British Journal of Nutrition (2012), **107**, 1833–1844 doi:10.1017/S0007114511005101

British Journal of Nutrition

Effects on nutrient intake of a family-based intervention to promote increased consumption of low-fat starchy foods through education, cooking skills and personalised goal setting: the Family Food and Health Project

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(Submitted 18 October 2010 – Final revision received 16 August 2011 – Accepted 16 August 2011 – First published online 12 October 2011)

Abstract

Reducing the prevalence of fat-rich, energy-dense diets is a public health priority. The present parallel-designed randomised study compared three interventions aimed to increase intakes of low-fat starchy foods and to reduce fat intakes among 589 individuals from 169 families in the Family Food and Health Project (FFHP). Intervention A was education only, intervention B provided 'cook and eat' sessions only, whereas intervention C included personalised goal setting, 'cook and eat' and education. Diet was assessed at baseline (T_0) and at 3 months (T_1), 6 months (T_2) and 18 months (T_3) post-intervention. Retention rates were 75 % at T_1, 63 % at T_2 and 40 % at T_3. ANCOVA (baseline intake as covariate) was assessed between intervention differences at T_1, T_2 and T_3. At T_1, individuals in intervention C consumed less fat ($P=0{\cdot}02$) and more total carbohydrate ($P=0{\cdot}001$), starch ($P=0{\cdot}04$) vitamin C ($P=0{\cdot}002$) and NSP ($P=0{\cdot}01$) than those in intervention A. Whereas similar dietary intakes were reported across interventions at T_2, participants in intervention C had less energy-dense diets that contained more NSP and vitamin C at T_3 than intervention A ($P<0{\cdot}0001$, $P=0{\cdot}002$ and $P=0{\cdot}01$, respectively). Across all intervention groups, the more socially deprived participants in the FFHP (*n* 119) consumed less fat ($P=0{\cdot}01$) and more total carbohydrate ($P=0{\cdot}02$) at T_2 than the least socially deprived (*n* 240). These data demonstrate the importance of personalised goal setting to translate knowledge and practical cooking skills into healthier food choices, suggesting that low-fat starchy food-focused interventions may be effective in reducing fat intake.

Key words: Starchy foods: Family-based interventions: Cooking skills: Social deprivation

It is widely recognised that dietary patterns that are typified by energy-dense, fat-rich foods (often described as a 'Western diet') are associated with an increased prevalence of obesity[1,2], diabetes[3,4], CVD[5] and cancers at several sites[6], and effective strategies to improve such dietary patterns are a public health priority[5]. The present UK dietary target to reduce fat intake to no more than 35 % of energy derived from food (%FE)[7] was established in 1984[8] and this target has been confirmed in a number of subsequent UK government health initiatives[7,9]. However, food purchasing data from the UK National Food Survey[10] and the Family Food 2008 report (based on the 2008 Expenditure and Food Survey data, UK) suggest that habitual intakes of fat in the UK are resistant to change and, if anything, have been increasing in recent years[11]. Although these indices of food purchasing should be interpreted with caution, it seems that reaching the dietary target for fat intake remains difficult for some UK consumers.

For more than a decade[12], it has been suggested that low-fat starchy foods such as bread, cereals, rice, pasta, potatoes, legumes and pulses may be a suitable replacement for energy-dense foods of low nutrient quality. These starchy foods are often described as 'complex carbohydrate-rich' foods and some are 'whole-grain-rich' foods and recommendations to eat more of these food groups continue to be promoted[13–15]. Despite this, evidence suggests that consumers have mixed views about the role of such foods in their diets[16]. Compared with the recommendations, present intakes of these foods are sub-optimal and, for example, it has been reported recently that only 55 % of French subjects meet specific targets for starchy food intake[17].

Abbreviations: %FE, percentage of food energy; %TE, percentage of energy derived from food and alcohol; ED, enumeration district; FFHP, Family Food and Health Project; GLM, general linear ANCOVA model; SES, socioeconomic status; T_0, baseline assessment; T_1, 3 months post-intervention; T_2, 6 months post-intervention; T_3, 18 months post-intervention.

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To date, relatively few studies have assessed explicitly the effectiveness of interventions aimed at increasing intake of low-fat starchy foods as a route to reduced intake of dietary fat. Of those that have, studies have either been restricted to obese/pre-obese individuals and those at increased risk of CVD[18–20] or have focused on a particular type of low-fat starchy food, e.g. breakfast cereals[21–23]. Few studies have used the family as a setting for low-fat starchy food/complex carbohydrate dietary interventions[24]. Although the available evidence is limited, it has been shown that fat intake can be reduced as a consequence of increasing intake of low-fat starchy foods/complex carbohydrates[21], and that the adoption of such diets can result in significant improvements in body mass[18,19,24,25] and biochemical markers of CVD risk[22,23].

In meta-analyses and systematic reviews of previous intervention strategies, specific intervention components such as family involvement, cooking skills and food-related activity, peer-support and tailored goal setting have been shown to facilitate dietary change[26–29]. In particular, there is evidence that family involvement is conducive to positive changes in diet and other health constructs including body weight management[24,30–33]. In addition, confidence in the ability to prepare and cook healthy food is correlated positively with purchasing of healthy foods (e.g. vegetables) in families[34], consumption of vegetables in adults[35] and meeting dietary targets (e.g. for fat and whole-grain intake) in young adults[36]. Interventions that have taught food preparation and cooking skills have resulted in increased intakes of healthy foods[37–39].

The Family Food and Health Project (FFHP) was designed to determine which combinations of key facilitators of dietary change (i.e. information based food-related activities, cooking skills or personalised goal setting) would affect the translation of a message to increase the intake of low-fat starchy foods into improvement in dietary behaviours and, in particular, in reductions in fat intake. To this end, we conducted a randomised, parallel-group design intervention study in which we compared the efficacy of three dietary intervention strategies that differed in the amount of education and cooking skill provision and the use of a personalised goal setting framework. The FFHP also examined the sustainability of changes in dietary behaviours.

