



**A new tool for converting food frequency questionnaire data into nutrient and food group values: FETA research methods and availability**

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1 A new tool for converting food frequency questionnaire data into nutrient and food group values:  
2 FETA research methods and availability

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46 **Abbreviations:** FFQ, food frequency questionnaire; EPIC, European Prospective Investigation into  
47 Cancer and Nutrition; FETA, FFQ EPIC Tool for Analysis; CAFÉ, Compositional Analyses from  
48 Frequency Estimates

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## 33 ABSTRACT

### 34 Objectives

35 To describe the research methods for the development of a new tool which processes data from the  
36 European Prospective Investigation into Cancer and Nutrition Norfolk Food Frequency  
37 Questionnaire (EPIC-Norfolk FFQ). A further aim was to compare nutrient and food group values  
38 derived from the current tool (FETA; FFQ EPIC Tool for Analysis) with the previously validated  
39 but less accessible tool, CAFÉ (Compositional Analyses from Frequency Estimates). The effect of  
40 text matching on intake data was also investigated

### 41 Design

42 Cross-sectional analysis of a prospective cohort study – EPIC-Norfolk.

### 43 Setting

44 East England population (city of Norwich and its surrounding small towns and rural areas).

### 45 Participants

46 Complete FFQ data from 11 250 men and 13 602 women with a mean age of 59 years (range 40 –  
47 79 years).

### 48 Outcome measures

49 Nutrient and food group intakes derived from FETA and CAFÉ analyses of EPIC-Norfolk FFQ  
50 data.

### 51 Results

52 Nutrient outputs from FETA and CAFÉ were similar; mean (SD) energy intake from FETA was  
53 9222 kJ (2633) in men, 8113 kJ (2296) in women, compared to CAFÉ intakes of 9175 kJ (2630) in  
54 men, 8091 kJ (2298) in women. The majority of differences resulted in one or less quintile change  
55 (98.7%). Only mean daily fruit and vegetable food group intakes were higher in women than in men  
56 (278 v 212 g and 284 v 255 g respectively). Quintile changes were evident for all nutrients, with the  
57 exception of alcohol, when text matching was not executed; however, only the cereals food group  
58 was affected.

## 59 **Conclusions**

60 FETA produces similar nutrient and food group values to the previously validated CAFÉ but has  
61 the advantages of being open source, cross-platform and complete with a data-entry form directly  
62 compatible with the software. The tool will facilitate research using the EPIC-Norfolk FFQ, and  
63 can be customised for different study populations.

## 64 **Strengths and limitations of this study**

- 65 • FETA has been tested using a large study sample of food intake data.
- 66 • No independent reference method used in the comparisons of Feta and CAFÉ nutrient intake  
67 data although the CAFÉ system has been previously validated.

## 69 **INTRODUCTION**

70 Food Frequency Questionnaires (FFQs) are commonly used in epidemiological studies to assess the  
71 dietary intake of large populations. Their popularity derives from ease of administration, ability to  
72 assess dietary intake over a defined period of time, and low costs (1). The European Prospective  
73 Investigation into Cancer and Nutrition (EPIC)-Norfolk FFQ is semi-quantitative and designed to  
74 record the average intake of foods during the previous year. The principles involved in data  
75 collection and processing of the EPIC-Norfolk FFQ and the development of the structure and  
76 content of the CAFÉ program for calculating nutrient intakes have been published previously (2).  
77 The EPIC-Norfolk FFQ has been extensively validated and has been widely used (3);(4);(5).  
78 However, the programs used to process these FFQs, including CAFÉ, have not been easily  
79 accessible to end-users.  
80 Our objectives were to develop a new, open source, cross-platform processing tool (FETA - FFQ  
81 EPIC Tool for Analysis) based on and building upon the earlier system, CAFÉ (2). The aim of this  
82 report was to describe the research methods of the development of FETA, and to compare nutrient  
83 output from the FETA and CAFÉ programs. Food group intake data from FETA has also been  
84 described as has the effect of free text matching on nutrient and food group intake data.

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4 86 **METHODS**5  
6 87 **EPIC-FFQ design**

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8 88 The questionnaire consists of two parts. Part 1 consists of a food list of 130 lines; each line has a  
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10 89 portion size attached to it: medium serving, standard unit or household measure. Study participants  
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12 90 were requested to select an appropriate frequency of consumption for each line, from the nine  
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14 91 frequency categories. As an example, Figure 1 illustrates the sections relating to bread, savoury  
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16 92 biscuits and breakfast cereals. A pdf copy of the EPIC-Norfolk FFQ may be downloaded from  
17  
18 93 <http://www.srl.cam.ac.uk/epic/epicffq/websitedocumentation.html>; information on how to complete  
19  
20 94 and code the FFQ is also available here. The questionnaire lines are either individual foods,  
21  
22 95 combinations of individual foods or food types. The FFQ food list is based on items from an FFQ  
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24 96 widely used within the USA (6);(7), but modified to reflect differences in American versus UK  
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26 97 brand names and some further food items were added.

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28 98 Part 2 contains further questions, a number of which ask for more detailed information that link  
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30 99 back to food lines in part one, as illustrated in Figure 2. Detailed information was requested for  
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32 100 breakfast cereals and fats as these are nutritionally important foods in the UK diet.

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37 101 **Data collection**

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39 102 The EPIC-Norfolk FFQ was posted to 25 639 participants in the EPIC-Norfolk cohort study (8).  
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41 103 The participants were aged 40-79 years and the questionnaire was completed between 1993 and  
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43 104 1997. The study was approved by the Norfolk Local Research Ethics Committee, adhered to the  
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45 105 Declaration of Helsinki and all participants gave written informed consent. The FFQ was returned  
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47 106 at a health examination, where it was checked and completed, if required, by trained nursing staff.  
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49 107 In total, 25 351 (99%) participants returned the completed questionnaire.

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52 108 **Comparison of FETA and CAFÉ programs**

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54 109 FETA uses a csv (comma-separated values) input file. Part 1 is coded as numeric values and Part 2  
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56 110 is coded as numeric values and food codes, using the flow-charts and look-up lists provided  
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2 111 (<http://www.srl.cam.ac.uk/epic/epicffq/>). We have also created a Microsoft Access form-based  
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4 112 entry tool to facilitate FFQ data entry, based on the EPIC-Norfolk FFQ. The tool exports data in a  
5  
6 113 format directly compatible with FETA. The FETA software was written in C and C++ languages,  
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8 114 enabling faster processing times than SAS and the C/C++ software can also be used from the  
9  
10 115 command line. The step-based graphical wizard for running FETA was written in Perl. Whereas in  
11  
12 116 the CAFÉ program, an Oracle (Oracle Corporation, Redwood Shores, CA, USA) -based entry  
13  
14 117 system was created to enter Part 1 frequency data as numeric codes and Part 2 data as numeric  
15  
16 118 codes and free text. CAFÉ was written using SAS (SAS Software, Version 8 of the SAS System for  
17  
18 119 Unix, SAS Institute Inc., Cary, NC, USA) and links to tables in an Oracle relational database.

#### 21 120 **Part 1- data entry**

22  
23  
24 121 Data were manually entered into a spreadsheet as numeric codes, using '1' for 'never or less than  
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26 122 once a month', to '9' for '6+ times per day'. A code of '-9' was used to mark data where a  
27  
28 123 frequency was not recorded. Where two frequencies were provided for a line, these were both  
29  
30 124 coded, separated by a semi-colon, e.g. '2;3', and FETA processed the first value. In the CAFÉ  
31  
32 125 program, two entries per line were treated as missing data.

#### 33 126 **Part 2 – assigning of food codes to ticked boxes and free text**

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37 127 Part 2 contains hand-written text for milk, breakfast cereals and cooking fats (see Figure 2,  
38  
39 128 questions 3, 5, 6 and 7 respectively), which needs to be matched to the most appropriate food code  
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41 129 in order to obtain nutrient data; this process is known as free text matching. The data in part 2 were  
42  
43 130 coded using reference lists of food codes for varieties of milk, breakfast cereal and cooking fat.  
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45  
46 131 Where there is no clear match, it is suggested that a researcher consults the ingredients and nutrient  
47  
48 132 information of the commercial item and compares this information with the nutrient profile of  
49  
50 133 similar items from the reference lists. These reference lists and figures relating to food codes that  
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52 134 may be assigned to appropriate ticked boxes may be found at  
53  
54  
55 135 <http://www.srl.cam.ac.uk/epic/epicffq/websitedocumentation.html>

1  
2 136 Differences between FETA versus CAFÉ processing may also be found at  
3  
4 137 <http://www.srl.cam.ac.uk/epic/epicffq/websitedocumentation.html>; these differences relate to  
5  
6 138 breakfast cereals, frying and baking fats, the outcome of selecting the 'None' or 'No' box, and  
7  
8 139 default milk, cereal, and fat codes.

#### 10 **Databases**

11  
12 141 Each line in Part 1 of the FFQ is mapped to up to six food codes. Decisions regarding which food  
13  
14 142 codes to use were based on data from UK government surveys and other UK population data (7);  
15  
16 143 (7,9,10). These decisions were based on data for individuals aged 40-74 years (7). Data for portion  
17  
18 144 weights were sourced from UK population data and weighed records in 40-74 year old study  
19  
20 145 participants (7,11).

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22 146 The EPIC-Norfolk FFQ uses 290 foods from the UK food composition database, McCance and  
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24 147 Widdowson's "The Composition of Foods" (5<sup>th</sup> edition) and its associated supplements (12–21). A  
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26 148 number of new food items were added to the EPIC-Norfolk FFQ food list, which are used in both in  
27  
28 149 FETA and CAFÉ programs. These include low calorie/diet fizzy drinks and crunchy oat cereal, as  
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30 150 well as modified home-baked and fried foods (without their fat), to enable an individual's fat type,  
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32 151 as recorded in Part 2 of the FFQ, to be incorporated. However, the nutrient data of six of the nine  
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34 152 new foods used in the CAFÉ program were modified in FETA. These foods include crunchy oat  
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36 153 cereal, milk non-specific, low calorie/diet fizzy drinks, solid vegetable oil, Crisp 'n Dry (solid fat),  
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38 154 and oil and fat non-specific. Modifications to the nutrient data were made to ensure a more accurate  
39  
40 155 nutrient profile and/or to better reflect the foods consumed, in the case of non-specific items, such  
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42 156 as milk and oil/fat.

#### 48 **Identification of outliers**

49  
50 158 Outliers were defined, as detailed previously (2). In brief, the ratio of energy intake (EI) to basal  
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52 159 metabolic rate (BMR) was calculated, where BMR was calculated using sex-specific Schofield  
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54 160 equations, which included age and body weight (22). Individuals in the top and bottom 0.5% of EI:

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2 161 BMR ratio were identified and excluded, as were individuals with FFQs containing 10 or more  
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4 162 missing lines of data in Part 1 of the FFQ.

### 5 6 163 **Nutrient and food group outputs**

7  
8 164 FETA produces four nutrient output formats and a sample of each of these can be viewed at

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10 165 <http://www.srl.cam.ac.uk/epic/epicffq/websitedocumentation.html>

11  
12 166 Output 1 contains average daily nutrient and food group intakes for an individual from all FFQ

13  
14 167 foods consumed, in wide format, suitable for import into a spreadsheet or statistical package. Intake

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16 168 data for 46 nutrients are provided as well as data for 14 basic food groups, however only a selection

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18 169 of these nutrients is shown in this report. Output 2 contains the same nutrient intake data as output

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20 170 1, but in long format, which is mostly suitable for programmers. Output 3 contains average daily

21  
22 171 nutrient and food group intakes (and amount of food consumed) for an individual for each FFQ line;

23  
24 172 this output file will be very large and is mostly suitable for programmers. The most detailed output

25  
26 173 (output 4) contains average daily nutrient and food group intakes, in addition to the amount of food

27  
28 174 consumed for an individual, for each food code, for each FFQ line (meal\_id). An online description

29  
30 175 of each meal\_id and nutrient code, including units of measurement, can be found in the data entry

31  
32 176 template. This output will also be very large and is mostly suitable for programmers.

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34 177 A log file is created along with each output file, which records the processing of the data and

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36 178 provides useful error information (see Appendix 1 for log file of output 1). In these files, both notes

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38 179 (general process information) and error messages are recorded, with a date and time stamp. The log

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40 180 files make it possible to calculate the number of missing frequencies based on Part 1 (main grid) of

41  
42 181 the FFQ in order to exclude individuals with 10 or more missing ticks. The log files also record

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44 182 situations where a food code does not have any nutrient data attached to it.

### 45 46 183 **Statistical analyses**

47  
48 184 The data were analysed using STATA 10 (STATA Corp., Texas, USA). Intake data were described

49  
50 185 using mean, standard deviation (SD), median, minimum and maximum for both FETA and CAFÉ

51  
52 186 program outputs, stratified by sex. The nutrients selected for comparison are those described in the



1  
2 187 original CAFÉ paper. Where data on quintile changes are shown, cut-off points were calculated  
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4 188 using CAFÉ nutrient data in order to compare quintile shift between FETA and CAFÉ output data.  
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## 8 190 **RESULTS**

9  
10 191 There were FFQ data available from 25 351 participants with a mean age of 59 years. Data from 11  
11  
12 192 250 men and 13 602 women are presented here, as individuals in the top and bottom 0.5% of EI:  
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14 193 BMR ratio have been excluded, as have individuals with FFQs containing 10 or more missing lines  
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16  
17 194 of data in Part 1 of the FFQ.

### 18 195 **Nutrient intake data from FETA and CAFÉ programs**

19  
20 196 Table 1 shows the average daily intake data for a number of selected nutrients for 11 250 men. The  
21  
22 197 data were similar for most nutrients across the two programs. The nutrients which had the highest  
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24 198 percentage of quintile change ( $\geq 10\%$ ) were monounsaturated fat, saturated fat, iron, vitamin D &  
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26 199 vitamin E. However, only 1.3% of the men changed more than one quintile, for two of these five  
27  
28 200 nutrients. The nutrients which had the lowest percentage of quintile changes were alcohol, calcium  
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30  
31 201 and carotene, with less than 3% change (Table 1).

32  
33 202 Table 2 shows average daily intake data for the selected nutrients for 13 602 women, from FETA  
34  
35 203 and CAFÉ programs. There were similar quintile changes observed in women to those found in men  
36  
37 204 for the selected nutrients; four of the nineteen nutrients had a quintile change of greater than 10%:  
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39 205 polyunsaturated fat, saturated fat, iron and Vitamin E. However, the number of women who shifted  
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41 206 more than one quintile was generally lower than the number observed in men. The nutrients which  
42  
43 207 had the greatest percentage of women who changed more than one quintile were vitamins D and E,  
44  
45 208 with 0.7 and 0.9% respectively.

