusted for age, sex, vitamin supplements, smoking and body mass index, *p* by analysis of covariance for linear trends *26 missing values (20 due to bio-markers, one to smoking and five to vitamin supplement)

tions per day) also had high urinary potassium excretion and only 24% of them (23/95) had high levels of plasma vitamin C. However, the questionnaire had high specificity; 83% (123/149) of those below the upper tertile of reported fruit and vegetable intake (less than five portions per day) had low levels of urinary potassium excretion and 76% (131/172) had low plasma levels of vitamin C.

## Discussion

The present study indicates that a simple dietary questionnaire can be used in a primary care setting without additional resources. Such questions may help to assess the level of implementation of the 'five-a-day programme' to increase fruit and vegetable consumption in Britain (22). The estimated portions of fruit and vegetable intake showed a weak relationship with established bio-markers of fruit and vegetable intake, like urinary potassium excretion, plasma vitamin C and β-carotene. However, the National Food Survey reported that in 1995-7 vitamin C intake was due to both fruit and vegetables and that β-carotene came mainly from vegetable intake (81%) rather than from fruit (3%)

**TABLE 5**
Multiple regression analysis of reported portions of daily fruit or vegetables as the independent variables and bio-markers.

| | β (95% C.I.) | *p* |
|---|---|---|
| | Fruit (portion) | |
| Plasma | | |
| Vitamin C (μmol) | 4 12 (1 00 to 7.25) | 0.01 |
| Vitamin E (μmol) | -0 25 (-1 32 to 0.82) | 0.64 |
| β-carotene (μmol) | 0 077 (0 003 to 0 151) | 0 04 |
| Urinary | | |
| Potassium (mmol) | 6 1 (3 3 to 8 8) | <0.001 |
| Potassium.creatinine (units) | 0.30 (0.07 to 0.53) | 0 01 |
| | Vegetable (portion) | |
| Plasma | | |
| Vitamin C (μmol) | 0 29 (-3 14 to 3.72) | 0.87 |
| Vitamin E (μmol) | -0 12 (-1.28 to 1 04) | 0 84 |
| β-carotene (μmol) | -0 033 (-0 115 to 0 046) | 0 41 |
| Urinary | | |
| Potassium (mmol) | 1 6 (-1 3 to 4 6) | 0.27 |
| Potassium.creatinine (units) | 0.19 (-0 04 to 0 43) | 0 11 |

Adjusted for age, sex, body mass index, smoking and vitamin supplements
β=regression coefficient

(30). In our study, the relationships were more consistent with the reported fruit than vegetable intake, suggesting that the questionnaire is amenable to further improvement for the detection of vegetable portions. One reason may be that people may find it easy to specify the number of pieces of fruit they eat, but that there is variation in understanding of what is meant by a portion of vegetables. The majority of people have an inaccurate idea of the recommended portion sizes (31). Providing a simple definition of a portion, as has been done by other investigators (32), and programmes to increase awareness may improve the assessment of vegetable intake, although assessment of vegetables served mixed with other food is always likely to be problematic.

In the UK there is still a considerable gap between awareness of what one should do and actual behaviour. Only 36% are aware of the recommended daily intake of fruit and vegetables (five a day). Our questionnaire identified more than 80% of the participants whose bio-markers were below the upper third of the distribution (*ie* consuming less than five portions of fruit and vegetables per day), thus proving particularly suited to identify those with the lowest intakes.

Our participants reported an average consumption of 3.6 portions of fruit and vegetables per day. This is in line with the participants in the Oxford Fruit and Vegetable Study (33) and in keeping with recent estimates of 3.9 portions per day in the National Food Survey (30). After controlling for confounders, participants in the upper third of reported fruit and vegetable intake (≥5 portions per day) compared to those in the lower third (≤2.5 portions per day) had about 20% higher potassium excretion (15.6 [95% CI: 6.2 to 25.0] mmol/24h) and 15% higher plasma vitamin C (10.0 [-0.9 to 20.8] µmol/L). These differences are meaningful when considered in the light of the results of large prospective cohort studies that have quantified the relationships of fruit and vegetable intake and bio-markers to outcome. For instance, in the Framingham Study, each increment of three daily servings of fruit and vegetables was associated with a 22% reduction in the risk of stroke (3). In the Women's Health Study, an increase in the daily fruit and vegetable intake from 2.2 to 5.4 (median servings of 1st and 3rd quintile of distribution comparable to differences in portions between 1st and 3rd tertile in the present study) was associated with a 23% reduction in overall cardiovascular events in women with no previous history of disease (19). Furthermore, in the EPIC-Norfolk cohort, a difference in 10 µmol/L of plasma levels of vitamin C (as that found in our study between 1st and 3rd tertile of fruit and vegetable intake) was associated with a 10% risk reduction in all-cause mortality (13). In the Oxford Fruit and Vegetable Study an increase in fruit and vegetable intake of 1.4 portions was associated with a significant fall in both systolic and diastolic blood pressure(33).

