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The impact of a school-based nutrition education intervention on dietary intake and cognitive and attitudinal variables relating to fruits and vegetables

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Abstract

Objective: To assess the impact of a school-based nutrition education intervention aimed at increasing the consumption of fruits and vegetables.

Design: The intervention programme increased the provision of fruits and vegetables in schools and provided a range of point-of-purchase marketing materials, newsletters for children and parents, and teacher information. Curriculum materials at age 6–7 and 10–11 years were also developed and utilised. Evaluation was undertaken with groups of younger (aged 6–7 years) and older (aged 10–11 years) children. Methods included 3-day dietary records with interview and cognitive and attitudinal measures at baseline, with follow-up at 9 months, in intervention and control schools.

Setting: The work was undertaken in primary schools in Dundee, Scotland.

Subjects: Subjects comprised 511 children in two intervention schools with a further 464 children from two schools acting as controls.

Results: Children ($n = 64$) in the intervention schools had an average increase in fruit intake (133 ± 1.9 to $183 \pm 17.0\,g\,day^{-1}$) that was significantly ($P < 0.05$) greater than the increase (100 ± 11.7 to $107 \pm 14.2\,g\,day^{-1}$) estimated in children ($n = 65$) in control schools. No other changes in food or nutrient intake were detected. Increases in scores for variables relating to knowledge about fruits and vegetables and subjective norms were also greater in the intervention than in the control group, although taste preferences for fruits and vegetables were unchanged.

Conclusions: It is concluded that a whole school approach to increasing intakes of fruits and vegetables has a modest but significant effect on cognitive and attitudinal variables and on fruit intake.

Keywords
Fruit
Vegetables
Children
School

It is widely accepted that high intakes of fruits and vegetables (F&V) are associated with lower rates of chronic diet-related diseases including cardiovascular disease and certain cancers[1–3]. Current dietary recommendations[4] promote a minimum intake of 400 g F&V daily, and this has generally been translated into 5 portions of approximately 80 g. A number of countries have now adopted a 'five-a-day' message, including the USA, where the National Cancer Institute initiated a national '5-A-Day for Better Health Programme' in 1991[5], and more recently England[6].

In the UK, recent surveys have reported low intakes of F&V throughout the life span. In children aged 4–18 years, a recent study reported that more than half of 845 children surveyed in a 7-day period had not eaten any citrus fruit, green vegetables or tomatoes[7]. Boys' intakes of F&V were notably poor. Of all the vegetable categories recorded by boys, only peas, baked beans and cooked carrots had been consumed by more than half the sample.

Dietary habits in childhood will impact on growth, development and disease risk throughout life[8]. However, it is recognised that establishing healthy eating habits in children is a major challenge to health promotion. It is likely that children's eating habits are still being developed during early school years and this provides an important opportunity to target F&V consumption. Studies that have examined the principles of learning theory reveal the power and significance of associative conditioning, exposure, experience and positive reinforcement[9]. Recent

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work[10] highlights the importance of 'liking' as a predictor of F&V intake in children.

School-based interventions have shown some success in promoting appropriate dietary behaviours in children, notably with multi-strategy interventions[11]. The principle of the 'health-promoting school'[12] offers an opportunity to incorporate curriculum approaches, food service settings, and parental and community networks for health benefits. The aim of the present work was to assess the impact of a whole school intervention on cognitive and attitudinal variables relating to F&V and estimated dietary intake.

Methods

Overview

A whole school intervention was implemented from October 1999 to June 2000 in two junior schools in Dundee, Scotland. Its impact was assessed by comparing changes in knowledge, beliefs and attitudes towards F&V and dietary intake. These assessments were made at baseline (T1) (e.g. during September before the intervention commenced) with a follow-up (T2) which occurred 9 months after baseline (e.g. during June, after implementation of the intervention was complete). The assessments were made in groups of children aged 6–7 and 10–11 years.

Background data

Schools were selected following discussions with the local education authority, which advised on 12 schools not currently involved in research studies. Four schools agreed to participate and these were paired for similarity of social background and size; each pair was then randomly assigned to the intervention or control group. The school provided information on school roll and other relevant social characteristics. Data on age and postal codes were obtained from children.

Intervention programme

The intervention programme provided increased provision of F&V in schools (tuck shops and school lunches), tasting opportunities, a range of point-of-purchase marketing (posters and quizzes), newsletters for children and parents, and teacher information sessions (delivered in school assemblies, training sessions and classroom presentations). Curriculum materials at age 6–7 and 10–11 years (largely focusing on practical food preparation and tasting, promoted through hands-on activities, written work, videos, self-monitoring materials and story books) were also utilised. Table 1 provides an overview of the programme. A graphics package was developed using cartoon characters (The Bash Street Kids®, DC Thomson & Co. Ltd) which were used as a theme in the communication and promotional materials. Full programme details are available elsewhere[13].