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47 209 Detailed (output 4) nutrient intake data at the individual level obtained from the two programs were  
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49 210 compared for approximately half of the participants (n=12 500; data not shown). All differences (>  
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51 211 0.1%) found were investigated and explanations for these differences are considered in the  
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53 212 discussion.  
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Table 1 Average daily nutrient intakes for men (N=11 250) participating in the EPIC-Norfolk study, from the FETA and CAFÉ programs, after the exclusion of outliers, with numbers and percentages of men who moved quintile

Nutrient	FETA program					CAFÉ program					Quintile			
	Median	Mean	SD	Mini	Maxi	Median	Mean	SD	Mini	Maxi	Quintile change	change > 1		
				mum	mum				mum	mum		N	%	N
Energy (kcal)	2126	2190	627	748	5085	2115	2179	626	748	5101	892	7.9	0	0.0
Energy (kJ)	8947	9222	2633	3124	21394	8900	9175	2630	3124	21440	891	7.9	0	0.0
Protein (g)	83.4	85.2	22.0	23.3	319.8	83.2	84.9	22.0	23.3	318.4	464	4.1	0	0.0
Alcohol (g)	6.7	12.3	16.1	0.0	134.2	6.7	12.3	16.1	0.0	134.2	0	0.0	0	0.0
Carbohydrate (g)	261	271	87	48	737	259	269	87	48	729	726	6.5	0	0.0
Starch (g)	123	128	45	10	504	122	127	45	10	501	813	7.2	1	0.0
Englyst fibre (g)	17.5	18.2	6.4	1.3	89.9	17.3	18.0	6.4	1.3	89.9	743	6.6	1	0.0
Fat (g)	78.9	83.2	31.3	13.4	260.6	78.7	83.0	31.3	13.4	260.6	1049	9.3	8	0.1
Monounsaturated fat (g)	27.0	28.8	11.6	4.8	101.2	26.8	28.5	11.5	4.8	105.1	1264	11.2	21	0.2
Polyunsaturated fat (g)	13.5	15.0	6.9	1.6	66.6	13.7	15.3	7.1	1.6	69.5	1074	9.5	24	0.2
Saturated fat (g)	30.1	32.3	13.6	3.0	110.6	29.8	31.9	13.5	3.0	106.7	1288	11.5	20	0.2
Calcium (mg)	1021	1039	301	189	2848	1018	1037	300	189	2849	296	2.6	1	0.0
Iron (mg)	12.1	12.4	3.6	2.6	38.7	11.9	12.3	3.5	2.5	38.5	1149	10.2	7	0.1
Potassium (mg)	3814	3881	911	1305	11718	3802	3869	909	1284	11718	411	3.7	0	0.0

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3															
4	Carotene (mcg)	3188	3321	1573	147	25720	3178	3309	1571	147	25720	156	1.4	0	0.0
5	Folate (mcg)	320	331	97	77	1547	316	327	96	77	1547	836	7.4	3	0.0
6															
7	Vitamin C (mg)	103	111	52	10	669	105	113	52	10	669	411	3.7	14	0.1
8															
9	Vitamin D (mcg)	3.16	3.65	2.08	0.03	27.08	3.13	3.62	2.06	0.03	27.12	1161	10.3	145	1.3
10															
11	Vitamin E (mg)	13.2	14.9	7.2	2.1	62.3	12.9	14.4	6.8	2.1	62.0	1545	13.7	146	1.3
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Table 2 Average daily nutrient intakes for women (N=13 602) participating in the EPIC-Norfolk study, from the FETA and CAFÉ programs, after the exclusion of outliers, with numbers and percentages of women who moved quintile

Nutrient	FETA program					CAFÉ program					Quintile			
	Median	Mean	SD	Mini	Maxi	Median	Mean	SD	Mini	Maxi	Quintile change		change > 1	
				mum	mum				mum	mum	N	%	N	%
Energy (kcal)	1859	1925	546	538	4733	1853	1920	547	518	4643	1030	7.6	0	0.0
Energy (kJ)	7833	8113	2296	2261	19910	7811	8091	2298	2179	19537	1018	7.5	0	0.0
Protein (g)	79.8	81.5	21.1	23.0	246.0	79.6	81.3	21.0	22.7	246.1	495	3.6	1	0.0
Alcohol (g)	2.0	5.6	8.4	0.0	99.5	2.0	5.6	8.4	0.0	99.5	0	0.0	0	0.0
Carbohydrate (g)	237	247	77	59	766	235	245	77	58	766	974	7.2	1	0.0
Starch (g)	107	112	39	13	405	106	111	39	13	406	1142	8.4	1	0.0
Englyst fibre (g)	18.2	19.0	6.8	2.3	118.5	18.0	18.8	6.7	2.4	118.6	850	6.2	1	0.0
Fat (g)	67.0	70.8	27.1	11.7	221.0	67.2	71.2	27.3	11.6	217.2	1194	8.8	4	0.0
Monounsaturated fat (g)	22.5	24.1	9.9	3.8	100.3	22.5	24.1	9.9	3.5	100.6	1338	9.8	7	0.1
Polyunsaturated fat (g)	12.2	13.5	6.2	2.0	53.6	12.5	13.8	6.3	2.0	53.6	1434	10.5	23	0.2
Saturated fat (g)	25.0	27.0	11.7	3.6	102.3	25.0	26.9	11.7	3.7	99.3	1443	10.6	9	0.1
Calcium (mg)	971	992	290	128	3159	969	990	290	127	3159	390	2.9	4	0.0
Iron (mg)	11.5	11.8	3.6	1.7	66.1	11.3	11.7	3.5	1.8	65.7	1496	11.0	12	0.1
Potassium (mg)	3781	3861	942	1150	16568	3769	3848	939	1147	16587	486	3.6	1	0.0
Carotene (mcg)	3477	3719	1917	67	61971	3469	3712	1917	64	61983	122	0.9	0	0.0

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4	Folate (mcg)	322	332	103	65	2039		317	328	101	65	2024	1025	7.5	5	0.0
5	Vitamin C (mg)	123	133	64	4	1006		125	135	64	4	1006	746	5.5	35	0.3
6																
7	Vitamin D (mcg)	3.01	3.46	1.90	0.00	17.83		3.02	3.45	1.90	0.00	17.75	1119	8.2	90	0.7
8																
9	Vitamin E (mg)	12.4	13.8	6.2	1.5	52.4		12.2	13.5	6.0	1.6	49.8	1863	13.7	123	0.9
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2 217 **Food group intake data from FETA**

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4 218 Average daily intakes for both men and women of the fourteen food groups readily available from  
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6 219 FETA are shown in Table 3. Mean daily intakes of six of the food groups were higher in men than  
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8 220 in women: alcohol, cereals, fats, meat, potatoes and sugars. However, women had higher intakes of  
9  
10 221 fruit (278g v 212g) and vegetables (284g v 25+5g). Mean daily intakes of eggs, fish, milk, non-  
11  
12 222 alcoholic beverages, nuts and seeds, and soups and sauces were similar in both men and women.

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14 223 **The effect of text matching in FETA**

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16  
17 224 Tables 4 and 5 illustrate the variation in nutrient and food group intake data obtained in a random  
18  
19 225 subset of 1 159 men and 1 340 women, respectively, depending on whether text matching of milks,  
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21 226 breakfast cereals and baking and frying fats was applied. In general, mean nutrient intakes were  
22  
23 227 higher when text matching was carried out. In men, (Table 4), quintile changes (>15%) were most  
24  
25 228 evident in the following nutrients: Englyst fibre, polyunsaturated fat, folate, vitamin D and vitamin  
26  
27 229 E. The food group “cereals and cereal products” was the only one of the fourteen groups where  
28  
29 230 there was a difference, with 31 men moving 1 quintile.  
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31  
32 231 In women, (Table 5), quintile changes (>15%) were also most evident in the same five nutrients.  
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34 232 However, almost 21% of women also changed quintile for iron. Once again, the “cereals and cereal  
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36 233 products” food group was the only food group where there was any difference, with 40 women  
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39 234 moving 1 quintile.  
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Table 3 Average daily food group intakes for men (N=11 250) and women (N=13 602) participating in the EPIC-Norfolk study, from the FETA program

Food group	Men					Women				
	Median	Mean	SD	Mini mum	Maxi mum	Median	Mean	SD	Mini mum	Maxi mum
Alcoholic beverages (g)	101	204	315	0	2483	23	64	109	0	1728
Cereals & cereal products (g)	242	260	127	0	1456	215	231	110	0	1172
Eggs & egg dishes (g)	18	17	15	0	225	14	16	14	0	236
Fats & oils (g)	31	36	22	0	207	27	30	20	0	218
Fish & fish products (g)	32	37	26	0	362	32	38	26	0	309
Fruit (g)	179	212	164	0	2654	238	278	201	0	3742
Meat & meat products (g)	99	106	54	0	856	91	94	48	0	606
Milk & milk products (g)	407	420	182	0	1303	386	410	175	0	1560
Non-alcoholic beverages (g)	1157	1177	396	0	3707	1150	1165	403	0	4501
Nuts & seeds (g)	0	3	9	0	228	0	3	9	0	188
Potatoes (g)	125	122	69	0	1007	116	112	64	0	1506
Soups & sauces (g)	43	58	54	0	1004	43	57	53	0	1376
Sugars (g)	53	64	50	0	572	37	48	42	0	541
Vegetables (g)	236	255	123	0	2398	262	284	143	0	3539

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Table 4 Comparison of average daily nutrient and food group intakes for men (N=1 159) participating in the EPIC-Norfolk study, from the FETA program, with and without the application of text matching

Nutrient/Food group	FETA program, with text matching					FETA program, without text matching					Quintile change		Quintile change > 1	
	Median	Mean	SD	Mini mum	Maxi mum	Median	Mean	SD	Mini mum	Maxi mum	N	%	N	%
	Energy (kcal)	2095	2176	678	658	7766	2091	2170	678	658	7787	28	2.4	0
Energy (kJ)	8822	9161	2848	2780	32555	8804	9138	2850	2780	32647	26	2.2	0	0.0
Protein (g)	82.8	85.0	22.8	22.1	272.3	82.5	84.7	22.8	22.1	272.3	34	2.9	0	0.0
Alcohol (g)	7.2	12.3	16.1	0.0	112.9	7.2	12.3	16.1	0.0	112.9	0	0.0	0	0.0
Carbohydrate (g)	261	270	93	63	1006	259	269	93	63	1003	48	4.1	0	0.0
Starch (g)	120	127	49	7	643	121	126	48	7	636	65	5.6	0	0.0
Englyst fibre (g)	17.5	18.3	6.6	3.6	71.8	17.3	17.9	6.3	3.6	64.5	198	17.1	10	0.9
Fat (g)	77.8	82.1	33.1	12.8	387.8	77.3	82.1	33.1	12.8	389.3	32	2.8	0	0.0
Monounsaturated fat (g)	26.5	28.2	12.2	3.5	131.1	26.7	28.7	12.5	3.7	138.7	88	7.6	0	0.0
Polyunsaturated fat (g)	13.5	14.9	7.3	3.0	67.0	12.7	14.1	6.8	3.0	60.7	179	15.4	17	1.5
Saturated fat (g)	30.1	31.8	14.1	3.3	160.0	30.3	32.2	14.3	3.3	160.3	72	6.2	1	0.1
Calcium (mg)	1015	1044	312	242	2848	1012	1044	313	242	2861	42	3.6	0	0.0
Iron (mg)	11.9	12.5	3.8	2.6	37.9	11.7	12.0	3.5	2.6	38.1	173	14.9	16	1.4
Potassium (mg)	3824	3889	957	1353	12675	3812	3873	951	1353	12551	52	4.5	0	0.0



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4	Carotene (mcg)	3150	3348	1671	507	18295	3162	3353	1672	507	18338	6	0.5	0	0.0
5	Folate (mcg)	325	333	103	94	1222	316	326	101	94	1262	226	19.5	2	0.2
6	Vitamin C (mg)	105	113	55	17	619	104	112	55	17	619	22	1.9	0	0.0
7	Vitamin D (mcg)	3.08	3.64	2.17	0.03	16.40	3.06	3.64	2.19	0.03	20.52	227	19.6	8	0.7
8	Vitamin E (mg)	13.3	15.0	7.6	2.7	74.7	13.0	14.5	7.1	2.7	71.2	238	20.5	30	2.6
9	Alcoholic beverages (g)	104	201	301	0	1866	104	201	301	0	1866	0	0.0	0	0.0
10	Cereals & cereal products (g)	240	257	131	0	1378	238	255	130	0	1378	31	2.7	0	0.0
11	Eggs & egg dishes (g)	18	17	17	0	225	18	17	17	0	225	0	0.0	0	0.0
12	Fats & oils (g)	31	36	25	0	313	31	36	25	0	313	0	0.0	0	0.0
13	Fish & fish products (g)	32	37	25	0	153	32	37	25	0	153	0	0.0	0	0.0
14	Fruit (g)	184	216	158	0	1037	184	216	158	0	1037	0	0.0	0	0.0
15	Meat & meat products (g)	98	104	52	0	690	98	104	52	0	690	0	0.0	0	0.0
16	Milk & milk products (g)	414	428	187	0	1302	414	428	187	0	1302	0	0.0	0	0.0
17	Non-alcoholic beverages (g)	1159	1191	397	22	3677	1159	1191	397	22	3677	0	0.0	0	0.0
18	Nuts & seeds (g)	0	3	8	0	135	0	3	8	0	135	0	0.0	0	0.0
19	Potatoes (g)	125	121	78	0	1518	125	121	78	0	1518	0	0.0	0	0.0
20	Soups & sauces (g)	43	56	51	0	556	43	56	51	0	556	0	0.0	0	0.0
21	Sugars (g)	51	63	50	0	358	51	63	50	0	358	0	0.0	0	0.0
22	Vegetables (g)	238	256	128	15	1047	238	256	128	15	1047	0	0.0	0	0.0
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Table 5 Comparison of average daily nutrient and food group intakes for women (N=1 340) participating in the EPIC-Norfolk study, from the FETA program, with and without the application of text matching

Nutrient/Food group	FETA program, with text matching					FETA program, without text matching								
	Median	Mean	SD	Mini	Maxi	Median	Mean	SD	Mini	Maxi	Quintile change		Quintile change > 1	
				mum	mum				mum	mum	N	%	N	%
Energy (kcal)	1886	1946	607	608	8103	1880	1941	605	608	8134	50	3.7	0	0.0
Energy (kJ)	7938	8202	2554	2552	34410	7909	8177	2547	2552	34541	47	3.5	0	0.0
Protein (g)	80.3	82.5	22.2	26.8	277.0	79.9	82.1	22.1	26.8	276.6	43	3.2	0	0.0
Alcohol (g)	2.0	5.4	8.1	0.0	65.3	2.0	5.4	8.1	0.0	65.3	0	0.0	0	0.0
Carbohydrate (g)	238	250	90	67	1596	237	249	90	67	1603	58	4.3	0	0.0
Starch (g)	109	114	52	25	1288	108	114	52	25	1301	99	7.4	0	0.0
Englyst fibre (g)	18.6	19.3	7.4	4.1	103.7	17.8	18.7	7.1	3.3	97.2	247	18.4	13	1.0
Fat (g)	67.6	71.4	28.5	17.2	259.4	67.5	71.3	28.4	17.2	259.7	45	3.4	0	0.0
Monounsaturated fat (g)	22.7	24.4	10.6	4.8	104.2	23.1	24.6	10.6	4.8	103.8	133	9.9	0	0.0
Polyunsaturated fat (g)	12.2	13.6	6.2	2.6	42.5	11.5	12.9	5.9	2.5	39.4	224	16.7	11	0.8
Saturated fat (g)	25.2	27.2	12.4	5.1	109.6	25.5	27.5	12.4	5.1	109.6	74	5.5	2	0.1
Calcium (mg)	978	995	298	242	2528	976	992	297	242	2534	46	3.4	1	0.1
Iron (mg)	11.7	11.9	3.9	3.1	67.8	11.1	11.4	3.5	3.1	55.3	280	20.9	44	3.3
Potassium (mg)	3788	3874	994	1284	12702	3744	3848	987	1280	12526	68	5.1	0	0.0

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4	Carotene (mcg)	3489	3731	1705	178	13796		3500	3736	1707	175	13796	11	0.8	0	0.0
5	Folate (mcg)	326	337	107	102	1311		318	329	105	97	1276	291	21.7	1	0.1
6	Vitamin C (mg)	124	133	63	4	809		122	132	62	4	809	34	2.5	0	0.0
7	Vitamin D (mcg)	3.07	3.49	1.89	0.22	12.06		3.02	3.46	1.89	0.29	12.46	248	18.5	9	0.7
8	Vitamin E (mg)	12.5	13.8	6.3	2.7	52.4		12.1	13.3	5.9	3.3	43.6	270	20.2	21	1.6
9																
10																
11	Alcoholic beverages (g)	21	61	104	0	1350		21	61	104	0	1350	0	0.0	0	0.0
12	Cereals & cereal products (g)	214	236	174	9	4948		212	234	174	9	4948	40	3.0	0	0.0
13	Eggs & egg dishes (g)	14	16	14	0	136		14	16	14	0	136	0	0.0	0	0.0
14	Fats & oils (g)	27	30	19	0	133		27	30	19	0	133	0	0.0	0	0.0
15	Fish & fish products (g)	32	39	26	0	187		32	39	26	0	187	0	0.0	0	0.0
16	Fruit (g)	238	277	199	0	2830		238	277	199	0	2830	0	0.0	0	0.0
17	Meat & meat products (g)	90	95	49	0	392		90	95	49	0	392	0	0.0	0	0.0
18	Milk & milk products (g)	381	410	174	0	959		381	410	174	0	959	0	0.0	0	0.0
19	Non-alcoholic beverages (g)	1148	1153	404	8	3215		1148	1153	404	8	3215	0	0.0	0	0.0
20	Nuts & seeds (g)	0	3	11	0	180		0	3	11	0	180	0	0.0	0	0.0
21	Potatoes (g)	116	113	61	0	785		116	113	61	0	785	0	0.0	0	0.0
22	Soups & sauces (g)	45	57	53	0	900		45	57	53	0	900	0	0.0	0	0.0
23	Sugars (g)	38	50	46	0	540		38	50	46	0	540	0	0.0	0	0.0
24	Vegetables (g)	265	288	140	2	1387		265	288	140	2	1387	0	0.0	0	0.0
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2 243 **DISCUSSION**