Experimental methods

Study participants

The data presented in the present paper relate to the individuals in the families that participated in the FFHP. Between 1998 and 2000, 169 families with a mean dietary intake at screening, who did not meet the targets of the study ($\leq$29 %FE from starch and/or $\geq$35 %FE from fat) and who were in the middle three quintiles (quintiles 2–4) of relative socioeconomic deprivation, based on unemployment, car ownership, owner occupation and overcrowding in given postcode areas (Townsend Deprivation Index[40]) were recruited to one of three interventions promoting increased consumption of low-fat starchy foods (Fig. 1).

At the time of the study, the mean UK adult %FE derived from starch and fat was approximately 24 and 40 %, respectively, with a target to reduce %FE from fat to 35 %. On this basis, an increase in %FE from starch to 29 % was judged to

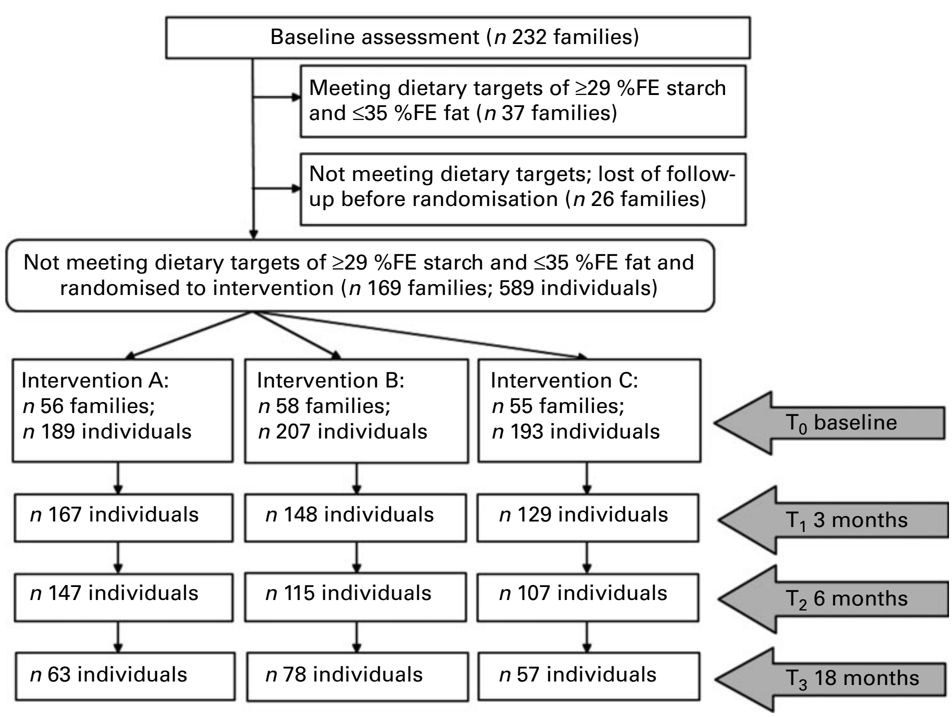

Fig. 1. Flow chart of family recruitment to the Family Food and Health Project and the subsequent involvement of individuals at the 3, 6 and 18 months post-intervention dietary assessments (T_1, T_2 and T_3, respectively). Intervention A, education only; intervention B, cook and eat only; intervention C, education + cook and eat + personalised goal setting; %FE, percentage of energy derived from food, excluding alcohol.

be an important change. In the absence of data on variance of change in %FE from starch or fat following intervention, based on available data on inter-person variation in %FE from fat[41], fifty individuals would be required to detect a change of 3·5% units in energy from starch ($\alpha = 0{\cdot}05$, power 90%). We anticipated that this would provide the power to detect a reciprocal change in %FE from fat.

Families were defined as groups of cohabiting persons containing any number of adults and at least one person under the age of 16 years. Local Health Authority National Health Service (NHS) registers were used to identify 2977 prospective families (addresses identified to have a child under the age of 16 years) who were sent a study information pack by the Local Health Authority, which was labelled 'for the attention of the parent/guardian' of the named person under 16 years of age residing in the household. The information pack included a participant information sheet, a contact sheet for families to register an interest in the trial and a stamped addressed envelope (addressed to the research team). Recruitment took place in six phases, and was restricted to targeted areas of Newcastle upon Tyne, UK, which had local community venues that were suitable for hosting the interventions. Families received no financial incentive to participate in the study. A total of 475 (16% response) of households mailed responded positively (4% gave a negative response), and of these 335 families were contacted to discuss the study further. Of these, 232 had a baseline dietary assessment, thirty-seven families met the dietary target of ≥29%FE from starch and ≤35%FE from fat and were excluded, twenty-six families were lost to follow-up before randomisation to treatment and the remaining 169 proceeded to the intervention (Fig. 1). Families with individual prescribed high-fat diets (*n* 2 children) were excluded; a total of 589 individuals participated per protocol in the study (Table 1). Baseline data were collected at T_0, with outcome data collected at 3 months (T_1), 6 months (T_2) and 18 months (T_3) after the end of the intervention. The dietary data from individuals reporting less than 3 d at any given time point (T_0, T_1, T_2 or T_3), were excluded from analysis at that data assessment point (at T_0, T_1, T_2 and T_3, the number of individuals

Table 1. Baseline non-dietary characteristics of the 169 families and the 589 individuals randomised to three intervention groups in the Family Food and Health Project and the retention rates of individuals at 3, 6 and 18 months post-intervention (T_1, T_2 and T_3, respectively)