Cognitive and attitudinal assessments to F&V

Age-appropriate assessments were developed to examine beliefs, attitudes and knowledge (related to F&V) based on the Theory of Planned Behaviour[14]. The assessments used age-appropriate language and involved a combination of card-sort techniques and short interview questions (Table 2). Most assessments focused on 12 core foods/drinks (Table 3). In addition, a tray containing small samples of these items was offered to the children for tasting. Core items, representing high and low fruit and vegetable content, were selected as familiar to children. The children were asked to taste and then rate their liking on a 5-point hedonic scale adapted from Birch *et al.*[15] and to rank these foods in order of preference.

Table 1 Intervention programme

Area	Activities
Food provision within the school	Fruit sold daily in the tuck shop School dinners • Vegetable soup or starter once a week • Daily choice of salad and a cooked vegetable • Weekly choice of a fruit-based pudding • Daily choice of fruit as a desert
Communications	A news sheet suitable for 11-year-olds School assembly Class presentation on portion size Demonstration to teachers on practical F&V activities which could be reproduced in a class room to encourage the children to taste and enjoy F&V
Learning materials	Topic work using F&V for 'myself' and 'senses' projects as part of the Environmental Studies curriculum Lunchbox topic for infants Lunchbox topic for upper primary
Peer/community support	Parent helpers in the tuck shop Parent newsletter

F&V – fruits and vegetables.

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Table 2 Details of attitudinal assessments

Description	Construct	Purpose of measure
Relevant background information		Name, date of birth
	Taste experience	Previous experience of tasting the foods discussed throughout the test
	Access to F&V in home	Access to fruits, vegetables, sweets, biscuits and crisps in the home
Knowledge and behavioural intention	Understanding of the concept 'healthy'	Children were asked if they knew the word 'healthy' and to give examples of foods which were 'healthy' or 'less healthy'
	Categorisation skills	A card-sort technique which assessed each child's ability to categorise F&V accurately
	Knowledge of F&V content of foods	Card-sort technique. Children placed photographs of the target foods into one of three response categories: 'lots of F&V', 'some F&V', 'no F&V'
	Subjective norms	Card-sort technique. Children placed cards in one of two response categories according to perceived social pressure from school nurse to 'eat less' or 'eat more'
	Paired choices	Task requiring children to choose the healthier of two options from core foods assessing child's knowledge of healthier food choices
	Knowledge of relationship between diet and heart disease	Questions examining children's knowledge of the relationship between diet and heart disease
	Behavioural intention	Card-sort technique requiring children to sort foods into categories according to their intention to eat more or less of the core foods
	Knowledge of '5-a-day' (10–11-year-old pupils only)	Card-sort technique. Children were required to select 5 portions of F&V from nine photographs of F&V[8] and nine other foods taken from the target foods
Measures for recording food preferences	Taste preferences (facial hedonic scales)	5-point facial hedonic scale on which children assigned a pleasantness value after tasting and ranked order of preference
	Taste preferences (ranked)	Card-sort technique. Children selected their five favourite foods from all target foods and ranked these five in order of preference

F&V – fruits and vegetables.

Assessment of food and nutrient intakes

Since the intervention was school-based, all dietary assessments were made on school days only to facilitate dietary recalls in these young children.

At baseline and follow-up, children completed a 3-day food diary accompanied by an interview to ascertain all foods eaten and portion sizes. The younger age group (6- to 7-year-olds) was interviewed on a daily basis while the older children (10- to 11-year-olds) were interviewed only once, at the end of the recording period. Lay assistants, who received one week's training in the methodology, conducted the interviews.

Table 3 Target foods

Core foods used for taste preferences and card-sort tasks	Additional foods used for ranked preferences and card-sort tasks
Fresh orange juice	Cherries
Carrots	Fruit salad
Tomatoes	Raisins
Grapes	Melon
Bananas	Pears
Apples	
Cheese-filled biscuits	Chips
Chocolate buttons	Burgers
Tomato-flavoured crisps	Doughnuts
Apple pie	Chocolate biscuits
Cola drink	Ice cream
Jelly sweets	

Food diaries were included in the nutrient analysis if the child had completed the 3-day diaries at both time points. Foods were coded using standard food tables[16–25]. Food codes and weights were entered in a nutrient analysis database and subjected to both automated and manual quality control checks. Mean daily intakes were calculated from the 3-day totals and change from T1 to T2 was calculated. Analyses were carried out on the dataset as a whole and, following the protocol for the National Diet and Nutrition Survey[7], no exclusions for under- or overreporting were made.

Statistical analysis

Univariate analysis of variance was used to identify statistically significant differences between the control and intervention groups over time.

Results

A description of the participating schools is presented in Table 4. A total of 135 participants (Table 5) completed the cognitive and attitude assessments (69 in the intervention and 66 in the control group, respectively), representing 46% of the total possible sample. A total of 128 participants (Table 5) completed food diaries (64 in the intervention and 65 in the control groups respectively), representing 44% of the possible sample.