3 244 FETA provides a new, freely available, standalone tool that can produce nutrient and food group  
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5 245 intake values from data collected using the EPIC-Norfolk FFQ. It makes the EPIC-Norfolk FFQ  
6  
7 246 readily accessible to end-users and enables them to process and analyse nutritional data. The data  
8  
9 247 can either be entered into a spreadsheet, using the instructions provided, or by using the  
10  
11 248 specifically developed Microsoft Access form-based entry tool. The Access entry tool allows  
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13 249 easier entry without requiring knowledge of specific food codes. The software for FETA for  
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15 250 Windows and Linux can be downloaded from the website, as can the Microsoft Access data entry  
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17 251 utility (<http://www.srl.cam.ac.uk/epic/epicffq/>). Users are encouraged to register with EPIC-  
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19 252 Norfolk, as this enables them to request assistance and support. The various types of output (with  
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21 253 four levels of information) available should prove beneficial to researchers, especially those  
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23 254 requiring more detailed information. There is an on-going need for information on the intake of  
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25 255 food groups. While the data from either output 3 or 4 could be used to generate more detailed  
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27 256 food group data, we have treated food groups as another type of nutrient – a pseudo-nutrient. The  
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29 257 FETA input/look-up files can be easily modified to create new groups, greatly adding to the  
30  
31 258 flexibility of the system for analysing food group consumption, while requiring no spreadsheet or  
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33 259 programming skills on the part of the analyst. A helpful feature of FETA is the log file which  
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35 260 documents errors relating to FFQ data and/or default food codes assigned.  
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37 261 FETA was designed and based on the extensively validated EPIC-Norfolk FFQ, originally  
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39 262 developed in 1988, to assess the nutrient and food group intake of 40-79 year olds, who  
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41 263 completed the FFQ between 1993 and 1997. The food list and look-up lists of milks, breakfast  
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43 264 cereals and fats reflect this time period and the study population, as do the default milk, cereal,  
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45 265 baking fat and frying fat codes assigned. However, the program was created in such a way that it  
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47 266 can be customised for different study populations, easily enabled by the separation of the  
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49 267 processing algorithm in the FETA program implementation from the data model text files. It is  
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51 268 possible to delete/add foods and/or FFQ lines, and modify portion sizes as desired for a study.  
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2 269 Comparisons were carried out for a number of selected nutrients obtained from FETA and the  
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4 270 previously validated CAFÉ program. These showed that the nutrient output from both programs  
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6 271 were generally similar. All differences (>0.1%) found from the comparison of detailed  
7  
8 272 food/nutrient data at the individual level for 12 500 participants from FETA and the CAFÉ  
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10 273 program can be explained by one or more of the following reasons: up to four cereal foods  
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12 274 assigned by FETA, as compared to a maximum of two cereal foods assigned by CAFÉ;  
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14 275 differences in default baking and frying fat codes assigned; correction for muesli portion size in  
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16 276 cereal data; exclusion of porridge from cereal data (free text); default codes assigned for milk,  
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18 277 cereals or fats to participants using FETA (where no food codes were assigned by CAFÉ  
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20 278 program); rounding error (only where percentage absolute differences were between 0.1 to 1%)  
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22 279 and changes made to the nutrient data of six of the nine new foods as well as to the default code  
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24 280 for milk. Although nutrient intakes as calculated by FETA and CAFÉ were similar, some  
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26 281 relatively small differences existed, but these and the quintile shift of men and women can be  
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28 282 explained. In FETA, a number of changes were made to the processing of breakfast cereals,  
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30 283 affecting carbohydrate, starch, Englyst fibre, iron and folate estimates. The vitamin C content per  
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32 284 100g of low calorie/diet fizzy drinks was changed from 5 to 0 mg and the vitamin E content of  
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34 285 crunchy oat cereal and oil and fat non-specific was increased. Changes made to the processing of  
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36 286 fats in Questions 6 and 7 in Part 2 of the FFQ, in addition to changes made to the fatty acid  
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38 287 profile of the three new fats, could help explain the small differences observed in  
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40 288 monounsaturated, polyunsaturated and saturated fat intakes.  
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42 289 There was quite a large range in intake in the fourteen food groups, with a minimum intake of  
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44 290 zero for each of the food groups. It is difficult to compare food group intake data as the groupings  
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46 291 of foods often varies. However, the combined mean intake of fruit (excluding juices) and  
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48 292 vegetables for men and women was 467g and 562g respectively, achieving the Government's  
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50 293 'Five a day' recommendation(23), using a portion size of 80 g.  
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2 294 Whilst text matching only affected one food group (cereals and cereal products), more than 15%  
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4 295 of men and women changed quintile for a number of nutrients: Englyst fibre, polyunsaturated fat,  
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6 296 folate, vitamin D and vitamin E, and iron (women only). Yet again, these nutrients related to the  
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8 297 text matching of breakfast cereals and baking and frying fats. The inclusion of these data  
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10 298 illustrates the effect of text matching on the ranking of individuals for certain nutrients and will  
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12 299 enable future researchers using FETA to make informed decisions on the benefit of text matching  
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14 300 for their study.

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17 301 We have not addressed or discussed common FFQ issues, such as the number of items in a food  
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19 302 list or the use of a single average portion size, as these are not the focus of this paper and have  
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21 303 been reviewed previously (24,25).

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23 304 It is anticipated that future updates of FETA might contain a number of improvements and  
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25 305 overcome some of the limitations of FETA, currently released as version 2.53 for Windows and  
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27 306 Linux (last updated 15/03/2013 and 21/02/2013 respectively). The source code has been made  
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29 307 available online which enables users to make modifications and improvements to the program.  
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31 308 Currently, we have made available Windows and Linux versions and it is hoped that an OS X  
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33 309 version will follow soon. We are currently working on a Libreoffice version of the Microsoft  
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35 310 Access form-based entry tool.

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37  
38 311 In conclusion, we have created a new, open source, standalone, cross-platform FFQ processing  
39  
40 312 tool, FETA, to produce nutrient and food group data for researchers using the EPIC-Norfolk  
41  
42 313 FFQ. The tool produces similar nutrient and food group values to the previously validated CAFÉ  
43  
44 314 program, but is more accessible. Although FETA was designed and based on the EPIC-Norfolk  
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46 315 FFQ, the program was created in such a way that it can be customised for different study  
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48 316 populations. It is anticipated that the development and availability of FETA will be a useful  
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50 317 addition to the field of nutritional epidemiology and dietary public health.  
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### 12 325 **Contributors**

13  
14 326 AAM contributed to the software development, assisted in statistical analyses and drafted the  
15  
16  
17 327 manuscript. AB and RL contributed to the software development, assisted in statistical analyses  
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19 328 and contributed to the manuscript. DJP-S wrote the step-based graphical wizard for running  
20  
21 329 FETA and contributed to the manuscript. NGF, LO'C and K-TK (Principal Investigator of EPIC-  
22  
23 330 Norfolk) contributed to the manuscript. APK created the Microsoft Access form-based entry tool  
24  
25 331 and contributed to the manuscript. All authors approved the final manuscript.

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37  
38 337 **Competing interests** None.

39  
40 338 **Ethics approval** Norwich Local Research Ethics Committee.

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FOODS AND AMOUNTS	AVERAGE USE LAST YEAR								
	Never or less than once/month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
<b>BREAD AND SAVOURY BISCUITS</b> (one slice or biscuit)									
White bread and rolls						√			
Brown bread and rolls				√					
Wholemeal bread and rolls	√								
Cream crackers, cheese biscuits		√							
Crispbread, eg. Ryvita		√							
<b>CEREALS</b> (one bowl)									
Porridge, Readybrek				√					
Breakfast cereal such as cornflakes, muesli etc.					√				

**Figure 1. Part 1 (main part) of the EPIC-Norfolk FFQ, illustrating bread, savoury biscuits and breakfast cereals**

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3. What type of milk did you most often use?  
**Select one only** Full cream, silver  Semi-skimmed, red/white   
 Skimmed/blue  Channel Islands, gold   
 Dried milk  Soya   
 Other, specify  None

4. How much milk did you drink each day, including milk with tea, coffee, cereals etc?  
 None  Three quarters of a pint   
 Quarter of a pint  One pint   
 Half a pint  More than one pint

5. Did you usually eat breakfast cereal (excluding porridge and Ready Brek mentioned earlier)?  
 Yes  No

**If yes, which brand and type of breakfast cereal, including muesli, did you usually eat?**  
**List the one or two types most often used**  
 Brand *e.g. Kellogg's*  Type *e.g. cornflakes*

6. What kind of fat did you most often use for frying, roasting, grilling etc?  
**Select one only** Butter  Solid vegetable fat   
 Lard/dripping  Margarine   
 Vegetable oil  None   
**If you used vegetable oil**, please give type eg. corn, sunflower

7. What kind of fat did you most often use for baking cakes etc?  
**Select one only** Butter  Solid vegetable fat   
 Lard/dripping  Margarine   
 Vegetable oil  None   
**If you used margarine**, please give name or type eg. Flora, Stork

10. What did you do with the visible fat on your meat?  
 Ate most of the fat  Ate as little as possible   
 Ate some of the fat  Did not eat meat

Figure 2. Questions from part 2 of the EPIC-Norfolk FFQ, used by FETA

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4 1 Appendix 1 Extract from a sample log file produced during the processing of 10 ids, using output 1.  
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6 2 2013-01-29 11:54 am: Note : Starting database setup  
7  
8 3 2013-01-29 11:54 am: Note : Loading imports for 'foods' completed  
9  
10 4 2013-01-29 11:54 am: Note : Loading imports for 'meals' completed  
11  
12 5 2013-01-29 11:54 am: Note : Loading imports for 'nutrients' completed  
13  
14 6 2013-01-29 11:54 am: Note : Loading imports for 'food\_nutrients' completed  
15  
16 7 2013-01-29 11:54 am: Note : Loading imports for 'meal\_foods' completed  
17  
18 8 2013-01-29 11:54 am: Note : Loading imports for 'weights' completed  
19  
20 9 2013-01-29 11:54 am: Note : Loading imports for 'portions' completed  
21  
22 10 2013-01-29 11:54 am: Note : Loading imports for 'frequencies' completed  
23  
24 11 2013-01-29 11:54 am: Note : Loading imports for 'cereals' completed  
25  
26 12 2013-01-29 11:54 am: Note : Loading imports for 'milks' completed  
27  
28 13 2013-01-29 11:54 am: Note : Completed database setup  
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33 15 2013-01-29 11:54 am: Error: Respondent: 001A supplied invalid frequency: -9 for meal: BURGER  
34  
35 16 2013-01-29 11:54 am: Error: Respondent: 001A supplied invalid frequency: -9 for meal: LIVER  
36  
37 17 2013-01-29 11:54 am: Error: Respondent: 003C supplied no baking fat food\_codes  
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4 18 2013-01-29 11:54 am: Note : Respondent: 003C using default baking fat code: 17018  
5  
6 19 2013-01-29 11:54 am: Error: Respondent: 004D supplied invalid frequency: -9 for meal: FRUIT\_SQUASH  
7  
8 20 2013-01-29 11:54 am: Error: Respondent: 005E supplied invalid frequency: -9 for meal: CHICKEN  
9  
10 21 2013-01-29 11:54 am: Error: Respondent: 005E supplied no frying fat food\_codes  
11  
12 22 2013-01-29 11:54 am: Note : Respondent: 005E using default frying fat code: 17046  
13  
14 23 2013-01-29 11:54 am: Error: Respondent: 008H supplied invalid frequency: -9 for meal: INSTANT\_COFFEE  
15  
16 24 2013-01-29 11:54 am: Error: Respondent: 008H supplied no baking fat food\_codes  
17  
18 25 2013-01-29 11:54 am: Note : Respondent: 008H using default baking fat code: 17018  
19  
20 26 2013-01-29 11:54 am: Error: Respondent: 009J supplied invalid frequency: -9 for meal: DAIRY\_DESSERT  
21  
22 27 2013-01-29 11:54 am: Error: Respondent: 009J supplied invalid frequency: -4 for meal: EGGS  
23  
24 28 2013-01-29 11:54 am: Error: Respondent: 009J supplied invalid frequency: -9 for meal: LOWCAL\_SALAD\_CREAM  
25  
26 29 2013-01-29 11:54 am: Error: Respondent: 009J supplied invalid frequency: -9 for meal: PLAIN\_BISCUIT  
27  
28 30 2013-01-29 11:54 am: Error: Respondent: 009J supplied invalid frequency: -9 for meal: INSTANT\_COFFEE  
29  
30 31 2013-01-29 11:54 am: Error: Respondent: 009J supplied invalid frequency: -9 for meal: COFFEE\_WHITENER  
31  
32 32 2013-01-29 11:54 am: Error: Respondent: 009J supplied invalid frequency: -9 for meal: SPINACH  
33  
34 33 2013-01-29 11:54 am: Error: Respondent: 009J supplied no visible fat weighting  
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36 34 2013-01-29 11:54 am: Note : Respondent: 009J using default weighting: 1  
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4 35 2013-01-29 11:54 am: Error: Respondent: 010K supplied no visible fat weighting  
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7 36 2013-01-29 11:54 am: Note : Respondent: 010K using default weighting: 1  
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9 37 2013-01-29 11:54 am: Note : Processing completed for Respondent: 001A  
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11 38 2013-01-29 11:54 am: Note : Processing completed for Respondent: 002B  
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13 39 2013-01-29 11:54 am: Note : Processing completed for Respondent: 003C  
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18 41 2013-01-29 11:54 am: Note : Processing completed for Respondent: 005E  
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20 42 2013-01-29 11:54 am: Note : Processing completed for Respondent: 006F  
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22 43 2013-01-29 11:54 am: Note : Processing completed for Respondent: 007G  
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24 44 2013-01-29 11:54 am: Note : Processing completed for Respondent: 008H  
25  
26 45 2013-01-29 11:54 am: Note : Processing completed for Respondent: 009J  
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29 46 2013-01-29 11:54 am: Note : Processing completed for Respondent: 010K  
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31 47 2013-01-29 11:54 am: Note : Questionnaire: sample\_input\_290113.csv processing completed successfully, processed(10) respondents  
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**A new tool for converting food frequency questionnaire data into nutrient and food group values: FETA research methods and availability**

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Keywords:	PUBLIC HEALTH, EPIDEMIOLOGY, Nutrient intakes, food frequency questionnaire

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3 A new tool for converting food frequency questionnaire data into nutrient and food group values:  
4 FETA research methods and availability

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21 Running title: FETA: new processing tool for FFQs

22  
23 **Key words:** food frequency questionnaire, nutritional output, processing tool, EPIC-Norfolk

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29  
30 **Abbreviations:** FFQ, food frequency questionnaire; EPIC, European Prospective Investigation into  
31 Cancer and Nutrition; FETA, FFQ EPIC Tool for Analysis; CAFÉ, Compositional Analyses from  
32 Frequency Estimates

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34 Word count: 3 380

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## 35 ABSTRACT

### 36 Objectives

37 To describe the research methods for the development of a new open source, cross-platform tool  
38 which processes data from the European Prospective Investigation into Cancer and Nutrition  
39 Norfolk Food Frequency Questionnaire (EPIC-Norfolk FFQ). A further aim was to compare  
40 nutrient and food group values derived from the current tool (FETA; FFQ EPIC Tool for Analysis)  
41 with the previously validated but less accessible tool, CAFÉ (Compositional Analyses from  
42 Frequency Estimates). The effect of text matching on intake data was also investigated.

### 43 Design

44 Cross-sectional analysis of a prospective cohort study – EPIC-Norfolk.

### 45 Setting

46 East England population (city of Norwich and its surrounding small towns and rural areas).

### 47 Participants

48 Complete FFQ data from 11 250 men and 13 602 women (mean age 59 years; range 40 – 79 years).

### 49 Outcome measures

50 Nutrient and food group intakes derived from FETA and CAFÉ analyses of EPIC-Norfolk FFQ  
51 data.

### 52 Results

53 Nutrient outputs from FETA and CAFÉ were similar; mean (SD) energy intake from FETA was  
54 9222 kJ (2633) in men, 8113 kJ (2296) in women, compared to CAFÉ intakes of 9175 kJ (2630) in  
55 men, 8091 kJ (2298) in women. The majority of differences resulted in one or less quintile change  
56 (98.7%). Only mean daily fruit and vegetable food group intakes were higher in women than in men  
57 (278 v 212 g and 284 v 255 g respectively). Quintile changes were evident for all nutrients, with the  
58 exception of alcohol, when text matching was not executed; however, only the cereals food group  
59 was affected.

### 60 Conclusions

1  
2 61 FETA produces similar nutrient and food group values to the previously validated CAFÉ but has  
3  
4 62 the advantages of being open source, cross-platform and complete with a data-entry form directly  
5  
6 63 compatible with the software. The tool will facilitate research using the EPIC-Norfolk FFQ, and  
7  
8 64 can be customised for different study populations.  
9

#### 10 65 **Strengths and limitations of this study**

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13 66 • FETA has been tested using a large study sample of food intake data.
- 14  
15 67 • No independent reference method used in the comparisons of FETA and CAFÉ nutrient
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17 68 intake data although the CAFÉ system has been previously validated.
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## 22 70 **INTRODUCTION**

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25 71 Food Frequency Questionnaires (FFQs) are commonly used in epidemiological studies to assess the  
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27 72 dietary intake of large populations. Their popularity derives from ease of administration, ability to  
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29 73 assess dietary intake over a defined period of time, and low costs (1). The European Prospective  
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31 74 Investigation into Cancer and Nutrition (EPIC)-Norfolk FFQ is semi-quantitative and designed to  
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33 75 record the average intake of foods during the previous year. The principles involved in data  
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35 76 collection and processing of the EPIC-Norfolk FFQ and the development of the structure and  
36  
37 77 content of the CAFÉ program for calculating nutrient intakes have been published previously (2).  
38  
39 78 The EPIC-Norfolk FFQ has been extensively validated and has been widely used (3);(4);(5).  
40  
41 79 However, the programs used to process these FFQs, including CAFÉ, have not been easily  
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43 80 accessible to end-users.  
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47 81 Our objectives were to develop a new, open source, cross-platform processing tool (FETA - FFQ  
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49 82 EPIC Tool for Analysis) based on and building upon the earlier system, CAFÉ (2). The aim of this  
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51 83 report was to describe the research methods of the development of FETA, and to compare nutrient  
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53 84 output from the FETA and CAFÉ programs. Food group intake data from FETA has also been  
54  
55 85 described as has the effect of free text matching on nutrient and food group intake data. Free text  
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2 86 matching refers to the assigning of an appropriate food code to hand-written text in the FFQ and  
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4 87 will be further described in the methods section.  
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## 89 **METHODS**

### 90 **EPIC-FFQ design**

91 The questionnaire consists of two parts. Part 1 consists of a food list of 130 lines; each line has a  
92 portion size attached to it: medium serving, standard unit or household measure. Study participants  
93 were requested to select an appropriate frequency of consumption for each line, from the nine  
94 frequency categories. As an example, Figure 1 illustrates the sections relating to bread, savoury  
95 biscuits and breakfast cereals. A pdf copy of the EPIC-Norfolk FFQ may be downloaded from  
96 <http://www.srl.cam.ac.uk/epic/epicffq/websitedocumentation.html>; information on how to complete  
97 and code the FFQ is also available here. The questionnaire lines are either individual foods,  
98 combinations of individual foods or food types. The FFQ food list is based on items from an FFQ  
99 widely used within the USA (6);(7), but modified to reflect differences in American versus UK  
100 brand names and some further food items were added.