(Mean values and standard deviations where variability of the mean is reported)*

	Total	Intervention A	Intervention B	Intervention C
Family characteristics				
Families at T_0	169	56	58	55
Children				
n	286	92	99	95
Percentage of intervention group	49	48·7	47·8	49·2
Adults				
n	303	97	108	98
Percentage of intervention group	51	51·3	52·2	51·8
Two participating parents/guardians (%)	64	61	67	64
Children per family				
Mean	1·8	1·8	1·9	1·9
SD	0·8	0·7	0·7	0·9
Average child age per family (years)				
Mean	8·7	9·1	8·8	8·1
SD	4·4	4·2	4·6	4·4
Families with <5 year old(s)				
n	59	17	21	21
%	35	30	36	38
Families with ≥16 year old(s)				
n	21	6	9	6
%	12	11	16	11
Individual characteristics				
Individuals at T_0	589	189	207	193
SES 2 (%)	62	63	73†	49†
SES 3 – omitted from GL model 2 (%)	3	4	5	0
SES 4 (%)	35	33	22†	51†
Retention of individuals at T_1				
n	444	167	148	129
T_0 (%)	75	88	71	67
Retention of individuals at T_2				
n	369	147	115	107
T_0 (%)	63	78	56	55
Retention of individuals at T_3				
n	198	63	78	57
T_0 (%)	34	33	38	30

Intervention A, education; intervention B, cook and eat; intervention C, education + cook and eat + personalised goal setting; T_0, baseline assessment; SES, socio-economic status; GL, general linear.

* SES differed significantly between interventions at baseline: P=0·04.

† Post-hoc Tukey test showed that SES differed between interventions B and C (P=0·03).

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with incomplete dietary records was 1, 11, 7 and 3, respectively). Collection of outcome data at T_3 included families recruited in phases 2–6 only, as funding for this additional work was secured after the due date for the T_3 assessment for those recruited in phase 1. The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Newcastle and North Tyneside Joint Ethics Committee and the Health Authorities Research Committee. Written informed consent was obtained from all subjects.

The interventions

Participating families were randomised by enumeration district (ED; a group of approximately 150 adjacent postal addresses). Briefly, participating families were first grouped by ED, and then three groups were formed that (1) consisted of contiguous ED and (ii) contained approximately equal numbers of families. The three groups were then randomly allocated to the three intervention strategies (interventions A–C). Allocation by ED was chosen to minimise potential 'contamination' arising from close neighbours being allocated to different interventions. All three interventions aimed to promote increased intake of low-fat starchy foods by both broadening the range of low-fat starchy foods consumed and increasing the portion sizes of these foods. At the beginning of the study (T_0), each family received a selection of low-fat starchy foods to trial at home and a recipe file with low-fat starchy meal/snack ideas.

The interventions were led by state-registered dietitians and were delivered using three strategies that differed in intensity (i.e. the amount of contact time with dietitians) and scope (i.e. the range of behavioural strategies adopted in the intervention). The three interventions included (1) a one-off 'education-based' intervention (intervention A); (2) a 'cook and eat' cooking skills-based intervention (intervention B); and (3) an 'education + cook and eat + personalised goal setting' intervention (intervention C).

Intervention A was centred on a health fayre, which was held in a local community centre and to which all members of the family were invited. Intervention A adopted an attitude-, awareness- and knowledge-centred approach (delivered during a 2 h session) that aimed to increase awareness of 'low-fat starchy foods', identified target portion sizes for men, women and children and emphasised on the potential health benefits of consuming more of these foods. To appeal to all family members, the health fayre included food tasting, food-related games and food challenges.

Intervention B (based on the 'cook and eat' approach) was skills-centred and was delivered in community centres. Families allocated to intervention B were offered four 'cook and eat' sessions each lasting for 2 h (over 6 weeks), which focused on the meal planning, food preparation and cooking skills required to incorporate more low-fat starchy foods into familiar meals and snacks. In addition, families were encouraged to try less familiar low-fat starchy foods during the 'cook and eat' sessions. Up to ten families were facilitated in each session and the cooking ingredients were provided at no cost. All family members were encouraged to participate in the food preparation and cooking, and each family was encouraged to prepare a different meal. A crèche facility was provided at the venue to accommodate those children unable to participate in the cooking sessions. At the end of each session, the foods prepared by all families were shared and families were encouraged to discuss their cooking experience and their preferences of the meals prepared. This approach was adopted to encourage group support from other families as well as from the study dietitians. In addition, a 2 h 'children-only' cooking session was also provided as part of intervention B; this was offered to all children aged at least 8 years.

Families allocated to intervention C received both the health fayre and 'cook and eat' sessions offered to participants in interventions A and B, respectively, and, in addition, were offered personalised goal setting. The latter was delivered by the study dietitians and was based on stages of change models[42]. Briefly, the process consisted of negotiation and agreement of three personalised dietary goals (consistent with the project aim of increasing low-fat starchy foods) at T_0 followed by monitoring, evaluation of progress and negotiation of further dietary goals, as original goals were achieved at two subsequent personalised face-to-face meetings with a research dietitian.

Dietary intake data

An in-house devised 3 d estimated food diary was used to report the dietary intakes of individuals at four time points, namely, T_0, T_1, T_2 and T_3[43]. Dietary reporting days ran sequentially and included two weekdays and one weekend day. For each food item consumed, a full description was recorded (time of consumption, brand name, relevant packaging information (e.g. weight and nutrient composition)) and the participants were asked to include an approximation of the quantity of each food consumed in household measures, e.g. slice, teaspoon or cup. Leftovers were excluded from the reporting process. The amount of food consumed was quantified at the interview principally by using the photographic atlas of food portion sizes[44] and from weights identified on product packaging. Where this approach was not applicable, a standard typical portion weight[45] was assigned. Energy and nutrient intakes were calculated using the UK food composition tables that were available at the time of the study. These were the supplements to the McCance and Widdowson standard UK food tables (Royal Society of Chemistry 1988–96[46–54]) and the fifth edition[55]. Where necessary, additional food composition data were obtained from Ministry of Agriculture, Fisheries and Food surveillance information sheets[56–63] and manufacturers' data. We are aware of the limitations of the dietary reporting approach used in the present study and the potential benefit of having biomarkers as independent indices of food intake[64,65]. However, there are no validated biomarkers suitable for measuring %FE from fat or intakes of starch (the primary foci of the present study).