Patients and people requiring dietary assessment and counselling are increasingly evaluated and managed in general practice. The cost effectiveness of dietary counselling by nurses is limited by the time (s)he spends on assessing the diet. Limited validation studies have been performed of dietary instruments in a general practice setting (34, 35). In a randomised trial of validation of dietary assessment tools in general practice, Little *et al* (36) found that simple self-assessment tools based on food groups, designed for practice nurse dietary assessment, showed acceptable agreement with the 'gold standard' seven-day weighed dietary record and with bio-markers (except for under-reporting of absolute energy intake). The study clearly suggested that it is possible to devise brief assessment instruments that work well enough for clinical work and possibly for population dietary monitoring. Our study complements Little's recent report to suggest that it is possible to devise and use a simple dietary method to assess fruit and vegetable intake in a primary care setting.

Our study does not provide a validation of the precision of the estimate of the 'true' intake nor does it substitute for the sophisticated and reliable methods available (9-13). Even these do not allow for the fact that any differences observed may represent differences in type of fruit and vegetables consumed. However, none of these are suitable for a widespread use in general practice as their use requires time, skills and resources not available in primary care (36).

Twenty-four-hour urinary excretions of sodium, potassium and nitrogen are good indicators of dietary intake (10). As in previous studies of 24-hour urine collection that we (37-39) and others (40, 41) have carried out over the years, we did not use the para-amino benzoic acid (PABA) method to check for the completeness of 24-hour urine collections. Although it would have undoubtedly provided a more direct assessment of completeness, in our experience it would have significantly reduced adherence to the already difficult request of 24-hour urine collections. Our response rate of 82% in a primary care setting is satisfactory and we have no reason to question the validity of the method we used. We gave very detailed instructions on how to collect complete daily urine samples. Twenty-four-hour creatinine measurements, urinary volume assessments, and detailed interviews of each participant were also used to ensure completeness of the collection. The use of a single urinary collection may have diluted any effect we might find, due to the difference between intra-individual and between individual variation (40). However, the results are consistent both using total urine output and when expressed for unit of creatinine. Furthermore, the relationships are specific for potassium and are not seen with sodium and calcium. Had the results been biased by the incompleteness of the urine collections, it would have shown in all electrolytes measured in the same collection.

Levels of bio-markers compared well with those recently reported in large British cohorts (13, 28). Plasma levels of vitamin E and β-carotene were comparable to those reported for men and women in the Whitehall II study (28). Also, the differences we found by smoking habit for both vitamin E and β-carotene had also been reported in the Whitehall II study. The levels of plasma vitamin C were within the range of distribution described in the EPIC-Norfolk cohort (13), but slightly higher than those reported in a local population-based cross-sectional study (42). However, in the latter the proportion of vitamin supplement takers was much lower (26). Yet again, the expected differences by gender and smoking habit were confirmed, providing external validity to the current measurements.

The data were collected in the context of baseline measurements for a trial of behavioural counselling (24). Therefore, participants may not be representative of the adult population at large. This may raise some legitimate concerns about the generalisability of our results to other patients in general practice. Those who agreed to take part in the trial may not be 'representative' of patients in that general practice. However, the range of socio-economic characteristics of participants was wide but not atypical (24). The results indicate the feasibility of a simple assessment for primary health care workers to monitor how the 'five-a-day programme' is implemented.

In conclusion, the assessment of the intake of fruit and vegetables is possible through a simple questionnaire which can be used as a quick tool to identify the majority of individuals who eat less than five portions of fruit and vegetable a day. Although the tool is amenable to improvements for the detection of vegetable portions, it may be useful to monitor dietary preventive approaches in primary care without the use of sophisticated, invasive and costly biochemical measurements, unsuitable for primary care settings.

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