101 Part 2 contains further questions, a number of which ask for more detailed information that link  
102 back to food lines in part one, as illustrated in Figure 2. Detailed information was requested for  
103 breakfast cereals and fats as these are nutritionally important foods in the UK diet.

### 104 **Data collection**

105 The EPIC-Norfolk FFQ was posted to 25 639 participants in the EPIC-Norfolk cohort study (8).  
106 The participants were aged 40-79 years and the questionnaire was completed between 1993 and  
107 1997. The study was approved by the Norfolk Local Research Ethics Committee, adhered to the  
108 Declaration of Helsinki and all participants gave written informed consent. The FFQ was returned  
109 at a health examination, where it was checked and completed, if required, by trained nursing staff.  
110 In total, 25 351 (99%) participants returned the completed questionnaire.

### 111 **Comparison of FETA and CAFÉ programs**

1  
2 112 FETA uses a csv (comma-separated values) input file. Part 1 is coded as numeric values and Part 2  
3  
4 113 is coded as numeric values and food codes, using the flow-charts and look-up lists provided  
5  
6 114 (<http://www.srl.cam.ac.uk/epic/epicffq/>). We have also created a Microsoft Access form-based  
7  
8 115 entry tool to facilitate FFQ data entry, based on the EPIC-Norfolk FFQ. The tool exports data in a  
9  
10 116 format directly compatible with FETA. The FETA software was written in C and C++ languages,  
11  
12 117 enabling faster processing times than SAS and the C/C++ software can also be used from the  
13  
14 118 command line. The step-based graphical wizard for running FETA was written in Perl. Whereas in  
15  
16 119 the CAFÉ program, an Oracle (Oracle Corporation, Redwood Shores, CA, USA) -based entry  
17  
18 120 system was created to enter Part 1 frequency data as numeric codes and Part 2 data as numeric  
19  
20 121 codes and free text. CAFÉ was written using SAS (SAS Software, Version 8 of the SAS System for  
21  
22 122 Unix, SAS Institute Inc., Cary, NC, USA) and links to tables in an Oracle relational database.

### 23 24 25 26 123 **Part 1- data entry**

27  
28 124 Data were manually entered into a spreadsheet as numeric codes, using '1' for 'never or less than  
29  
30 125 once a month', to '9' for '6+ times per day'. A code of '-9' was used to mark data where a  
31  
32 126 frequency was not recorded. Where two frequencies were provided for a line, this was coded as '-4'  
33  
34 127 and treated by both CAFÉ and FETA programs as missing data. However, in FETA, both  
35  
36 128 frequencies may now be entered, separated by a semi-colon, e.g. '2;3', and FETA will process the  
37  
38 129 first value.

### 39 40 41 42 130 **Part 2 – assigning of food codes to ticked boxes and free text**

43  
44 131 Part 2 contains hand-written text for milk, breakfast cereals and cooking fats (see Figure 2,  
45  
46 132 questions 3, 5, 6 and 7 respectively), which needs to be matched to the most appropriate food code  
47  
48 133 in order to obtain nutrient data; this process is known as free text matching. The data in part 2 were  
49  
50 134 coded using reference lists of food codes for varieties of milk, breakfast cereal and cooking fat.  
51  
52 135 Where there is no clear match, it is suggested that a researcher consults the ingredients and nutrient  
53  
54 136 information of the commercial item and compares this information with the nutrient profile of  
55  
56 137 similar items from the reference lists. These reference lists and figures relating to food codes that  
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1  
2 138 may be assigned to appropriate ticked boxes may be found at

3  
4 139 <http://www.srl.cam.ac.uk/epic/epicffq/websitedocumentation.html>

5  
6 140 Differences between FETA versus CAFÉ processing may also be found at

7  
8 141 <http://www.srl.cam.ac.uk/epic/epicffq/websitedocumentation.html>; these differences relate to

9  
10 142 breakfast cereals, frying and baking fats, the outcome of selecting the ‘None’ or ‘No’ box, and

11  
12 143 default milk, cereal, and fat codes.

#### 13 14 144 **Databases**

15  
16 145 Each line in Part 1 of the FFQ is mapped to up to six food codes. Decisions regarding which food

17  
18 146 codes to use were based on data from UK government surveys and other UK population data (7);

19  
20 147 (7,9,10). These decisions were based on data for individuals aged 40-74 years (7). Data for portion

21  
22 148 weights were sourced from UK population data and weighed records in 40-74 year old study

23  
24 149 participants (7,11).

25  
26 150 The EPIC-Norfolk FFQ uses 290 foods from the UK food composition database, McCance and

27  
28 151 Widdowson’s “The Composition of Foods” (5<sup>th</sup> edition) and its associated supplements (12–21). A

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30 152 number of new food items were added to the EPIC-Norfolk FFQ food list, which are used in both

31  
32 153 the FETA and CAFÉ programs. These include low calorie/diet fizzy drinks and crunchy oat cereal,

33  
34 154 as well as modified home-baked and fried foods (without their fat), to enable an individual’s fat

35  
36 155 type, as recorded in Part 2 of the FFQ, to be incorporated. However, the nutrient data of six of the

37  
38 156 nine new foods used in the CAFÉ program were modified in FETA. These foods include crunchy

39  
40 157 oat cereal, milk non-specific, low calorie/diet fizzy drinks, solid vegetable oil, Crisp ‘n Dry (solid

41  
42 158 fat), and oil and fat non-specific. Modifications to the nutrient data were made to ensure a more

43  
44 159 accurate nutrient profile and/or to better reflect the foods consumed, in the case of non-specific

45  
46 160 items, such as milk and oil/fat; these changes relate to nutrient/food data at the time of FFQ

47  
48 161 completion

#### 49 50 162 **Identification of outliers**

1  
2 163 Outliers were defined, as detailed previously (2). In brief, the ratio of energy intake (EI) to basal  
3  
4 164 metabolic rate (BMR) was calculated, where BMR was calculated using sex-specific Schofield  
5  
6 165 equations, which included age and body weight (22). Individuals in the top and bottom 0.5% of EI:  
7  
8 166 BMR ratio were identified and excluded, as were individuals with FFQs containing 10 or more  
9  
10 167 missing lines of data in Part 1 of the FFQ.

### 168 **Nutrient and food group outputs**

169 FETA produces four nutrient output formats and a sample of each of these can be viewed at  
170 <http://www.srl.cam.ac.uk/epic/epicffq/websitedocumentation.html>  
171 Output 1 contains average daily nutrient and food group intakes for an individual from all FFQ  
172 foods consumed, in wide format, suitable for import into a spreadsheet or statistical package. Intake  
173 data for 46 nutrients are provided as well as data for 14 basic food groups, however only a selection  
174 of these nutrients is shown in this report. Output 2 contains the same nutrient intake data as output  
175 1, but in long format, which is mostly suitable for programmers. Output 3 contains average daily  
176 nutrient and food group intakes (and amount of food consumed) for an individual for each FFQ line;  
177 this output file will be very large and is mostly suitable for programmers. The most detailed output  
178 (output 4) contains average daily nutrient and food group intakes, in addition to the amount of food  
179 consumed for an individual, for each food code, for each FFQ line (meal\_id). An online description  
180 of each meal\_id and nutrient code, including units of measurement, can be found in the data entry  
181 template. This output will also be very large and is mostly suitable for programmers.  
182 A log file is created along with each output file, which records the processing of the data and  
183 provides useful error information (see Appendix 1 for log file of output 1). In these files, both notes  
184 (general process information) and error messages are recorded, with a date and time stamp. The log  
185 files make it possible to calculate the number of missing frequencies based on Part 1 (main grid) of  
186 the FFQ in order to exclude individuals with 10 or more missing ticks. The log files also record  
187 situations where a food code does not have any nutrient data attached to it.

### 188 **Statistical analyses**

189 The data were analysed using STATA 10 (STATA Corp., Texas, USA). Intake data were described  
190 using mean, standard deviation (SD), median, minimum and maximum for both FETA and CAFÉ  
191 program outputs, stratified by sex. The nutrients selected for comparison are those described in the  
192 original CAFÉ paper. Where data on quintile changes are shown, cut-off points were calculated  
193 using CAFÉ nutrient data in order to compare quintile shift between FETA and CAFÉ output data.

194

## 195 **RESULTS**

196 We received FFQs from 25 351 participants (11 451 men and 13 900 women), with a mean age of  
197 59 years. From this set, 249 FFQs (90 men and 159 women) containing 10 or more missing lines of  
198 data in Part 1 of the FFQ were excluded, followed by a further exclusion of 250 FFQs (111 men and  
199 139 women) from the top and bottom 0.5% of EI:BMR. This resulted in the final analytical dataset  
200 of 24 852 participants (11 250 men and 13 602 women).

### 201 **Nutrient intake data from FETA and CAFÉ programs**

202 Table 1 shows the average daily intake data for a number of selected nutrients for 11 250 men. The  
203 data were similar for most nutrients across the two programs. The nutrients which had the highest  
204 percentage of quintile change ( $\geq 10\%$ ) were monounsaturated fat, saturated fat, iron, vitamin D &  
205 vitamin E. However, only 1.3% of the men changed more than one quintile, for two of these five  
206 nutrients. The nutrients which had the lowest percentage of quintile changes were alcohol, calcium  
207 and carotene, with less than 3% change (Table 1).

208 Table 2 shows average daily intake data for the selected nutrients for 13 602 women, from FETA  
209 and CAFÉ programs. There were similar quintile changes observed in women to those found in men  
210 for the selected nutrients; four of the nineteen nutrients had a quintile change of greater than 10%:  
211 polyunsaturated fat, saturated fat, iron and Vitamin E. However, the number of women who shifted  
212 more than one quintile was generally lower than the number observed in men. The nutrients which  
213 had the greatest percentage of women who changed more than one quintile were vitamins D and E,  
214 with 0.7 and 0.9% respectively.



1  
2 215 Detailed (output 4) nutrient intake data at the individual level obtained from the two programs were  
3  
4 216 compared for approximately half of the participants (n=12 500; data not shown). All differences (>  
5  
6 217 0.1%) found were investigated and explanations for these differences are considered in the  
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8 218 discussion.  
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Table 1 Average daily nutrient intakes for men (N=11 250) participating in the EPIC-Norfolk study, from the FETA and CAFÉ programs, after the exclusion of outliers, with numbers and percentages of men who moved quintile

Nutrient	FETA program					CAFÉ program					Quintile			
	Median	Mean	SD	Mini mum	Maxi mum	Median	Mean	SD	Mini mum	Maxi mum	Quintile change		change > 1	
											N	%	N	%
Energy (kcal)	2126	2190	627	748	5085	2115	2179	626	748	5101	892	7.9	0	0.0
Energy (kJ)	8947	9222	2633	3124	21394	8900	9175	2630	3124	21440	891	7.9	0	0.0
Protein (g)	83.4	85.2	22.0	23.3	319.8	83.2	84.9	22.0	23.3	318.4	464	4.1	0	0.0
Alcohol (g)	6.7	12.3	16.1	0.0	134.2	6.7	12.3	16.1	0.0	134.2	0	0.0	0	0.0
Carbohydrate (g)	261	271	87	48	737	259	269	87	48	729	726	6.5	0	0.0
Starch (g)	123	128	45	10	504	122	127	45	10	501	813	7.2	1	0.0
Englyst fibre (g)	17.5	18.2	6.4	1.3	89.9	17.3	18.0	6.4	1.3	89.9	743	6.6	1	0.0
Fat (g)	78.9	83.2	31.3	13.4	260.6	78.7	83.0	31.3	13.4	260.6	1049	9.3	8	0.1
Monounsaturated fat (g)	27.0	28.8	11.6	4.8	101.2	26.8	28.5	11.5	4.8	105.1	1264	11.2	21	0.2
Polyunsaturated fat (g)	13.5	15.0	6.9	1.6	66.6	13.7	15.3	7.1	1.6	69.5	1074	9.5	24	0.2
Saturated fat (g)	30.1	32.3	13.6	3.0	110.6	29.8	31.9	13.5	3.0	106.7	1288	11.5	20	0.2
Calcium (mg)	1021	1039	301	189	2848	1018	1037	300	189	2849	296	2.6	1	0.0
Iron (mg)	12.1	12.4	3.6	2.6	38.7	11.9	12.3	3.5	2.5	38.5	1149	10.2	7	0.1
Potassium (mg)	3814	3881	911	1305	11718	3802	3869	909	1284	11718	411	3.7	0	0.0

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Carotene (mcg)	3188	3321	1573	147	25720	3178	3309	1571	147	25720	156	1.4	0	0.0
Folate (mcg)	320	331	97	77	1547	316	327	96	77	1547	836	7.4	3	0.0
Vitamin C (mg)	103	111	52	10	669	105	113	52	10	669	411	3.7	14	0.1
Vitamin D (mcg)	3.16	3.65	2.08	0.03	27.08	3.13	3.62	2.06	0.03	27.12	1161	10.3	145	1.3
Vitamin E (mg)	13.2	14.9	7.2	2.1	62.3	12.9	14.4	6.8	2.1	62.0	1545	13.7	146	1.3

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Table 2 Average daily nutrient intakes for women (N=13 602) participating in the EPIC-Norfolk study, from the FETA and CAFÉ programs, after the exclusion of outliers, with numbers and percentages of women who moved quintile

Nutrient	FETA program					CAFÉ program					Quintile change		Quintile change > 1	
	Median	Mean	SD	Mini mum	Maxi mum	Median	Mean	SD	Mini mum	Maxi mum	N	%	N	%
	Energy (kcal)	1859	1925	546	538	4733	1853	1920	547	518	4643	1030	7.6	0
Energy (kJ)	7833	8113	2296	2261	19910	7811	8091	2298	2179	19537	1018	7.5	0	0.0
Protein (g)	79.8	81.5	21.1	23.0	246.0	79.6	81.3	21.0	22.7	246.1	495	3.6	1	0.0
Alcohol (g)	2.0	5.6	8.4	0.0	99.5	2.0	5.6	8.4	0.0	99.5	0	0.0	0	0.0
Carbohydrate (g)	237	247	77	59	766	235	245	77	58	766	974	7.2	1	0.0
Starch (g)	107	112	39	13	405	106	111	39	13	406	1142	8.4	1	0.0
Englyst fibre (g)	18.2	19.0	6.8	2.3	118.5	18.0	18.8	6.7	2.4	118.6	850	6.2	1	0.0
Fat (g)	67.0	70.8	27.1	11.7	221.0	67.2	71.2	27.3	11.6	217.2	1194	8.8	4	0.0
Monounsaturated fat (g)	22.5	24.1	9.9	3.8	100.3	22.5	24.1	9.9	3.5	100.6	1338	9.8	7	0.1
Polyunsaturated fat (g)	12.2	13.5	6.2	2.0	53.6	12.5	13.8	6.3	2.0	53.6	1434	10.5	23	0.2
Saturated fat (g)	25.0	27.0	11.7	3.6	102.3	25.0	26.9	11.7	3.7	99.3	1443	10.6	9	0.1
Calcium (mg)	971	992	290	128	3159	969	990	290	127	3159	390	2.9	4	0.0
Iron (mg)	11.5	11.8	3.6	1.7	66.1	11.3	11.7	3.5	1.8	65.7	1496	11.0	12	0.1
Potassium (mg)	3781	3861	942	1150	16568	3769	3848	939	1147	16587	486	3.6	1	0.0
Carotene (mcg)	3477	3719	1917	67	61971	3469	3712	1917	64	61983	122	0.9	0	0.0

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Folate (mcg)	322	332	103	65	2039	317	328	101	65	2024	1025	7.5	5	0.0
Vitamin C (mg)	123	133	64	4	1006	125	135	64	4	1006	746	5.5	35	0.3
Vitamin D (mcg)	3.01	3.46	1.90	0.00	17.83	3.02	3.45	1.90	0.00	17.75	1119	8.2	90	0.7
Vitamin E (mg)	12.4	13.8	6.2	1.5	52.4	12.2	13.5	6.0	1.6	49.8	1863	13.7	123	0.9

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1  
2 223 **Food group intake data from FETA**  
3

4 224 Average daily intakes for both men and women of the fourteen food groups readily available from  
5  
6 225 FETA are shown in Table 3. Mean daily intakes of six of the food groups were higher in men than  
7  
8 226 in women: alcohol, cereals, fats, meat, potatoes and sugars. However, women had higher intakes of  
9  
10 227 fruit (278g v 212g) and vegetables (284g v 255g). Mean daily intakes of eggs, fish, milk, non-  
11  
12 228 alcoholic beverages, nuts and seeds, and soups and sauces were similar in both men and women.