Total energy intake (%TE; including energy derived from alcohol) and food energy intake (excluding energy derived from alcohol) were calculated and the intakes of macronutrients were expressed as a proportion of food energy (%FE). The present format was chosen to aid comparisons between individuals who differed in age and sex (both characteristics known to influence absolute dietary intakes). As indicators of dietary quality, the intakes of NSP and selected micronutrients (vitamin C, Fe and Ca) were calculated and intakes expressed in g (for NSP) or mg (for micronutrients) per MJ of food energy consumed. Dietary energy density was calculated and expressed as kJ/g of food. Milk and milk-based drinks were included in food for this purpose, as milk was a constituent part of commonly consumed meals, e.g. breakfast, in mashed vegetables and as a component of dairy-based sauces. Milk-based beverages included in the analysis included milk, milkshakes and hot chocolate. Beverages excluded from the analysis include all alcohol-based beverages, fruit juices, soft drinks, water, tea and coffee. The dietary data reported at T_0, T_1, T_2 and T_3 include data only for those individuals who completed the 3 d dietary record per protocol; partial dietary records (i.e. 1 or 2 d records) were excluded.

Statistical analyses

Differences in the dietary and non-dietary characteristics of the three intervention groups at T_0 were determined using one-way ANOVA with *post hoc* Tukey's multiple comparison testing. The principal analysis of intervention effect on subsequent nutrient intake (at T_1, T_2 and T_3) was undertaken using a univariate general linear ANCOVA model (GLM), with T_0 values used as a covariate. *Post hoc* multiple pairwise comparisons of the GLM data were performed using the Bonferroni test. The data presented (Tables 2 and 3) for T_1, T_2 and T_3 intake are the estimated marginal mean values and standard errors derived from the primary GLM of intervention effect (GLM1; fixed factor, intervention group; covariates, socioeconomic status (SES), age, sex, phase of recruitment, parental participation and T_0 dietary intake). In Tables 2 and 3, T_0 intake refers to the mean and standard error of the mean derived from baseline ANOVA analysis.

Two further GLM models were conducted as secondary analyses. GLM2 (fixed factor, SES; covariates, intervention group, age, sex, phase of recruitment, parental participation and T_0 dietary intake) was conducted to establish whether the significant difference in SES, observed between intervention groups at baseline, influenced intervention effectiveness. Of note, in GLM2, quintile 3 (3%) the seventeen subjects in SES were omitted from the analysis due to under-representation in the model (Table 1). GLM3 (fixed factor, parental participation; covariates, intervention group, SES, age, phase of recruitment and T_0 dietary intake) was conducted to identify whether the level of familial involvement *per se*, across the three dietary interventions, could have influenced the degree of dietary change. For GLM3, individuals were categorised according to the number of parents/guardians who participated in the project (i.e. either one or two parents). Parents/guardians were considered to be 'participating' if they consented to dietary assessment. The individuals assigned to the grouping of one 'participating' parent included those with one parent residing in the household and families where only one of the resident parents was willing to participate in the study. Data were analysed using SPSS 16.0 for Windows statistical analysis software (SPSS Inc., Chicago, IL, USA) and probability levels $\leq 0{\cdot}05$ were considered significant.

Results

Baseline data

Following screening, 169 families (including 589 individuals of all ages) were randomised to one of three dietary interventions; 63 % of families (*n* 106 families, containing 62 % of individuals in the study) were from the more affluent SES quintile (SES2) compared with 34 % of families (*n* 58 families, containing 35 % of individuals in the study) from the less affluent SES quintile (SES4). At T_0, the intervention groups were similar ($P>0{\cdot}05$) with respect to mean child age per family, the number of children per family and the number of children aged under 5 or 16 years and over (Table 1). However, assessment of socioeconomic deprivation showed that despite randomisation to intervention treatment, the intervention groups differed at baseline (ANOVA, $P=0{\cdot}04$). Tukey's *post hoc* testing showed that a greater proportion of the most socially deprived individuals were randomised to intervention C (accounting for 51 % of the 'education + cook and eat + personalised goal setting' group) compared with intervention B (accounting for 22 % of the 'cook and eat' group; $P=0{\cdot}03$). Intakes of energy (MJ), alcohol (%TE) and macronutrients (as a %FE) were similar at baseline (Table 2), but individuals in intervention B consumed more vitamin C than those in interventions C and A ('education only' group; $P<0{\cdot}001$ and $P=0{\cdot}02$, respectively) and had a less energy-dense diet (kJ/g) than individuals in intervention C ($P=0{\cdot}003$; Table 3).

Primary analyses of effects of the interventions on dietary outcomes

Our primary analysis aimed to test the hypothesis that the nature (and intensity) of family-based interventions, aimed at increasing intake of low-fat starchy foods, differed in their effectiveness in eliciting change in dietary behaviour. To assess intervention efficacy, estimates of dietary intake were collected at T_1, T_2 and T_3; a total of 444 individuals completed T_1, 369 completed T_2 and 198 completed T_3 (Table 1).

Starch, fat and total carbohydrate intake

After adjusting the data for covariates in GLM1, dietary intakes at T_1 differed by intervention group for fat ($P=0{\cdot}02$), carbohydrate ($P<0{\cdot}01$) and starch ($P=0{\cdot}03$; all expressed as a %FE). In each case, Bonferroni analysis showed that individuals randomised to intervention C consumed less fat ($P=0{\cdot}02$) and more total carbohydrate ($P=0{\cdot}001$) and starch ($P=0{\cdot}04$) than those in intervention A (Table 2). Although the between-intervention difference in fat was not sustained at subsequent data collections (T_2 and T_3), there were significant

Table 2. Individual intakes of energy (MJ), alcohol (as percentage of energy derived from food and alcohol (%TE)) and macronutrients (as percentage of energy derived from food, excluding alcohol (%FE)) across all three intervention groups at baseline (T_0), and the intakes of individuals grouped by intervention allocation at T_0 and 3, 6 and 18 months post-intervention (T_1, T_2 and T_3, respectively)
(Mean values with their standard errors at T_0 and adjusted mean values with their standard errors at T_1, T_2, and T_3)

		Total energy (MJ)		Food energy (MJ)		Fat (%FE)		Carbohydrate (%FE)		Starch (%FE)		Sucrose (%FE)		Protein (%FE)		Alcohol (%TE)	
	Subjects (*n*)	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
All subjects																	
T_0	589	8·6	2·6	8·3	2·4	36·9	5·5	48·3	6·1	26·3	5·3	9·9	4·5	14·6	3·3	3·0	5·7
Intervention A																	
T_0	189	8·7	0·2	8·4	0·2	37·1	0·4	48·2	0·4	26·5	0·4	9·6	0·4	14·5	0·2	3·0	0·4
T_1	167	7·8**†‡	0·1	7·4***§‖	0·1	35·9*¶	0·4	49·3**††	0·4	28·2*‡	0·4	9·4	0·3	14·7	0·2	3·9	0·4
T_2	147	7·9	0·2	7·6	0·2	36·3	0·5	49·1	0·4	29·1*‡‡	0·4	8·9	0·3	14·5	0·2	3·5	0·4
T_3	63	7·8	0·2	7·4	0·2	36·0	0·7	48·3*§§	0·7	28·1	0·7	8·6	0·4	15·4	0·4	4·0	0·7
Intervention B																	
T_0	207	8·5	0·2	8·3	0·2	36·7	0·4	48·5	0·4	25·7	0·3	10·3	0·3	14·7	0·2	2·7	0·4
T_1	148	8·5**†	0·2	8·2***§	0·1	35·4*	0·5	50·1**	0·5	28·3*	0·4	9·5	0·3	14·4	0·2	3·2	0·4
T_2	115	8·0	0·2	7·5	0·2	35·6	0·5	49·6	0·5	27·3*‡‡	0·5	9·7	0·3	14·5	0·3	3·2	0·4
T_3	78	8·0	0·2	7·6	0·2	34·0	0·6	50·7*	0·6	28·3	0·6	9·3	0·4	15·3	0·4	3·9	0·6
Intervention C																	
T_0	193	8·5	0·2	8·1	0·2	37·0	0·4	48·3	0·5	26·7	0·4	9·8	0·3	14·5	0·3	3·4	0·5
T_1	129	8·3**‡	0·2	8·0***‖	0·2	34·1*¶	0·5	51·6**††	0·5	29·6*‡	0·5	9·4	0·3	14·3	0·2	2·9	0·4
T_2	107	8·3	0·2	8·0	0·2	35·5	0·5	49·4	0·5	28·7*	0·5	9·0	0·3	14·9	0·3	3·0	0·5
T_3	57	8·2	0·3	7·9	0·2	34·3	0·8	50·2*§§	0·8	26·9	0·8	10·1	0·5	15·5	0·5	3·1	0·8

Intervention A, education only; intervention B, cook and eat only; intervention C, education + cook and eat + personalised goal setting.
Mean values were significantly different between intervention (univariate general linear ANCOVA models): * $P<0·05$, ** $P<0·01$, *** $P<0·0001$.
† Mean values were significantly different for intervention A *v.* intervention B ($P=0·002$; *post-hoc* Bonferroni test, pairwise comparisons).
‡ Mean values were significantly different for intervention A *v.* intervention C ($P=0·04$; *post-hoc* Bonferroni test, pairwise comparisons).
§ Mean values were significantly different for intervention A *v.* intervention B ($P<0·0001$; *post-hoc* Bonferroni test, pairwise comparisons).
‖ Mean values were significantly different for intervention A *v.* intervention C ($P<0·001$; *post-hoc* Bonferroni test, pairwise comparisons).
¶ Mean values were significantly different for intervention A *v.* intervention C ($P=0·02$; *post-hoc* Bonferroni test, pairwise comparisons).
†† Mean values were significantly different for intervention A *v.* intervention C ($P=0·001$; *post-hoc* Bonferroni test, pairwise comparisons).
‡‡ Mean values were significantly different for intervention A *v.* intervention B ($P=0·02$; *post-hoc* Bonferroni test, pairwise comparisons).
§§ Mean values were significantly different for intervention A *v.* intervention B ($P=0·004$; *post-hoc* Bonferroni test, pairwise comparisons).