13  
14  
15 229 **The effect of text matching in FETA**  
16

17 230 Tables 4 and 5 illustrate the variation in nutrient and food group intake data obtained in a random  
18  
19 231 subset of 1 159 men and 1 340 women, respectively, depending on whether text matching of milks,  
20  
21 232 breakfast cereals and baking and frying fats was applied. In general, mean nutrient intakes were  
22  
23 233 higher when text matching was carried out. In men, (Table 4), quintile changes (>15%) were most  
24  
25 234 evident in the following nutrients: Englyst fibre, polyunsaturated fat, folate, vitamin D and vitamin  
26  
27 235 E. The food group “cereals and cereal products” was the only one of the fourteen groups where  
28  
29 236 there was a difference, with 31 men moving 1 quintile.  
30  
31  
32 237 In women, (Table 5), quintile changes (>15%) were also most evident in the same five nutrients.  
33  
34 238 However, almost 21% of women also changed quintile for iron. Once again, the “cereals and cereal  
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36 239 products” food group was the only food group where there was any difference, with 40 women  
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39 240 moving 1 quintile.  
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Table 3 Average daily food group intakes for men (N=11 250) and women (N=13 602) participating in the EPIC-Norfolk study, from the FETA program

Food group	Men					Women				
	Median	Mean	SD	Mini mum	Maxi mum	Median	Mean	SD	Mini mum	Maxi mum
Alcoholic beverages (g)	101	204	315	0	2483	23	64	109	0	1728
Cereals & cereal products (g)	242	260	127	0	1456	215	231	110	0	1172
Eggs & egg dishes (g)	18	17	15	0	225	14	16	14	0	236
Fats & oils (g)	31	36	22	0	207	27	30	20	0	218
Fish & fish products (g)	32	37	26	0	362	32	38	26	0	309
Fruit (g)	179	212	164	0	2654	238	278	201	0	3742
Meat & meat products (g)	99	106	54	0	856	91	94	48	0	606
Milk & milk products (g)	407	420	182	0	1303	386	410	175	0	1560
Non-alcoholic beverages (g)	1157	1177	396	0	3707	1150	1165	403	0	4501
Nuts & seeds (g)	0	3	9	0	228	0	3	9	0	188
Potatoes (g)	125	122	69	0	1007	116	112	64	0	1506
Soups & sauces (g)	43	58	54	0	1004	43	57	53	0	1376
Sugars (g)	53	64	50	0	572	37	48	42	0	541
Vegetables (g)	236	255	123	0	2398	262	284	143	0	3539

Table 4 Comparison of average daily nutrient and food group intakes for men (N=1 159) participating in the EPIC-Norfolk study, from the FETA program, with and without the application of text matching

Nutrient/Food group	FETA program, with text matching					FETA program, without text matching					Quintile			
	Median	Mean	SD	Mini mum	Maxi mum	Median	Mean	SD	Mini mum	Maxi mum	Quintile change		change > 1	
											N	%	N	%
Energy (kcal)	2095	2176	678	658	7766	2091	2170	678	658	7787	28	2.4	0	0.0
Energy (kJ)	8822	9161	2848	2780	32555	8804	9138	2850	2780	32647	26	2.2	0	0.0
Protein (g)	82.8	85.0	22.8	22.1	272.3	82.5	84.7	22.8	22.1	272.3	34	2.9	0	0.0
Alcohol (g)	7.2	12.3	16.1	0.0	112.9	7.2	12.3	16.1	0.0	112.9	0	0.0	0	0.0
Carbohydrate (g)	261	270	93	63	1006	259	269	93	63	1003	48	4.1	0	0.0
Starch (g)	120	127	49	7	643	121	126	48	7	636	65	5.6	0	0.0
Englyst fibre (g)	17.5	18.3	6.6	3.6	71.8	17.3	17.9	6.3	3.6	64.5	198	17.1	10	0.9
Fat (g)	77.8	82.1	33.1	12.8	387.8	77.3	82.1	33.1	12.8	389.3	32	2.8	0	0.0
Monounsaturated fat (g)	26.5	28.2	12.2	3.5	131.1	26.7	28.7	12.5	3.7	138.7	88	7.6	0	0.0
Polyunsaturated fat (g)	13.5	14.9	7.3	3.0	67.0	12.7	14.1	6.8	3.0	60.7	179	15.4	17	1.5
Saturated fat (g)	30.1	31.8	14.1	3.3	160.0	30.3	32.2	14.3	3.3	160.3	72	6.2	1	0.1
Calcium (mg)	1015	1044	312	242	2848	1012	1044	313	242	2861	42	3.6	0	0.0
Iron (mg)	11.9	12.5	3.8	2.6	37.9	11.7	12.0	3.5	2.6	38.1	173	14.9	16	1.4
Potassium (mg)	3824	3889	957	1353	12675	3812	3873	951	1353	12551	52	4.5	0	0.0



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Carotene (mcg)	3150	3348	1671	507	18295	3162	3353	1672	507	18338	6	0.5	0	0.0
Folate (mcg)	325	333	103	94	1222	316	326	101	94	1262	226	19.5	2	0.2
Vitamin C (mg)	105	113	55	17	619	104	112	55	17	619	22	1.9	0	0.0
Vitamin D (mcg)	3.08	3.64	2.17	0.03	16.40	3.06	3.64	2.19	0.03	20.52	227	19.6	8	0.7
Vitamin E (mg)	13.3	15.0	7.6	2.7	74.7	13.0	14.5	7.1	2.7	71.2	238	20.5	30	2.6
Alcoholic beverages (g)	104	201	301	0	1866	104	201	301	0	1866	0	0.0	0	0.0
Cereals & cereal products (g)	240	257	131	0	1378	238	255	130	0	1378	31	2.7	0	0.0
Eggs & egg dishes (g)	18	17	17	0	225	18	17	17	0	225	0	0.0	0	0.0
Fats & oils (g)	31	36	25	0	313	31	36	25	0	313	0	0.0	0	0.0
Fish & fish products (g)	32	37	25	0	153	32	37	25	0	153	0	0.0	0	0.0
Fruit (g)	184	216	158	0	1037	184	216	158	0	1037	0	0.0	0	0.0
Meat & meat products (g)	98	104	52	0	690	98	104	52	0	690	0	0.0	0	0.0
Milk & milk products (g)	414	428	187	0	1302	414	428	187	0	1302	0	0.0	0	0.0
Non-alcoholic beverages (g)	1159	1191	397	22	3677	1159	1191	397	22	3677	0	0.0	0	0.0
Nuts & seeds (g)	0	3	8	0	135	0	3	8	0	135	0	0.0	0	0.0
Potatoes (g)	125	121	78	0	1518	125	121	78	0	1518	0	0.0	0	0.0
Soups & sauces (g)	43	56	51	0	556	43	56	51	0	556	0	0.0	0	0.0
Sugars (g)	51	63	50	0	358	51	63	50	0	358	0	0.0	0	0.0
Vegetables (g)	238	256	128	15	1047	238	256	128	15	1047	0	0.0	0	0.0

Table 5 Comparison of average daily nutrient and food group intakes for women (N=1 340) participating in the EPIC-Norfolk study, from the FETA program, with and without the application of text matching

Nutrient/Food group	FETA program, with text matching					FETA program, without text matching					Quintile change > 1			
	Median	Mean	SD	Mini mum	Maxi mum	Median	Mean	SD	Mini mum	Maxi mum	Quintile change		change > 1	
											N	%	N	%
Energy (kcal)	1886	1946	607	608	8103	1880	1941	605	608	8134	50	3.7	0	0.0
Energy (kJ)	7938	8202	2554	2552	34410	7909	8177	2547	2552	34541	47	3.5	0	0.0
Protein (g)	80.3	82.5	22.2	26.8	277.0	79.9	82.1	22.1	26.8	276.6	43	3.2	0	0.0
Alcohol (g)	2.0	5.4	8.1	0.0	65.3	2.0	5.4	8.1	0.0	65.3	0	0.0	0	0.0
Carbohydrate (g)	238	250	90	67	1596	237	249	90	67	1603	58	4.3	0	0.0
Starch (g)	109	114	52	25	1288	108	114	52	25	1301	99	7.4	0	0.0
Englyst fibre (g)	18.6	19.3	7.4	4.1	103.7	17.8	18.7	7.1	3.3	97.2	247	18.4	13	1.0
Fat (g)	67.6	71.4	28.5	17.2	259.4	67.5	71.3	28.4	17.2	259.7	45	3.4	0	0.0
Monounsaturated fat (g)	22.7	24.4	10.6	4.8	104.2	23.1	24.6	10.6	4.8	103.8	133	9.9	0	0.0
Polyunsaturated fat (g)	12.2	13.6	6.2	2.6	42.5	11.5	12.9	5.9	2.5	39.4	224	16.7	11	0.8
Saturated fat (g)	25.2	27.2	12.4	5.1	109.6	25.5	27.5	12.4	5.1	109.6	74	5.5	2	0.1
Calcium (mg)	978	995	298	242	2528	976	992	297	242	2534	46	3.4	1	0.1
Iron (mg)	11.7	11.9	3.9	3.1	67.8	11.1	11.4	3.5	3.1	55.3	280	20.9	44	3.3
Potassium (mg)	3788	3874	994	1284	12702	3744	3848	987	1280	12526	68	5.1	0	0.0

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Carotene (mcg)	3489	3731	1705	178	13796	3500	3736	1707	175	13796	11	0.8	0	0.0
Folate (mcg)	326	337	107	102	1311	318	329	105	97	1276	291	21.7	1	0.1
Vitamin C (mg)	124	133	63	4	809	122	132	62	4	809	34	2.5	0	0.0
Vitamin D (mcg)	3.07	3.49	1.89	0.22	12.06	3.02	3.46	1.89	0.29	12.46	248	18.5	9	0.7
Vitamin E (mg)	12.5	13.8	6.3	2.7	52.4	12.1	13.3	5.9	3.3	43.6	270	20.2	21	1.6
Alcoholic beverages (g)	21	61	104	0	1350	21	61	104	0	1350	0	0.0	0	0.0
Cereals & cereal products (g)	214	236	174	9	4948	212	234	174	9	4948	40	3.0	0	0.0
Eggs & egg dishes (g)	14	16	14	0	136	14	16	14	0	136	0	0.0	0	0.0
Fats & oils (g)	27	30	19	0	133	27	30	19	0	133	0	0.0	0	0.0
Fish & fish products (g)	32	39	26	0	187	32	39	26	0	187	0	0.0	0	0.0
Fruit (g)	238	277	199	0	2830	238	277	199	0	2830	0	0.0	0	0.0
Meat & meat products (g)	90	95	49	0	392	90	95	49	0	392	0	0.0	0	0.0
Milk & milk products (g)	381	410	174	0	959	381	410	174	0	959	0	0.0	0	0.0
Non-alcoholic beverages (g)	1148	1153	404	8	3215	1148	1153	404	8	3215	0	0.0	0	0.0
Nuts & seeds (g)	0	3	11	0	180	0	3	11	0	180	0	0.0	0	0.0
Potatoes (g)	116	113	61	0	785	116	113	61	0	785	0	0.0	0	0.0
Soups & sauces (g)	45	57	53	0	900	45	57	53	0	900	0	0.0	0	0.0
Sugars (g)	38	50	46	0	540	38	50	46	0	540	0	0.0	0	0.0
Vegetables (g)	265	288	140	2	1387	265	288	140	2	1387	0	0.0	0	0.0

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249 **DISCUSSION**

250 FETA provides a new, freely available, standalone tool that can produce nutrient and food group  
251 intake values from data collected using the EPIC-Norfolk FFQ. It makes the EPIC-Norfolk FFQ  
252 readily accessible to end-users and enables them to process and analyse nutritional data. The data  
253 can either be entered into a spreadsheet, using the instructions provided, or by using the  
254 specifically developed Microsoft Access form-based entry tool. The Access entry tool allows  
255 easier entry without requiring knowledge of specific food codes. The software for FETA for  
256 Windows and Linux can be downloaded from the website, as can the Microsoft Access data entry  
257 utility (<http://www.srl.cam.ac.uk/epic/epicffq/>). Users are encouraged to register with EPIC-  
258 Norfolk, as this enables them to request assistance and support. The various types of output (with  
259 four levels of information) available should prove beneficial to researchers, especially those  
260 requiring more detailed information. There is an on-going need for information on the intake of  
261 food groups. While the data from either output 3 or 4 could be used to generate more detailed  
262 food group data, we have treated food groups as another type of nutrient – a pseudo-nutrient. The  
263 FETA input/look-up files can be easily modified to create new groups, greatly adding to the  
264 flexibility of the system for analysing food group consumption, while requiring no spreadsheet or  
265 programming skills on the part of the analyst. A helpful feature of FETA is the log file which  
266 documents errors relating to FFQ data and/or default food codes assigned.

267 FETA was designed and based on the extensively validated EPIC-Norfolk FFQ, originally  
268 developed in 1988, to assess the nutrient and food group intake of 40-79 year olds, who  
269 completed the FFQ between 1993 and 1997. The food list and look-up lists of milks, breakfast  
270 cereals and fats reflect this time period and the study population, as do the default milk, cereal,  
271 baking fat and frying fat codes assigned. However, the program was created in such a way that it  
272 can be customised for different study populations, easily enabled by the separation of the  
273 processing algorithm in the FETA program implementation from the data model text files. It is  
274 possible to delete/add foods and/or FFQ lines, and modify portion sizes as desired for a study.

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2 275 Nutrient data may also be easily modified or added. It is also possible for FETA to be used with  
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4 276 other questionnaires containing a different set of line items or different numbers of frequencies.  
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6 277 Comparisons were carried out for a number of selected nutrients obtained from FETA and the  
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8 278 previously validated CAFÉ program. These showed that the nutrient output from both programs  
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10 279 were generally similar. All differences (>0.1%) found from the comparison of detailed  
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12 280 food/nutrient data at the individual level for 12 500 participants from FETA and the CAFÉ  
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14 281 program can be explained by one or more of the following reasons: up to four cereal foods  
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16 282 assigned by FETA, as compared to a maximum of two cereal foods assigned by CAFÉ;  
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18 283 differences in default baking and frying fat codes assigned; correction for muesli portion size in  
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20 284 cereal data; exclusion of porridge from cereal data (free text); default codes assigned for milk,  
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22 285 cereals or fats to participants using FETA (where no food codes were assigned by CAFÉ  
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24 286 program); rounding error (only where percentage absolute differences were between 0.1 to 1%)  
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26 287 and changes made to the nutrient data of six of the nine new foods as well as to the default code  
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28 288 for milk. A section entitled 'What are the differences between FETA versus CAFÉ processing?'  
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30 289 found at <http://www.srl.cam.ac.uk/epic/epicffq/FAQs.html> further explains the aforementioned  
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32 290 differences.  
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37 291 Although nutrient intakes as calculated by FETA and CAFÉ were similar, some relatively small  
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39 292 differences existed, but these and the quintile shift of men and women can be explained. In  
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41 293 FETA, a number of changes were made to the processing of breakfast cereals, affecting  
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43 294 carbohydrate, starch, Englyst fibre, iron and folate estimates. The vitamin C content per 100g of  
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45 295 low calorie/diet fizzy drinks was changed from 5 to 0 mg and the vitamin E content of crunchy  
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47 296 oat cereal and oil and fat non-specific was increased. Changes made to the processing of fats in  
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49 297 Questions 6 and 7 in Part 2 of the FFQ, in addition to changes made to the fatty acid profile of the  
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51 298 three new fats, could help explain the small differences observed in monounsaturated,  
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53 299 polyunsaturated and saturated fat intakes.  
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2 300 There was quite a large range in intake in the fourteen food groups, with a minimum intake of  
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4 301 zero for each of the food groups. It is difficult to compare food group intake data as the groupings  
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6 302 of foods often varies. However, the combined mean intake of fruit (excluding juices) and  
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8 303 vegetables for men and women was 467g and 562g respectively, achieving the Government's  
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10 304 'Five a day' recommendation(23), using a portion size of 80 g.

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12 305 Whilst text matching only affected one food group (cereals and cereal products), more than 15%  
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14 306 of men and women changed quintile for a number of nutrients: Englyst fibre, polyunsaturated fat,  
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16 307 folate, vitamin D and vitamin E, and iron (women only). Yet again, these nutrients related to the  
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18 308 text matching of breakfast cereals and baking and frying fats. The inclusion of these data  
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20 309 illustrates the effect of text matching on the ranking of individuals for certain nutrients and will  
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22 310 enable future researchers using FETA to make informed decisions on the benefit of text matching  
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24 311 for their study.

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26 312 We have not addressed or discussed common FFQ issues, such as the number of items in a food  
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28 313 list or the use of a single average portion size, as these are not the focus of this paper and have  
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30 314 been reviewed previously (24,25).

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32 315 It is anticipated that future updates of FETA might contain a number of improvements and  
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34 316 overcome some of the limitations of FETA, currently released as version 2.53 for Windows and  
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36 317 Linux (last updated 15/03/2013 and 21/02/2013 respectively). The source code has been made  
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38 318 available online which enables users to make modifications and improvements to the program.  
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40 319 Currently, we have made available Windows and Linux versions and it is hoped that an OS X  
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42 320 version will follow soon. We are currently working on a Libreoffice version of the Microsoft  
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44 321 Access form-based entry tool.

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46 322 In conclusion, we have created a new, open source, standalone, cross-platform FFQ processing  
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48 323 tool, FETA, to produce nutrient and food group data for researchers using the EPIC-Norfolk  
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50 324 FFQ. The tool produces similar nutrient and food group values to the previously validated CAFÉ  
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52 325 program, but is more accessible. Although FETA was designed and based on the EPIC-Norfolk  
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1 326 FFQ, the program was created in such a way that it can be customised for different study  
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4 327 populations. It is anticipated that the development and availability of FETA will be a useful  
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6 328 addition to the field of nutritional epidemiology and dietary public health.  
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### **Contributors**

AAM contributed to the software development, assisted in statistical analyses and drafted the manuscript. AB and RL contributed to the software development, assisted in statistical analyses and contributed to the manuscript. DJP-S wrote the step-based graphical wizard for running FETA and contributed to the manuscript. NGF, LO'C and K-TK (Principal Investigator of EPIC-Norfolk) contributed to the manuscript. APK created the Microsoft Access form-based entry tool and contributed to the manuscript. All authors approved the final manuscript.

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**Competing interests** None.

**Data Sharing Statement:** Epic-Norfolk has a wide range of collaborators. Contact details, publications and the process for collaborating and data requests can be found on the website ([www.epic-norfolk.org.uk](http://www.epic-norfolk.org.uk)).

**Ethics approval** Norwich Local Research Ethics Committee.



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2 451 **Figure Legends**  
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5 452 **Figure 1:** Part 1 (main part) of the EPIC-Norfolk FFQ, illustrating bread, savoury biscuits and  
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7 453 breakfast cereals  
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10 454 **Figure 2:** Questions from part 2 of the EPIC-Norfolk FFQ, used by FETA  
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1 A new tool for converting food frequency questionnaire data into nutrient and food group values:  
2 FETA research methods and availability

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19 Running title: FETA: new processing tool for FFQs

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21 **Key words:** food frequency questionnaire, nutritional output, processing tool, EPIC-Norfolk

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28 **Abbreviations:** FFQ, food frequency questionnaire; EPIC, European Prospective Investigation into  
29 Cancer and Nutrition; FETA, FFQ EPIC Tool for Analysis; CAFÉ, Compositional Analyses from  
30 Frequency Estimates

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## ABSTRACT

### Objectives

To describe the research methods for the development of a new [open source, cross-platform](#) tool which processes data from the European Prospective Investigation into Cancer and Nutrition Norfolk Food Frequency Questionnaire (EPIC-Norfolk FFQ). A further aim was to compare nutrient and food group values derived from the current tool (FETA; FFQ EPIC Tool for Analysis) with the previously validated but less accessible tool, CAFÉ (Compositional Analyses from Frequency Estimates). The effect of text matching on intake data was also investigated.

### Design

Cross-sectional analysis of a prospective cohort study – EPIC-Norfolk.

### Setting

East England population (city of Norwich and its surrounding small towns and rural areas).

### Participants

Complete FFQ data from 11 250 men and 13 602 women ~~with a~~ (mean age ~~of~~ 59 years; ~~(range~~ 40 – 79 years).

### Outcome measures

Nutrient and food group intakes derived from FETA and CAFÉ analyses of EPIC-Norfolk FFQ data.

### Results

Nutrient outputs from FETA and CAFÉ were similar; mean (SD) energy intake from FETA was 9222 kJ (2633) in men, 8113 kJ (2296) in women, compared to CAFÉ intakes of 9175 kJ (2630) in men, 8091 kJ (2298) in women. The majority of differences resulted in one or less quintile change (98.7%). Only mean daily fruit and vegetable food group intakes were higher in women than in men (278 v 212 g and 284 v 255 g respectively). Quintile changes were evident for all nutrients, with the exception of alcohol, when text matching was not executed; however, only the cereals food group was affected.

## Conclusions

FETA produces similar nutrient and food group values to the previously validated CAFÉ but has the advantages of being open source, cross-platform and complete with a data-entry form directly compatible with the software. The tool will facilitate research using the EPIC-Norfolk FFQ, and can be customised for different study populations.

## Strengths and limitations of this study

- FETA has been tested using a large study sample of food intake data.
- No independent reference method used in the comparisons of FETA and CAFÉ nutrient intake data although the CAFÉ system has been previously validated.

## INTRODUCTION

Food Frequency Questionnaires (FFQs) are commonly used in epidemiological studies to assess the dietary intake of large populations. Their popularity derives from ease of administration, ability to assess dietary intake over a defined period of time, and low costs (1). The European Prospective Investigation into Cancer and Nutrition (EPIC)-Norfolk FFQ is semi-quantitative and designed to record the average intake of foods during the previous year. The principles involved in data collection and processing of the EPIC-Norfolk FFQ and the development of the structure and content of the CAFÉ program for calculating nutrient intakes have been published previously (2). The EPIC-Norfolk FFQ has been extensively validated and has been widely used (3);(4);(5). However, the programs used to process these FFQs, including CAFÉ, have not been easily accessible to end-users.

Our objectives were to develop a new, open source, cross-platform processing tool (FETA - FFQ EPIC Tool for Analysis) based on and building upon the earlier system, CAFÉ (2). The aim of this report was to describe the research methods of the development of FETA, and to compare nutrient output from the FETA and CAFÉ programs. Food group intake data from FETA has also been described as has the effect of free text matching on nutrient and food group intake data. [Free text](#)

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6 85 matching refers to the assigning of an appropriate food code to hand-written text in the FFQ and  
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8 86 will be further described in the methods section.  
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## 11 12 88 **METHODS**

### 13 14 89 **EPIC-FFQ design**

15 90 The questionnaire consists of two parts. Part 1 consists of a food list of 130 lines; each line has a  
16 91 portion size attached to it: medium serving, standard unit or household measure. Study participants  
17 92 were requested to select an appropriate frequency of consumption for each line, from the nine  
18 93 frequency categories. As an example, Figure 1 illustrates the sections relating to bread, savoury  
19 94 biscuits and breakfast cereals. A pdf copy of the EPIC-Norfolk FFQ may be downloaded from  
20 95 <http://www.srl.cam.ac.uk/epic/epicffq/websitedocumentation.html>; information on how to complete  
21 96 and code the FFQ is also available here. The questionnaire lines are either individual foods,  
22 97 combinations of individual foods or food types. The FFQ food list is based on items from an FFQ  
23 98 widely used within the USA (6);(7), but modified to reflect differences in American versus UK  
24 99 brand names and some further food items were added.

25 100 Part 2 contains further questions, a number of which ask for more detailed information that link  
26 101 back to food lines in part one, as illustrated in Figure 2. Detailed information was requested for  
27 102 breakfast cereals and fats as these are nutritionally important foods in the UK diet.  
28 103

### 29 104 **Data collection**

30 105 The EPIC-Norfolk FFQ was posted to 25 639 participants in the EPIC-Norfolk cohort study (8).  
31 106 The participants were aged 40-79 years and the questionnaire was completed between 1993 and  
32 107 1997. The study was approved by the Norfolk Local Research Ethics Committee, adhered to the  
33 108 Declaration of Helsinki and all participants gave written informed consent. The FFQ was returned  
34 109 at a health examination, where it was checked and completed, if required, by trained nursing staff.  
35 110 In total, 25 351 (99%) participants returned the completed questionnaire.

### 36 111 **Comparison of FETA and CAFÉ programs**



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6 111 FETA uses a csv (comma-separated values) input file. Part 1 is coded as numeric values and Part 2  
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8 112 is coded as numeric values and food codes, using the flow-charts and look-up lists provided  
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10 113 (<http://www.srl.cam.ac.uk/epic/epicffq/>). We have also created a Microsoft Access form-based  
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12 114 entry tool to facilitate FFQ data entry, based on the EPIC-Norfolk FFQ. The tool exports data in a  
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14 115 format directly compatible with FETA. The FETA software was written in C and C++ languages,  
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16 116 enabling faster processing times than SAS and the C/C++ software can also be used from the  
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18 117 command line. The step-based graphical wizard for running FETA was written in Perl. Whereas in  
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20 118 the CAFÉ program, an Oracle (Oracle Corporation, Redwood Shores, CA, USA) -based entry  
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22 119 system was created to enter Part 1 frequency data as numeric codes and Part 2 data as numeric  
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24 120 codes and free text. CAFÉ was written using SAS (SAS Software, Version 8 of the SAS System for  
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26 121 Unix, SAS Institute Inc., Cary, NC, USA) and links to tables in an Oracle relational database.

#### 27 122 **Part 1- data entry**

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29 123 Data were manually entered into a spreadsheet as numeric codes, using '1' for 'never or less than  
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31 124 once a month', to '9' for '6+ times per day'. A code of '-9' was used to mark data where a  
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33 125 frequency was not recorded. Where two frequencies were provided for a line, ~~thisese wasere coded~~  
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35 126 as '-4' and treated by both CAFÉ and FETA programs as missing data. However, in FETA, both  
36  
37 127 frequencies may now be entered both-coded, separated by a semi-colon, e.g. '2;3', and FETA will  
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39 128 processed the first value. In the CAFÉ program, two entries per line were treated as missing data.

#### 40 129 **Part 2 – assigning of food codes to ticked boxes and free text**

41  
42 130 Part 2 contains hand-written text for milk, breakfast cereals and cooking fats (see Figure 2,  
43  
44 131 questions 3, 5, 6 and 7 respectively), which needs to be matched to the most appropriate food code  
45  
46 132 in order to obtain nutrient data; this process is known as free text matching. The data in part 2 were  
47  
48 133 coded using reference lists of food codes for varieties of milk, breakfast cereal and cooking fat.  
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50 134 Where there is no clear match, it is suggested that a researcher consults the ingredients and nutrient  
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52 135 information of the commercial item and compares this information with the nutrient profile of  
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54 136 similar items from the reference lists. These reference lists and figures relating to food codes that

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6 137 may be assigned to appropriate ticked boxes may be found at

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8 138 <http://www.srl.cam.ac.uk/epic/epicffq/websitedocumentation.html>

9  
10 139 Differences between FETA versus CAFÉ processing may also be found at

11  
12 140 <http://www.srl.cam.ac.uk/epic/epicffq/websitedocumentation.html>; these differences relate to

13  
14 141 breakfast cereals, frying and baking fats, the outcome of selecting the ‘None’ or ‘No’ box, and

15  
16 142 default milk, cereal, and fat codes.

### 17 143 **Databases**

18  
19 144 Each line in Part 1 of the FFQ is mapped to up to six food codes. Decisions regarding which food

20  
21 145 codes to use were based on data from UK government surveys and other UK population data (7);

22  
23 146 (7,9,10). These decisions were based on data for individuals aged 40-74 years (7). Data for portion

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25 147 weights were sourced from UK population data and weighed records in 40-74 year old study

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27 148 participants (7,11).

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29 149 The EPIC-Norfolk FFQ uses 290 foods from the UK food composition database, McCance and

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31 150 Widdowson’s “The Composition of Foods” (5<sup>th</sup> edition) and its associated supplements (12–21). A

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33 151 number of new food items were added to the EPIC-Norfolk FFQ food list, which are used in both

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35 152 ~~the~~ FETA and CAFÉ programs. These include low calorie/diet fizzy drinks and crunchy oat

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37 153 cereal, as well as modified home-baked and fried foods (without their fat), to enable an individual’s

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39 154 fat type, as recorded in Part 2 of the FFQ, to be incorporated. However, the nutrient data of six of

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41 155 the nine new foods used in the CAFÉ program were modified in FETA. These foods include

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43 156 crunchy oat cereal, milk non-specific, low calorie/diet fizzy drinks, solid vegetable oil, Crisp ‘n Dry

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45 157 (solid fat), and oil and fat non-specific. Modifications to the nutrient data were made to ensure a

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47 158 more accurate nutrient profile and/or to better reflect the foods consumed, ~~in~~ in the case of non-

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49 159 specific items, such as milk and oil/fat; these changes relate to nutrient/food data at the time of FFQ

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### 52 161 **Identification of outliers**

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Outliers were defined, as detailed previously (2). In brief, the ratio of energy intake (EI) to basal metabolic rate (BMR) was calculated, where BMR was calculated using sex-specific Schofield equations, which included age and body weight (22). Individuals in the top and bottom 0.5% of EI: BMR ratio were identified and excluded, as were individuals with FFQs containing 10 or more missing lines of data in Part 1 of the FFQ.

### **Nutrient and food group outputs**

FETA produces four nutrient output formats and a sample of each of these can be viewed at

<http://www.srl.cam.ac.uk/epic/epicffq/websitedocumentation.html>

Output 1 contains average daily nutrient and food group intakes for an individual from all FFQ foods consumed, in wide format, suitable for import into a spreadsheet or statistical package. Intake data for 46 nutrients are provided as well as data for 14 basic food groups, however only a selection of these nutrients is shown in this report. Output 2 contains the same nutrient intake data as output 1, but in long format, which is mostly suitable for programmers. Output 3 contains average daily nutrient and food group intakes (and amount of food consumed) for an individual for each FFQ line; this output file will be very large and is mostly suitable for programmers. The most detailed output (output 4) contains average daily nutrient and food group intakes, in addition to the amount of food consumed for an individual, for each food code, for each FFQ line (meal\_id). An online description of each meal\_id and nutrient code, including units of measurement, can be found in the data entry template. This output will also be very large and is mostly suitable for programmers.

A log file is created along with each output file, which records the processing of the data and provides useful error information (see Appendix 1 for log file of output 1). In these files, both notes (general process information) and error messages are recorded, with a date and time stamp. The log files make it possible to calculate the number of missing frequencies based on Part 1 (main grid) of the FFQ in order to exclude individuals with 10 or more missing ticks. The log files also record situations where a food code does not have any nutrient data attached to it.

### **Statistical analyses**

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6 188 The data were analysed using STATA 10 (STATA Corp., Texas, USA). Intake data were described  
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8 189 using mean, standard deviation (SD), median, minimum and maximum for both FETA and CAFÉ  
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10 190 program outputs, stratified by sex. The nutrients selected for comparison are those described in the  
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12 191 original CAFÉ paper. Where data on quintile changes are shown, cut-off points were calculated  
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14 192 using CAFÉ nutrient data in order to compare quintile shift between FETA and CAFÉ output data.  
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## 17 194 RESULTS

19 195 ~~We received~~ There were FFQs data available from 25 351 participants (11 451 men and 13 900  
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21 196 women), with a mean age of 59 years. From this set, 249 FFQs (90 men and 159 women)  
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23 197 containing 10 or more missing lines of data in Part 1 of the FFQ were excluded, followed by a  
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25 198 further exclusion of 250 FFQs (111 men and 139 women) from the top and bottom 0.5% of  
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27 199 EI:BMR. This resulted in the final analytical dataset of 24 852 participants Data from (11 250 men  
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29 200 and 13 602 women), are presented here, as individuals in the top and bottom 0.5% of EI: BMR ratio  
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31 201 have been excluded, as have individuals with FFQs containing 10 or more missing lines of data in  
32  
33 202 Part 1 of the FFQ.

### 34 203 Nutrient intake data from FETA and CAFÉ programs

36 204 Table 1 shows the average daily intake data for a number of selected nutrients for 11 250 men. The  
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38 205 data were similar for most nutrients across the two programs. The nutrients which had the highest  
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40 206 percentage of quintile change ( $\geq 10\%$ ) were monounsaturated fat, saturated fat, iron, vitamin D &  
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42 207 vitamin E. However, only 1.3% of the men changed more than one quintile, for two of these five  
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44 208 nutrients. The nutrients which had the lowest percentage of quintile changes were alcohol, calcium  
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46 209 and carotene, with less than 3% change (Table 1).

47  
48 210 Table 2 shows average daily intake data for the selected nutrients for 13 602 women, from FETA  
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50 211 and CAFÉ programs. There were similar quintile changes observed in women to those found in men  
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52 212 for the selected nutrients; four of the nineteen nutrients had a quintile change of greater than 10%:  
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54 213 polyunsaturated fat, saturated fat, iron and Vitamin E. However, the number of women who shifted  
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more than one quintile was generally lower than the number observed in men. The nutrients which had the greatest percentage of women who changed more than one quintile were vitamins D and E, with 0.7 and 0.9% respectively.

Detailed (output 4) nutrient intake data at the individual level obtained from the two programs were compared for approximately half of the participants (n=12 500; data not shown). All differences (> 0.1%) found were investigated and explanations for these differences are considered in the discussion.