Table 3. Individual intakes of energy density (kJ/g), NSP (g/MJ) and micronutrients (mg/MJ) across all three intervention groups at baseline (T_0), and intakes at T_0 and 3, 6 and 18 months post-intervention (T_1, T_2 and T_3, respectively) of individuals by intervention allocation

(Mean values with their standard errors at T_0 and adjusted mean values with their adjusted standard errors at T_1, T_2, and T_3)

		Energy density (kJ/g)		NSP (g/MJ)		Vitamin C (mg/MJ)		Fe (mg/MJ)		Ca (mg/MJ)	
	Subjects (*n*)	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
All subjects											
T_0	589	6·78	0·07	1·46	0·02	9·40	0·32	1·27	0·02	104·10	1·46
Intervention A											
T_0	189	6·76**	0·12	1·39	0·04	8·93***†	0·54	1·24	0·04	106·12	2·99
T_1	167	6·75	0·12	1·54**‡§	0·04	8·32**‖	0·46	1·26	0·03	103·46	2·05
T_2	147	6·82	0·13	1·54	0·04	8·13	0·52	1·31	0·04	105·23	2·31
T_3	63	7·04***¶	0·19	1·41**	0·06	8·84*††	0·78	1·33	0·05	102·15**‡‡	3·40
Intervention B											
T_0	207	6·53**§§	0·11	1·51	0·04	11·04***†‖‖	0·60	1·30	0·03	102·76	2·30
T_1	148	6·70	0·13	1·48**§	0·04	9·09**	0·49	1·30	0·03	103·87	2·18
T_2	115	6·57	0·14	1·54	0·05	9·29	0·60	1·36	0·05	103·77	2·65
T_3	78	6·11***¶	0·17	1·57**¶¶	0·06	10·44*	0·70	1·43	0·05	115·41**‡‡†††	3·04
Intervention C											
T_0	193	7·08**§§	0·13	1·46	0·04	8·11***‖‖	0·46	1·27	0·04	103·56	2·31
T_1	129	6·45	0·14	1·69**‡	0·04	10·49**‖	0·53	1·36	0·04	101·03	2·36
T_2	107	6·55	0·15	1·45	0·05	9·80	0·62	1·38	0·05	105·22	2·77
T_3	57	5·94***¶	0·20	1·71**¶¶	0·07	11·83*††	0·84	1·44	0·06	98·35**†††	3·68

Intervention A, education only; intervention B, cook and eat only; intervention C, education + cook and eat + personalised goal setting.
Mean values were significantly different between intervention (univariate general linear ANCOVA models): * $P<0·05$, ** $P<0·01$, *** $P<0·0001$.
† Mean values were significantly different for intervention B *v.* intervention A ($P=0·02$; *post-hoc* Bonferroni test, pairwise comparisons).
‡ Mean values were significantly different for intervention C *v.* intervention A ($P=0·012$; *post-hoc* Bonferroni test, pairwise comparisons).
§ Mean values were significantly different for intervention C *v.* intervention B ($P<0·0001$; *post-hoc* Bonferroni test, pairwise comparisons).
‖ Mean values were significantly different for intervention C *v.* intervention A ($P=0·002$; *post-hoc* Bonferroni test, pairwise comparisons).
¶ Mean values were significantly different for interventions B and C *v.* intervention A ($P<0·0001$; *post-hoc* Bonferroni test, pairwise comparisons).
†† Mean values were significantly different for intervention C *v.* intervention A ($P=0·01$; *post-hoc* Bonferroni test, pairwise comparisons).
‡‡ Mean values were significantly different for intervention B *v.* intervention A ($P=0·004$; *post-hoc* Bonferroni test, pairwise comparisons).
§§ Mean values were significantly different for intervention C *v.* intervention B ($P=0·003$; *post-hoc* Bonferroni test, pairwise comparisons).
‖‖ Mean values were significantly different for intervention B *v.* intervention C ($P<0·001$; *post-hoc* Bonferroni test, pairwise comparisons).
¶¶ Mean values were significantly different for intervention C *v.* intervention A ($P=0·002$; *post-hoc* Bonferroni test, pairwise comparisons).
††† Mean values were significantly different for intervention B *v.* intervention C ($P=0·001$; *post-hoc* Bonferroni test, pairwise comparisons).

inter-intervention differences in starch intake at T_2 ($P=0·02$) and carbohydrate intake at T_3 ($P=0·04$). Those individuals in intervention A consumed more starch than individuals in intervention B at T_2 (Bonferroni test; $P=0·04$), whereas at T_3, the individuals in intervention B had higher intakes of total carbohydrate ($P=0·04$) than those in intervention A (Table 2).

Micronutrient and energy intake (food energy, total energy and energy density)

After adjusting the data for covariates in GLM1, the intakes of vitamin C (mg/MJ) and NSP (g/MJ) at T_1 differed between intervention groups (both $P<0·01$), with intervention C consuming more vitamin C than intervention A ($P=0·002$) and also more NSP than both interventions A and B ($P=0·01$ and $P<0·0001$, respectively; Table 3). At T_1, total energy and food energy intakes differed between intervention groups ($P<0·01$ and $P<0·0001$, respectively). In each instance, individuals in intervention A reported lower intakes of total energy and food energy than those in interventions B and C (total energy, $P=0·002$ and $P=0·04$; food energy, $P<0·001$ and $P<0·001$ for intervention A *v.* interventions B and C, respectively). At T_2, there were no between-intervention differences for micronutrients, energy intakes (total energy and food energy) or energy density.

At T_3, there were significant between-intervention differences for intakes of NSP (g/MJ; $P<0·01$), vitamin C ($P=0·04$) and Ca ($P=0·001$; expressed in mg/MJ) and for energy density of food consumed (g/kJ; $P<0·0001$). *Post hoc* testing showed that individuals in intervention C consumed more NSP ($P=0·002$) and vitamin C ($P=0·01$) than those in intervention A, and that the diets of those in interventions containing a 'cook and eat' component (interventions B and C) were less energy dense than those for individuals in intervention A (both $P<0·0001$). In addition, at T_3, participants in intervention B consumed more Ca than those in both interventions A and C ($P=0·004$ and $P=0·001$, respectively).