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Table 1 Average daily nutrient intakes for men (N=11 250) participating in the EPIC-Norfolk study, from the FETA and CAFÉ programs, after the exclusion of outliers, with numbers and percentages of men who moved quintile

Nutrient	FETA program					CAFÉ program					Quintile			
	Median	Mean	SD	Mini mum	Maxi mum	Median	Mean	SD	Mini mum	Maxi mum	Quintile change		change > 1	
											N	%	N	%
Energy (kcal)	2126	2190	627	748	5085	2115	2179	626	748	5101	892	7.9	0	0.0
Energy (kJ)	8947	9222	2633	3124	21394	8900	9175	2630	3124	21440	891	7.9	0	0.0
Protein (g)	83.4	85.2	22.0	23.3	319.8	83.2	84.9	22.0	23.3	318.4	464	4.1	0	0.0
Alcohol (g)	6.7	12.3	16.1	0.0	134.2	6.7	12.3	16.1	0.0	134.2	0	0.0	0	0.0
Carbohydrate (g)	261	271	87	48	737	259	269	87	48	729	726	6.5	0	0.0
Starch (g)	123	128	45	10	504	122	127	45	10	501	813	7.2	1	0.0
Englyst fibre (g)	17.5	18.2	6.4	1.3	89.9	17.3	18.0	6.4	1.3	89.9	743	6.6	1	0.0
Fat (g)	78.9	83.2	31.3	13.4	260.6	78.7	83.0	31.3	13.4	260.6	1049	9.3	8	0.1
Monounsaturated fat (g)	27.0	28.8	11.6	4.8	101.2	26.8	28.5	11.5	4.8	105.1	1264	11.2	21	0.2
Polyunsaturated fat (g)	13.5	15.0	6.9	1.6	66.6	13.7	15.3	7.1	1.6	69.5	1074	9.5	24	0.2
Saturated fat (g)	30.1	32.3	13.6	3.0	110.6	29.8	31.9	13.5	3.0	106.7	1288	11.5	20	0.2
Calcium (mg)	1021	1039	301	189	2848	1018	1037	300	189	2849	296	2.6	1	0.0
Iron (mg)	12.1	12.4	3.6	2.6	38.7	11.9	12.3	3.5	2.5	38.5	1149	10.2	7	0.1
Potassium (mg)	3814	3881	911	1305	11718	3802	3869	909	1284	11718	411	3.7	0	0.0

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Carotene (mcg)	3188	3321	1573	147	25720	3178	3309	1571	147	25720	156	1.4	0	0.0
Folate (mcg)	320	331	97	77	1547	316	327	96	77	1547	836	7.4	3	0.0
Vitamin C (mg)	103	111	52	10	669	105	113	52	10	669	411	3.7	14	0.1
Vitamin D (mcg)	3.16	3.65	2.08	0.03	27.08	3.13	3.62	2.06	0.03	27.12	1161	10.3	145	1.3
Vitamin E (mg)	13.2	14.9	7.2	2.1	62.3	12.9	14.4	6.8	2.1	62.0	1545	13.7	146	1.3

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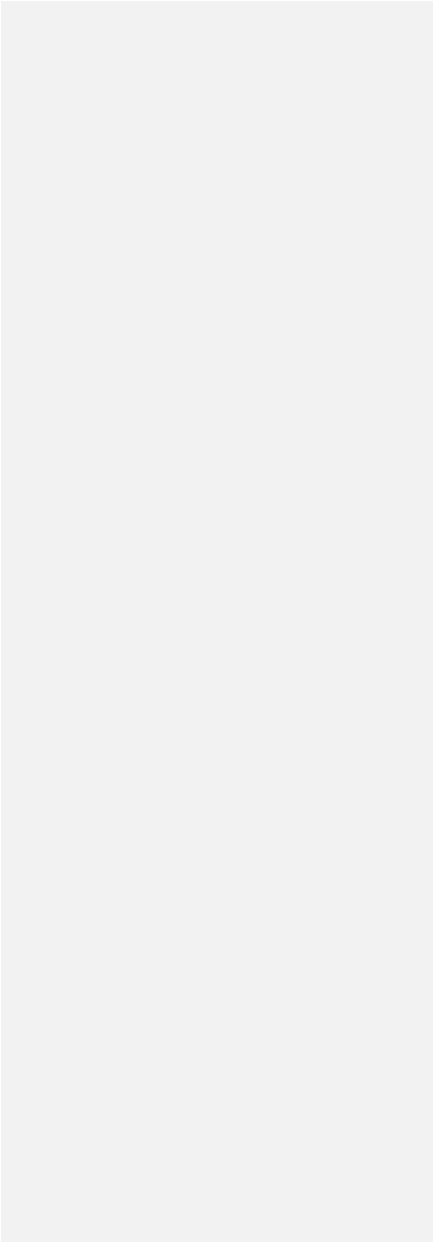


Table 2 Average daily nutrient intakes for women (N=13 602) participating in the EPIC-Norfolk study, from the FETA and CAFÉ programs, after the exclusion of outliers, with numbers and percentages of women who moved quintile

Nutrient	FETA program					CAFÉ program					Quintile change			
	Median	Mean	SD	Mini mum	Maxi mum	Median	Mean	SD	Mini mum	Maxi mum	Quintile change		Quintile change > 1	
											N	%	N	
Energy (kcal)	1859	1925	546	538	4733	1853	1920	547	518	4643	1030	7.6	0	0.0
Energy (kJ)	7833	8113	2296	2261	19910	7811	8091	2298	2179	19537	1018	7.5	0	0.0
Protein (g)	79.8	81.5	21.1	23.0	246.0	79.6	81.3	21.0	22.7	246.1	495	3.6	1	0.0
Alcohol (g)	2.0	5.6	8.4	0.0	99.5	2.0	5.6	8.4	0.0	99.5	0	0.0	0	0.0
Carbohydrate (g)	237	247	77	59	766	235	245	77	58	766	974	7.2	1	0.0
Starch (g)	107	112	39	13	405	106	111	39	13	406	1142	8.4	1	0.0
Englyst fibre (g)	18.2	19.0	6.8	2.3	118.5	18.0	18.8	6.7	2.4	118.6	850	6.2	1	0.0
Fat (g)	67.0	70.8	27.1	11.7	221.0	67.2	71.2	27.3	11.6	217.2	1194	8.8	4	0.0
Monounsaturated fat (g)	22.5	24.1	9.9	3.8	100.3	22.5	24.1	9.9	3.5	100.6	1338	9.8	7	0.1
Polyunsaturated fat (g)	12.2	13.5	6.2	2.0	53.6	12.5	13.8	6.3	2.0	53.6	1434	10.5	23	0.2
Saturated fat (g)	25.0	27.0	11.7	3.6	102.3	25.0	26.9	11.7	3.7	99.3	1443	10.6	9	0.1
Calcium (mg)	971	992	290	128	3159	969	990	290	127	3159	390	2.9	4	0.0
Iron (mg)	11.5	11.8	3.6	1.7	66.1	11.3	11.7	3.5	1.8	65.7	1496	11.0	12	0.1
Potassium (mg)	3781	3861	942	1150	16568	3769	3848	939	1147	16587	486	3.6	1	0.0
Carotene (mcg)	3477	3719	1917	67	61971	3469	3712	1917	64	61983	122	0.9	0	0.0

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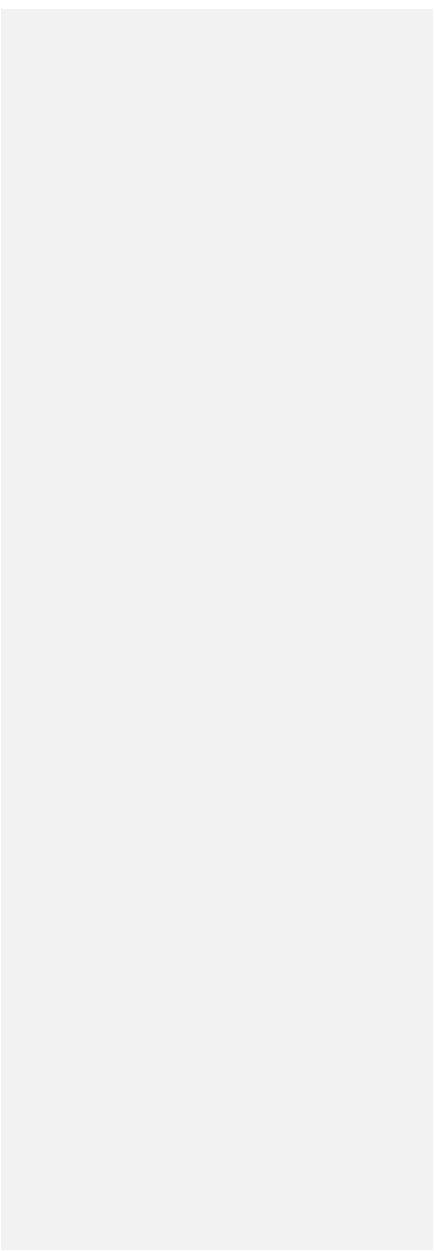
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Folate (mcg)	322	332	103	65	2039	317	328	101	65	2024	1025	7.5	5	0.0
Vitamin C (mg)	123	133	64	4	1006	125	135	64	4	1006	746	5.5	35	0.3
Vitamin D (mcg)	3.01	3.46	1.90	0.00	17.83	3.02	3.45	1.90	0.00	17.75	1119	8.2	90	0.7
Vitamin E (mg)	12.4	13.8	6.2	1.5	52.4	12.2	13.5	6.0	1.6	49.8	1863	13.7	123	0.9

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### Food group intake data from FETA

Average daily intakes for both men and women of the fourteen food groups readily available from FETA are shown in Table 3. Mean daily intakes of six of the food groups were higher in men than in women: alcohol, cereals, fats, meat, potatoes and sugars. However, women had higher intakes of fruit (278g v 212g) and vegetables (284g v 255g). Mean daily intakes of eggs, fish, milk, non-alcoholic beverages, nuts and seeds, and soups and sauces were similar in both men and women.

### The effect of text matching in FETA

Tables 4 and 5 illustrate the variation in nutrient and food group intake data obtained in a random subset of 1 159 men and 1 340 women, respectively, depending on whether text matching of milks, breakfast cereals and baking and frying fats was applied. In general, mean nutrient intakes were higher when text matching was carried out. In men, (Table 4), quintile changes (>15%) were most evident in the following nutrients: Englyst fibre, polyunsaturated fat, folate, vitamin D and vitamin E. The food group “cereals and cereal products” was the only one of the fourteen groups where there was a difference, with 31 men moving 1 quintile.

In women, (Table 5), quintile changes (>15%) were also most evident in the same five nutrients. However, almost 21% of women also changed quintile for iron. Once again, the “cereals and cereal products” food group was the only food group where there was any difference, with 40 women moving 1 quintile.

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Table 3 Average daily food group intakes for men (N=11 250) and women (N=13 602) participating in the EPIC-Norfolk study, from the FETA program

Food group	Men					Women				
	Median	Mean	SD	Mini mum	Maxi mum	Median	Mean	SD	Mini mum	Maxi mum
Alcoholic beverages (g)	101	204	315	0	2483	23	64	109	0	1728
Cereals & cereal products (g)	242	260	127	0	1456	215	231	110	0	1172
Eggs & egg dishes (g)	18	17	15	0	225	14	16	14	0	236
Fats & oils (g)	31	36	22	0	207	27	30	20	0	218
Fish & fish products (g)	32	37	26	0	362	32	38	26	0	309
Fruit (g)	179	212	164	0	2654	238	278	201	0	3742
Meat & meat products (g)	99	106	54	0	856	91	94	48	0	606
Milk & milk products (g)	407	420	182	0	1303	386	410	175	0	1560
Non-alcoholic beverages (g)	1157	1177	396	0	3707	1150	1165	403	0	4501
Nuts & seeds (g)	0	3	9	0	228	0	3	9	0	188
Potatoes (g)	125	122	69	0	1007	116	112	64	0	1506
Soups & sauces (g)	43	58	54	0	1004	43	57	53	0	1376
Sugars (g)	53	64	50	0	572	37	48	42	0	541
Vegetables (g)	236	255	123	0	2398	262	284	143	0	3539

Table 4 Comparison of average daily nutrient and food group intakes for men (N=1 159) participating in the EPIC-Norfolk study, from the FETA program, with and without the application of text matching

Nutrient/Food group	FETA program, with text matching					FETA program, without text matching					Formatted Table			
	Median	Mean	SD	Mini	Maxi	Median	Mean	SD	Mini	Maxi	Quintile change		Quintile change > 1	
				mum	mum				mum	mum	N	%	N	%
Energy (kcal)	2095	2176	678	658	7766	2091	2170	678	658	7787	28	2.4	0	0.0
Energy (kJ)	8822	9161	2848	2780	32555	8804	9138	2850	2780	32647	26	2.2	0	0.0
Protein (g)	82.8	85.0	22.8	22.1	272.3	82.5	84.7	22.8	22.1	272.3	34	2.9	0	0.0
Alcohol (g)	7.2	12.3	16.1	0.0	112.9	7.2	12.3	16.1	0.0	112.9	0	0.0	0	0.0
Carbohydrate (g)	261	270	93	63	1006	259	269	93	63	1003	48	4.1	0	0.0
Starch (g)	120	127	49	7	643	121	126	48	7	636	65	5.6	0	0.0
Englyst fibre (g)	17.5	18.3	6.6	3.6	71.8	17.3	17.9	6.3	3.6	64.5	198	17.1	10	0.9
Fat (g)	77.8	82.1	33.1	12.8	387.8	77.3	82.1	33.1	12.8	389.3	32	2.8	0	0.0
Monounsaturated fat (g)	26.5	28.2	12.2	3.5	131.1	26.7	28.7	12.5	3.7	138.7	88	7.6	0	0.0
Polyunsaturated fat (g)	13.5	14.9	7.3	3.0	67.0	12.7	14.1	6.8	3.0	60.7	179	15.4	17	1.5
Saturated fat (g)	30.1	31.8	14.1	3.3	160.0	30.3	32.2	14.3	3.3	160.3	72	6.2	1	0.1
Calcium (mg)	1015	1044	312	242	2848	1012	1044	313	242	2861	42	3.6	0	0.0
Iron (mg)	11.9	12.5	3.8	2.6	37.9	11.7	12.0	3.5	2.6	38.1	173	14.9	16	1.4
Potassium (mg)	3824	3889	957	1353	12675	3812	3873	951	1353	12551	52	4.5	0	0.0

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Carotene (mcg)	3150	3348	1671	507	18295	3162	3353	1672	507	18338	6	0.5	0	0.0
Folate (mcg)	325	333	103	94	1222	316	326	101	94	1262	226	19.5	2	0.2
Vitamin C (mg)	105	113	55	17	619	104	112	55	17	619	22	1.9	0	0.0
Vitamin D (mcg)	3.08	3.64	2.17	0.03	16.40	3.06	3.64	2.19	0.03	20.52	227	19.6	8	0.7
Vitamin E (mg)	13.3	15.0	7.6	2.7	74.7	13.0	14.5	7.1	2.7	71.2	238	20.5	30	2.6
Alcoholic beverages (g)	104	201	301	0	1866	104	201	301	0	1866	0	0.0	0	0.0
Cereals & cereal products (g)	240	257	131	0	1378	238	255	130	0	1378	31	2.7	0	0.0
Eggs & egg dishes (g)	18	17	17	0	225	18	17	17	0	225	0	0.0	0	0.0
Fats & oils (g)	31	36	25	0	313	31	36	25	0	313	0	0.0	0	0.0
Fish & fish products (g)	32	37	25	0	153	32	37	25	0	153	0	0.0	0	0.0
Fruit (g)	184	216	158	0	1037	184	216	158	0	1037	0	0.0	0	0.0
Meat & meat products (g)	98	104	52	0	690	98	104	52	0	690	0	0.0	0	0.0
Milk & milk products (g)	414	428	187	0	1302	414	428	187	0	1302	0	0.0	0	0.0
Non-alcoholic beverages (g)	1159	1191	397	22	3677	1159	1191	397	22	3677	0	0.0	0	0.0
Nuts & seeds (g)	0	3	8	0	135	0	3	8	0	135	0	0.0	0	0.0
Potatoes (g)	125	121	78	0	1518	125	121	78	0	1518	0	0.0	0	0.0
Soups & sauces (g)	43	56	51	0	556	43	56	51	0	556	0	0.0	0	0.0
Sugars (g)	51	63	50	0	358	51	63	50	0	358	0	0.0	0	0.0
Vegetables (g)	238	256	128	15	1047	238	256	128	15	1047	0	0.0	0	0.0

Table 5 Comparison of average daily nutrient and food group intakes for women (N=1 340) participating in the EPIC-Norfolk study, from the FETA program, with and without the application of text matching

Nutrient/Food group	FETA program, with text matching					FETA program, without text matching					Quintile change > 1			
	Median	Mean	SD	Mini mum	Maxi mum	Median	Mean	SD	Mini mum	Maxi mum	N	%	N	%
Energy (kcal)	1886	1946	607	608	8103	1880	1941	605	608	8134	50	3.7	0	0.0
Energy (kJ)	7938	8202	2554	2552	34410	7909	8177	2547	2552	34541	47	3.5	0	0.0
Protein (g)	80.3	82.5	22.2	26.8	277.0	79.9	82.1	22.1	26.8	276.6	43	3.2	0	0.0
Alcohol (g)	2.0	5.4	8.1	0.0	65.3	2.0	5.4	8.1	0.0	65.3	0	0.0	0	0.0
Carbohydrate (g)	238	250	90	67	1596	237	249	90	67	1603	58	4.3	0	0.0
Starch (g)	109	114	52	25	1288	108	114	52	25	1301	99	7.4	0	0.0
Englyst fibre (g)	18.6	19.3	7.4	4.1	103.7	17.8	18.7	7.1	3.3	97.2	247	18.4	13	1.0
Fat (g)	67.6	71.4	28.5	17.2	259.4	67.5	71.3	28.4	17.2	259.7	45	3.4	0	0.0
Monounsaturated fat (g)	22.7	24.4	10.6	4.8	104.2	23.1	24.6	10.6	4.8	103.8	133	9.9	0	0.0
Polyunsaturated fat (g)	12.2	13.6	6.2	2.6	42.5	11.5	12.9	5.9	2.5	39.4	224	16.7	11	0.8
Saturated fat (g)	25.2	27.2	12.4	5.1	109.6	25.5	27.5	12.4	5.1	109.6	74	5.5	2	0.1
Calcium (mg)	978	995	298	242	2528	976	992	297	242	2534	46	3.4	1	0.1
Iron (mg)	11.7	11.9	3.9	3.1	67.8	11.1	11.4	3.5	3.1	55.3	280	20.9	44	3.3
Potassium (mg)	3788	3874	994	1284	12702	3744	3848	987	1280	12526	68	5.1	0	0.0

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Carotene (mcg)	3489	3731	1705	178	13796	3500	3736	1707	175	13796	11	0.8	0	0.0
Folate (mcg)	326	337	107	102	1311	318	329	105	97	1276	291	21.7	1	0.1
Vitamin C (mg)	124	133	63	4	809	122	132	62	4	809	34	2.5	0	0.0
Vitamin D (mcg)	3.07	3.49	1.89	0.22	12.06	3.02	3.46	1.89	0.29	12.46	248	18.5	9	0.7
Vitamin E (mg)	12.5	13.8	6.3	2.7	52.4	12.1	13.3	5.9	3.3	43.6	270	20.2	21	1.6
Alcoholic beverages (g)	21	61	104	0	1350	21	61	104	0	1350	0	0.0	0	0.0
Cereals & cereal products (g)	214	236	174	9	4948	212	234	174	9	4948	40	3.0	0	0.0
Eggs & egg dishes (g)	14	16	14	0	136	14	16	14	0	136	0	0.0	0	0.0
Fats & oils (g)	27	30	19	0	133	27	30	19	0	133	0	0.0	0	0.0
Fish & fish products (g)	32	39	26	0	187	32	39	26	0	187	0	0.0	0	0.0
Fruit (g)	238	277	199	0	2830	238	277	199	0	2830	0	0.0	0	0.0
Meat & meat products (g)	90	95	49	0	392	90	95	49	0	392	0	0.0	0	0.0
Milk & milk products (g)	381	410	174	0	959	381	410	174	0	959	0	0.0	0	0.0
Non-alcoholic beverages (g)	1148	1153	404	8	3215	1148	1153	404	8	3215	0	0.0	0	0.0
Nuts & seeds (g)	0	3	11	0	180	0	3	11	0	180	0	0.0	0	0.0
Potatoes (g)	116	113	61	0	785	116	113	61	0	785	0	0.0	0	0.0
Soups & sauces (g)	45	57	53	0	900	45	57	53	0	900	0	0.0	0	0.0
Sugars (g)	38	50	46	0	540	38	50	46	0	540	0	0.0	0	0.0
Vegetables (g)	265	288	140	2	1387	265	288	140	2	1387	0	0.0	0	0.0

**DISCUSSION**

FETA provides a new, freely available, standalone tool that can produce nutrient and food group intake values from data collected using the EPIC-Norfolk FFQ. It makes the EPIC-Norfolk FFQ readily accessible to end-users and enables them to process and analyse nutritional data. The data can either be entered into a spreadsheet, using the instructions provided, or by using the specifically developed Microsoft Access form-based entry tool. The Access entry tool allows easier entry without requiring knowledge of specific food codes. The software for FETA for Windows and Linux can be downloaded from the website, as can the Microsoft Access data entry utility (<http://www.srl.cam.ac.uk/epic/epicffq/>). Users are encouraged to register with EPIC-Norfolk, as this enables them to request assistance and support. The various types of output (with four levels of information) available should prove beneficial to researchers, especially those requiring more detailed information. There is an on-going need for information on the intake of food groups. While the data from either output 3 or 4 could be used to generate more detailed food group data, we have treated food groups as another type of nutrient – a pseudo-nutrient. The FETA input/look-up files can be easily modified to create new groups, greatly adding to the flexibility of the system for analysing food group consumption, while requiring no spreadsheet or programming skills on the part of the analyst. A helpful feature of FETA is the log file which documents errors relating to FFQ data and/or default food codes assigned.

FETA was designed and based on the extensively validated EPIC-Norfolk FFQ, originally developed in 1988, to assess the nutrient and food group intake of 40-79 year olds, who completed the FFQ between 1993 and 1997. The food list and look-up lists of milks, breakfast cereals and fats reflect this time period and the study population, as do the default milk, cereal, baking fat and frying fat codes assigned. However, the program was created in such a way that it can be customised for different study populations, easily enabled by the separation of the processing algorithm in the FETA program implementation from the data model text files. It is possible to delete/add foods and/or FFQ lines, and modify portion sizes as desired for a study.



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6 277 Nutrient data may also be easily modified or added. It is also possible for FETA to be used with  
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8 278 other questionnaires containing a different set of line items or different numbers of frequencies.

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10 279 Comparisons were carried out for a number of selected nutrients obtained from FETA and the  
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12 280 previously validated CAFÉ program. These showed that the nutrient output from both programs  
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14 281 were generally similar. All differences (>0.1%) found from the comparison of detailed  
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16 282 food/nutrient data at the individual level for 12 500 participants from FETA and the CAFÉ  
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18 283 program can be explained by one or more of the following reasons: up to four cereal foods  
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20 284 assigned by FETA, as compared to a maximum of two cereal foods assigned by CAFÉ;  
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22 285 differences in default baking and frying fat codes assigned; correction for muesli portion size in  
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24 286 cereal data; exclusion of porridge from cereal data (free text); default codes assigned for milk,  
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26 287 cereals or fats to participants using FETA (where no food codes were assigned by CAFÉ  
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28 288 program); rounding error (only where percentage absolute differences were between 0.1 to 1%)  
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30 289 and changes made to the nutrient data of six of the nine new foods as well as to the default code  
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32 290 for milk. A section entitled ‘What are the differences between FETA versus CAFÉ processing?’  
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34 291 found at <http://www.srl.cam.ac.uk/epic/epicffq/FAQs.html> further explains the aforementioned  
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36 292 differences.

37 293 Although nutrient intakes as calculated by FETA and CAFÉ were similar, some relatively small  
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39 294 differences existed, but these and the quintile shift of men and women can be explained. In  
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41 295 FETA, a number of changes were made to the processing of breakfast cereals, affecting  
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43 296 carbohydrate, starch, Englyst fibre, iron and folate estimates. The vitamin C content per 100g of  
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45 297 low calorie/diet fizzy drinks was changed from 5 to 0 mg and the vitamin E content of crunchy  
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47 298 oat cereal and oil and fat non-specific was increased. Changes made to the processing of fats in  
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49 299 Questions 6 and 7 in Part 2 of the FFQ, in addition to changes made to the fatty acid profile of the  
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51 300 three new fats, could help explain the small differences observed in monounsaturated,  
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53 301 polyunsaturated and saturated fat intakes.  
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6 302 There was quite a large range in intake in the fourteen food groups, with a minimum intake of  
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8 303 zero for each of the food groups. It is difficult to compare food group intake data as the groupings  
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10 304 of foods often varies. However, the combined mean intake of fruit (excluding juices) and  
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12 305 vegetables for men and women was 467g and 562g respectively, achieving the Government's  
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14 306 'Five a day' recommendation(23), using a portion size of 80 g.

15 307 Whilst text matching only affected one food group (cereals and cereal products), more than 15%  
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17 308 of men and women changed quintile for a number of nutrients: Englyst fibre, polyunsaturated fat,  
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19 309 folate, vitamin D and vitamin E, and iron (women only). Yet again, these nutrients related to the  
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21 310 text matching of breakfast cereals and baking and frying fats. The inclusion of these data  
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23 311 illustrates the effect of text matching on the ranking of individuals for certain nutrients and will  
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25 312 enable future researchers using FETA to make informed decisions on the benefit of text matching  
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27 313 for their study.

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29 314 We have not addressed or discussed common FFQ issues, such as the number of items in a food  
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31 315 list or the use of a single average portion size, as these are not the focus of this paper and have  
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33 316 been reviewed previously (24,25).

34 317 It is anticipated that future updates of FETA might contain a number of improvements and  
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36 318 overcome some of the limitations of FETA, currently released as version 2.53 for Windows and  
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38 319 Linux (last updated 15/03/2013 and 21/02/2013 respectively). The source code has been made  
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40 320 available online which enables users to make modifications and improvements to the program.

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42 321 Currently, we have made available Windows and Linux versions and it is hoped that an OS X  
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44 322 version will follow soon. We are currently working on a Libreoffice version of the Microsoft  
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46 323 Access form-based entry tool.

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48 324 In conclusion, we have created a new, open source, standalone, cross-platform FFQ processing  
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50 325 tool, FETA, to produce nutrient and food group data for researchers using the EPIC-Norfolk  
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52 326 FFQ. The tool produces similar nutrient and food group values to the previously validated CAFÉ  
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54 327 program, but is more accessible. Although FETA was designed and based on the EPIC-Norfolk

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328 FFQ, the program was created in such a way that it can be customised for different study  
329 populations. It is anticipated that the development and availability of FETA will be a useful  
330 addition to the field of nutritional epidemiology and dietary public health.

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### 338 **Contributors**

339 AAM contributed to the software development, assisted in statistical analyses and drafted the  
340 manuscript. AB and RL contributed to the software development, assisted in statistical analyses  
341 and contributed to the manuscript. DJP-S wrote the step-based graphical wizard for running  
342 FETA and contributed to the manuscript. NGF, LO'C and K-TK (Principal Investigator of EPIC-  
343 Norfolk) contributed to the manuscript. APK created the Microsoft Access form-based entry tool  
344 and contributed to the manuscript. All authors approved the final manuscript.

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350 **Competing interests** None.

351 **Ethics approval** Norwich Local Research Ethics Committee.

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FOODS AND AMOUNTS	AVERAGE USE LAST YEAR								
	Never or less than once/month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
<b>BREAD AND SAVOURY BISCUITS</b> (one slice or biscuit)									
White bread and rolls						✓			
Brown bread and rolls				✓					
Wholemeal bread and rolls	✓								
Cream crackers, cheese biscuits		✓							
Crispbread, eg. Ryvita		✓							
<b>CEREALS</b> (one bowl)									
Porridge, Readybrek				✓					
Breakfast cereal such as cornflakes, muesli etc.					✓				

Part 1 (main part) of the EPIC-Norfolk FFQ, illustrating bread, savoury biscuits and breakfast cereals  
191x81mm (300 x 300 DPI)

Peer review only

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3. What type of milk did you most often use?  
**Select one only** Full cream/whole  Semi-skimmed   
 Skimmed  Channel Islands, gold   
 Dried milk  Soya   
 Other, specify  None

4. How much milk did you drink each day, including milk with tea, coffee, cereals etc?  
 None  Three quarters of a pint   
 Quarter of a pint  One pint   
 Half a pint  More than one pint

5. Did you usually eat breakfast cereal (excluding porridge and Ready Brek mentioned earlier)?  
 Yes  No

If **YES**, which brand and type of breakfast cereal, including muesli, did you usually eat?  
**List the one or two types most often used**  
 Brand e.g. Kellogg's  Type e.g. cornflakes

6. What kind of fat did you most often use for frying, roasting, grilling etc?  
**Select one only** Butter  Solid vegetable fat   
 Lard/dripping  Margarine   
 Vegetable oil  None   
 If you used vegetable oil, please give type eg. corn, sunflower

7. What kind of fat did you most often use for baking cakes etc?  
**Select one only** Butter  Solid vegetable fat   
 Lard/dripping  Margarine   
 Vegetable oil  None   
 If you used margarine, please give name or type eg. Flora, Stork

10. What did you do with the visible fat on your meat?  
 Ate most of the fat  Ate as little as possible   
 Ate some of the fat  Did not eat meat

Questions from part 2 of the EPIC-Norfolk FFQ, used by FETA  
 207x208mm (300 x 300 DPI)





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4 1 Appendix 1 Extract from a sample log file produced during the processing of 10 ids, using output 1.  
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7 2 2013-01-29 11:54 am: Note : Starting database setup  
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9 3 2013-01-29 11:54 am: Note : Loading imports for 'foods' completed  
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11 4 2013-01-29 11:54 am: Note : Loading imports for 'meals' completed  
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13 5 2013-01-29 11:54 am: Note : Loading imports for 'nutrients' completed  
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15 6 2013-01-29 11:54 am: Note : Loading imports for 'food\_nutrients' completed  
16  
17 7 2013-01-29 11:54 am: Note : Loading imports for 'meal\_foods' completed  
18  
19 8 2013-01-29 11:54 am: Note : Loading imports for 'weights' completed  
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21 9 2013-01-29 11:54 am: Note : Loading imports for 'portions' completed  
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23 10 2013-01-29 11:54 am: Note : Loading imports for 'frequencies' completed  
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25 11 2013-01-29 11:54 am: Note : Loading imports for 'cereals' completed  
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27 12 2013-01-29 11:54 am: Note : Loading imports for 'milks' completed  
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29 13 2013-01-29 11:54 am: Note : Completed database setup  
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35 15 2013-01-29 11:54 am: Error: Respondent: 001A supplied invalid frequency: -9 for meal: BURGER  
36  
37 16 2013-01-29 11:54 am: Error: Respondent: 001A supplied invalid frequency: -9 for meal: LIVER  
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39 17 2013-01-29 11:54 am: Error: Respondent: 003C supplied no baking fat food\_codes  
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4 18 2013-01-29 11:54 am: Note : Respondent: 003C using default baking fat code: 17018  
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6 19 2013-01-29 11:54 am: Error: Respondent: 004D supplied invalid frequency: -9 for meal: FRUIT\_SQUASH  
7  
8 20 2013-01-29 11:54 am: Error: Respondent: 005E supplied invalid frequency: -9 for meal: CHICKEN  
9  
10 21 2013-01-29 11:54 am: Error: Respondent: 005E supplied no frying fat food\_codes  
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12 22 2013-01-29 11:54 am: Note : Respondent: 005E using default frying fat code: 17046  
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14 23 2013-01-29 11:54 am: Error: Respondent: 008H supplied invalid frequency: -9 for meal: INSTANT\_COFFEE  
15  
16 24 2013-01-29 11:54 am: Error: Respondent: 008H supplied no baking fat food\_codes  
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18 25 2013-01-29 11:54 am: Note : Respondent: 008H using default baking fat code: 17018  
19  
20 26 2013-01-29 11:54 am: Error: Respondent: 009J supplied invalid frequency: -9 for meal: DAIRY\_DESSERT  
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22 27 2013-01-29 11:54 am: Error: Respondent: 009J supplied invalid frequency: -4 for meal: EGGS  
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24 28 2013-01-29 11:54 am: Error: Respondent: 009J supplied invalid frequency: -9 for meal: LOWCAL\_SALAD\_CREAM  
25  
26 29 2013-01-29 11:54 am: Error: Respondent: 009J supplied invalid frequency: -9 for meal: PLAIN\_BISCUIT  
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28 30 2013-01-29 11:54 am: Error: Respondent: 009J supplied invalid frequency: -9 for meal: INSTANT\_COFFEE  
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30 31 2013-01-29 11:54 am: Error: Respondent: 009J supplied invalid frequency: -9 for meal: COFFEE\_WHITENER  
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32 32 2013-01-29 11:54 am: Error: Respondent: 009J supplied invalid frequency: -9 for meal: SPINACH  
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34 33 2013-01-29 11:54 am: Error: Respondent: 009J supplied no visible fat weighting  
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36 34 2013-01-29 11:54 am: Note : Respondent: 009J using default weighting: 1  
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4 35 2013-01-29 11:54 am: Error: Respondent: 010K supplied no visible fat weighting  
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6 36 2013-01-29 11:54 am: Note : Respondent: 010K using default weighting: 1  
7  
8 37 2013-01-29 11:54 am: Note : Processing completed for Respondent: 001A  
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10 38 2013-01-29 11:54 am: Note : Processing completed for Respondent: 002B  
11  
12 39 2013-01-29 11:54 am: Note : Processing completed for Respondent: 003C  
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14 40 2013-01-29 11:54 am: Note : Processing completed for Respondent: 004D  
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16 41 2013-01-29 11:54 am: Note : Processing completed for Respondent: 005E  
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18 42 2013-01-29 11:54 am: Note : Processing completed for Respondent: 006F  
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20 43 2013-01-29 11:54 am: Note : Processing completed for Respondent: 007G  
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22 44 2013-01-29 11:54 am: Note : Processing completed for Respondent: 008H  
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24 45 2013-01-29 11:54 am: Note : Processing completed for Respondent: 009J  
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26 46 2013-01-29 11:54 am: Note : Processing completed for Respondent: 010K  
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28 47 2013-01-29 11:54 am: Note : Questionnaire: sample\_input\_290113.csv processing completed successfully, processed(10) respondents  
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