Secondary analyses of factors potentially influencing intervention effects

Outcomes from GLM2 demonstrated that individuals in the most socially deprived group in the present study (SES quintile 4; *n* 119 at T_2) consumed less fat ($P=0·01$; adjusted mean values and their standard error; 34·8 (SE 0·51) %FE compared with 36·3 (SE 0·35) %FE for SES2 (Fig. 2(a)), more carbohydrate ($P=0·02$; adjusted mean values and standard error; 50·3 (SE 0·50) %FE compared with 48·9 (SE 0·35) %FE for SES2 (Fig. 2(b)), and less food energy ($P=0·01$; adjusted mean values and standard error; 7·32 (SE 0·17) MJ compared with 7·85 (SE 0·11) MJ for SES2) and total energy intake ($P=0·05$;

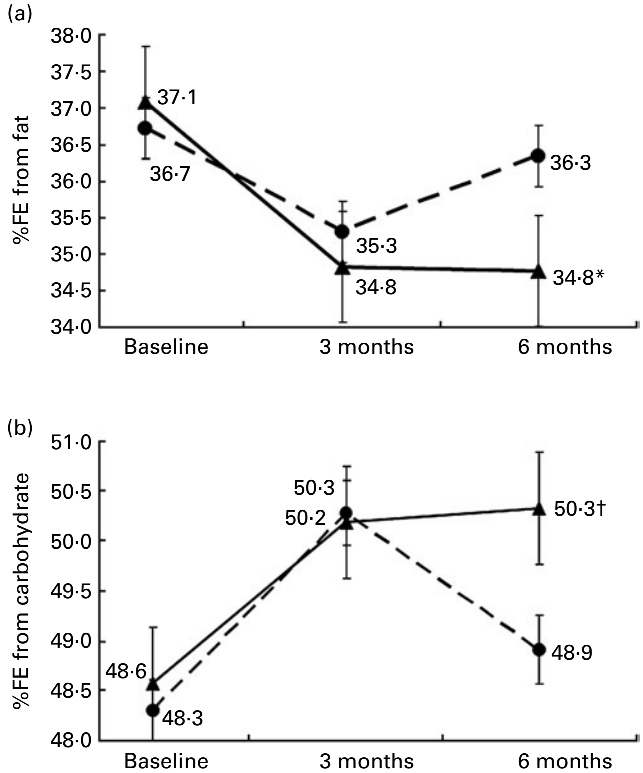

Fig. 2. Mean dietary intakes of percentage of food energy (%FE) from (a) fat and (b) total carbohydrate at baseline (T_0), and at 3 and 6 months post-intervention (T_1 and T_2, respectively) by individuals in the Family Food and Health Project, grouped by quintile of relative socioeconomic status (SES) assessed using the Townsend Deprivation Index. SES2 refers to the least socially deprived participants (-●-) and SES4 refers to the most socially deprived participants (—▲—). Values are adjusted means, with their standard errors represented by vertical bars. * Mean value of fat intake (%FE) for the SES4 group was significantly lower than that for the SES2 group at T_2 (P=0·01; univariate general linear ANCOVA model (model 2)). † Mean value of the SES4 group for the intake of %FE from carbohydrate was significantly higher than that for the SES2 group (P=0·02; univariate general linear ANCOVA model (model 2)).

adjusted mean values and standard error; 7·69 (SE 0·18) MJ compared with 8·11 (SE 0·13) MJ for SES2) than those in the least socially deprived group in the present study (SES quintile 2; n 240 at T_2). At T_1, those in the least deprived quintile also consumed more food energy (P=0·04). Using GLM3, we observed that individuals within families with two parents/guardians participating in the FFHP consumed more carbohydrate at T_2 (P=0·01) than did individuals within families with one participating parent/guardian. At both T_1 and T_3, individuals from families with two participating parents/guardians had higher sucrose intakes (P=0·03 at T_1, P=0·05 at T_3).

Retention of individuals within each intervention group

Compared with T_0, individual retention rates in the study (estimated as those who completed the corresponding dietary assessments) were 75 % at T_1, 63 % at T_2 and 40 % at T_3 (T_3 data are given as a percentage of those individuals recruited in phases 2–6). At T_1 and T_2, participant retention was in the order: intervention A > intervention B > intervention C (Table 1). As described earlier, T_3 data were obtained only from families recruited in phases 2–6. There were less marked differences in retention rates between intervention groups at T_3.

Discussion

The primary objective of the present family-based intervention was to establish whether a focus on increasing the intake of low-fat starchy foods could lower the intake of dietary fat towards the UK dietary target of not more than 35 %FE[7]. We tested the relative efficacy of three intervention strategies that differed in the provision of education, teaching of cooking skills and the use of a personalised goal setting framework. Several of the elements of these interventions, namely, family component, food-related activity and goal setting[26,27,66], have been shown previously to improve dietary behaviours. The present study is one of the first to test the hypothesis that a family-focused, low-fat starchy food intervention will improve the dietary behaviours of (relatively) high-fat consumers.

Analysis of the dietary intakes of the 589 individuals randomised to intervention revealed that our most intensive intervention, which provided knowledge, taught practical cooking skills and utilised a goal setting strategy (intervention C), was more effective in lowering fat intake in the short term (T_1) than the education alone treatment (intervention A). This is consistent with reports that intensive interventions are more effective in inducing beneficial dietary changes than brief interventions[26]. As anticipated, the increase in carbohydrate intake in the ‘education + cook and eat + personalised goal setting’ group (intervention C) was predominantly in the form of starch. Improvements in the macronutrient balance of the diet were matched by significant increases in vitamin C and NSP concentration relative to the other intervention strategies, which suggests that this intervention was most effective in improving the overall nutritional quality of the diet.

The present observations suggest that a personalised intervention approach that set and re-evaluated individual dietary goals helped to translate theory (education) and practical cooking skills (cook and eat) into changes in dietary behaviour, as has been reported by others for a range of diet and health settings[67] including reducing fat intake[68] and improving the dietary behaviours of low-income groups[69].

Despite the greater relative effectiveness of intervention C in the short term (T_1), all three interventions had intakes at 6 and 18 months which were statistically similar for the key macronutrients that were targeted in the study (i.e. fat, total carbohydrate and starch), with intakes across all intervention groups being lower in fat and higher in carbohydrate and starch compared with baseline. An explanation for the lack of sustained superiority in effectiveness from the personalised goal setting approach (intervention C) at 6 and 18 months may be attributable, in part, to the present trial design, which did not incorporate further skill provision, goal setting or reinforcement of the dietary message after the interventions were completed. Recent systematic review data show that periodic prompts to sustain behaviour change can be efficacious[70].

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Of interest was the finding that, at T_3, those exposed to interventions B and C consumed diets that were significantly lower in energy density than those exposed to intervention A. The common characteristic of both interventions B and C was the inclusion of a family-based cooking skills element that encouraged participants to base meals and snacks on low-fat starchy foods. A reduction in energy density in the longer term is of particular consequence, as the diets of adults and children that are less energy-dense correlate with greater nutrient quality[71–75] and, conversely, more energy-dense diets are associated with a higher risk of a cluster of conditions including obesity[1,2], diabetes[3] and CVD[5].

Although not designed to investigate socioeconomic differences in response to the interventions, the FFHP recruited participants by ED (as a surrogate for socioeconomic circumstances) and families were randomised to interventions within ED. We observed that individuals residing in areas of greater relative social deprivation exhibited more favourable dietary changes in response to the dietary intervention (averaged across all three interventions) than those residing in more relatively affluent areas, and that this difference was significant for measurements made T_2. The mean reported reductions in fat and increases in carbohydrate at the 3- and 6-month assessments (see Fig. 2) were greatest for the least affluent participants in the present study (SES4) and met the UK dietary recommendations[7,8] at both time points. The present data are in contrast with the findings of a recent systematic review of the socioeconomic determinants of dietary interventions[76], which has shown that positive changes in the intakes of fruits, vegetables and fat are associated with greater affluence. In addition, a recent review of forty-two school-based studies showed limited intervention effectiveness in children from lower socioeconomic groups[77].

The widening gap in health provision and dietary behaviours associated with social inequalities[78–80] underscores the importance of developing interventions that are effective among the more disadvantaged. The present data are the first to demonstrate that an intervention focused on increasing the intake of low-fat starchy foods may be particularly effective in lower-income households in producing sustained reductions in fat intakes. These findings require confirmation in further intervention studies, targeted to households of increased deprivation and designed specifically to test the efficacy of a low-fat starchy food intervention.

We designed a family-based intervention because of the evidence that such interventions produce favourable dietary changes[27,66], that shared family meals are positively associated with greater dietary quality[81,82] and that childhood food choices ‘track’ into life-long eating habits[81,83]. Additional parental/guardian involvement has been shown to enhance the effectiveness of breakfast eating interventions[82].

When considering the importance of the present findings, a number of characteristics of the study design should be noted. We undertook interventions in families because of the potential beneficial changes with respect to shared food shopping, food preparation and eating behaviours. However, a consequence of this approach is that the dietary data from individuals within these families, and to a lesser extent the intervention groups, will exhibit some degree of inter-dependency. Similarly, the present strategy of grouping families by ED in an attempt to minimise ‘contamination’ of the intervention message between neighbours may have resulted in subjects in neighbouring families not being fully independent. As such, the extrapolation of the present findings to other settings should be approached with caution. Further, fewer subjects dropped-out from intervention A than from the more time-demanding, and arguably more successful, interventions C and B. As a result of this disparity in retention rates, it could be speculated that interventions C and B may have had greater representation of more highly motivated subjects, and that the present per protocol assessment may therefore favour the more demanding interventions. As aforementioned, families in phase 1 of recruitment were not able to participate in T_3; this, along with attrition of phases 2–6 families at the 18-month assessment, means that the T_3 results should be interpreted with some caution. Finally, across the intervention groups, there was a pattern of lower reported mean energy intake (although, less pronounced in intervention C) at T_1, T_2 and T_3 (compared with baseline) and it is possible that this may indicate higher levels of dietary underreporting as the study progressed.

Conclusions

In the present family-based study, we have shown that the most intensive low-fat starchy food intervention, which included education, cooking skills and goal setting components, was the most effective in reducing fat intake and improving diet quality in both the short and longer term. Irrespective of intervention approach, the secondary analysis of the present study suggested that individuals residing in households with greater socioeconomic deprivation responded more favourably to the intervention in the medium term than those from more affluent areas. Further studies, which are explicitly designed to account for differences in SES, are warranted to confirm whether this positive approach to dietary change (encouraging greater intake of low-fat starchy foods) may be useful in addressing social inequalities in dietary intake.

Acknowledgements

The present study was commissioned by the Food Standards Agency (project code, N09001). A. J. A. and J. C. M. designed the study and obtained funding. P. J. C. conducted the research and analysed the data. P. J. C., A. J. A. and J. C. M. wrote the paper. All authors read and approved the final manuscript. J. C. M. had primary responsibility for final content. The authors acknowledge the contributions made by the study dietitians: Jane Loughridge, Clare Beard and Nigel Denby; the study’s qualitative researcher: Anne Spendiff; the quantitative data collector for 18-month assessments: Una Tohill; the support team at the dietary intervention sessions: Julie Hooper, Emma Foster, Emma Northover and Sara Wynn; and are grateful for quality assurance assessment of the dietary interventions performed by Moira Hill and for the clerical assistance of Pauline Winship. In addition, they also acknowledge the input of Simon Raybould for power calculations and geographical mapping, Leslie Carlin for project management assistance and the study's steering committee; Andrew Rugg-Gunn, Martin White, Chris Seal, Neil Niven, Nigel Unwin, Rosie Stacey and John Matthews. Finally, the authors thank the participants of the FFHP, Newcastle upon Tyne, who gave their time to ensure the success of the project. The authors declare no conflict of interest.

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