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Table 4 Characteristics of schools

School	School roll	Denomination	Number of free school dinners served	Size of Year 2	Size of Year 7	Group
A	251	Roman Catholic	36 (14%)	28	32	Intervention
B	234	Roman Catholic	80–90* (36%)	29	36	Control
C	260	Non-denominational	80–90 (33%)	48	50	Intervention
D	230	Non-denominational	90 (39%)	31	40	Control

* Reviewed 6 weekly.

Cognitive and attitudinal assessments

Table 6 summarises significant findings of the cognitive and attitudinal variables where there were differences between intervention and control groups over time. Children in the intervention group tasted more F&V items over time than did children from the control group ($P < 0.001$). At the end of the study period, the intervention group reported having tasted several F&V that had not been tasted at baseline (e.g. turnips, pineapple).

Understanding of the concept 'healthy' altered significantly ($P = 0.002$) with time in the intervention group, with clear identification of concepts such as strength, healthy heart and energy emerging from their answers. Both age groups were reasonably competent at categorising F&V, although the scores for knowledge of paired choices (healthier options) was significantly greater in the intervention group than in the controls. The subjective norm (perceived social pressure) scores indicate that increased awareness of social pressure became greater in the intervention rather than the control group ($P = 0.021$).

Using the facial hedonic scales, children in the intervention group reported decreasing preference for the foods/drinks in the high-fat or higher sugar category. The intervention group chose fewer high-fat or high-sugar options in their top five favourites at T2 (as compared with T1), whilst in the control group ranked preferences remained constant ($P = 0.042$).

Food and nutrients

The weight of fruit intake increased in both intervention (+50 g) and control groups (+7 g), and was significantly ($P = 0.042$) greater in the intervention group. Vegetable intake showed no significant change in intervention (−17 g) or control groups (−15 g) (Table 7).

In boys, the changes between T1 and T2 in the intervention and control groups were not significant for fruit (122 to 141 g in the intervention group, 94 to 108 g in the control group), vegetables (74 to 47 g in the intervention group, 75 to 54 g in the control group) and total F&V (196 to 189 g in the intervention group, 169 to 163 g in the control group).

In girls, the change between T1 and T2 in the intervention and control groups was significant ($P = 0.02$) for fruit (141 to 216 g in the intervention group, 106 to 106 g in the control group). Differences in intakes of vegetables (65 to 56 g in the intervention group, 65 to 56 g in the control group) and in total F&V (207 to 272 g in the intervention group, 171 to 163 g in the control group) were not significant.

The range of fruits consumed increased in the intervention group but remained constant in the control group. The range of vegetables consumed decreased in both groups; the frequency of consumption and portion size are presented in Table 8. This undoubtedly reflects seasonal choices, with indications for future promotional work. There were no significant changes in macronutrient intakes between T1 and T2 (Table 9).

Discussion

Overall, these findings suggest that the intervention was delivered successfully. The results are generally consistent with studies in US schools[27–31], which have shown significant increases in fruit intake and (with one exception[29]) little impact on vegetable intake. In these US projects, interventions have been associated with increases of around 0.5 F&V portions per day[31], ranging from 0.2 (California) to 0.6 (Minnesota) servings. Commentators have concluded that the interventions

Table 5 Respondents participating in assessments

Assessment/school	Number	Age (years), mean ± SE	Depcat score* based on post code (%) 1–3	4–6
Cognitive and attitudinal assessments				
Intervention				
Males	31	8.10 ± 0.49	17	83
Females	38	8.00 ± 2.48	14	86
Total	69	8.04 ± 2.55	16	84
Control				
Males	32	7.72 ± 2.52	15	85
Females	34	9.12 ± 2.33	6	94
Total	66	8.44 ± 2.53	10	90
Food diaries				
Intervention				
Males	28	8.4 ± 2.28	21	79
Females	36	8.5 ± 2.19	22	78
Total	64	8.4 ± 2.21	22	78
Control				
Males	31	8.1 ± 2.11	13	87
Females	34	9.2 ± 2.23	12	88
Total	65	8.6 ± 2.23	12	88

SE – standard error.
* Depcat scores categorise deprivation category[26]: 4–6, most deprived; 1–3, least deprived.

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Table 6 Scores for cognitive and attitudinal variables in intervention ($n = 69$) and control ($n = 66$) groups

Description of measure	Total possible score	Score, mean ± SE		Significant differences between groups × time*
		T1	T2	
Number of foods tasted	32			0.001
Intervention		22.4 ± 0.7	27.0 ± 0.6	
Control		24.3 ± 0.7	25.0 ± 0.8	
Understanding of the concept 'healthy'	10			0.002
Intervention		3.8 ± 0.3	5.4 ± 0.2	
Control		3.5 ± 0.2	4.2 ± 0.3	
Diet and heart disease knowledge	3			0.001
Intervention		1.8 ± 0.1	2.4 ± 0.1	
Control		2.0 ± 0.1	2.2 ± 0.1	
Categorisation	25			0.002
Intervention		20.3 ± 0.5	22.4 ± 0.4	
Control		19.9 ± 0.6	21.1 ± 0.6	
Subjective norm	12			0.021
Intervention		9.5 ± 0.3	10.8 ± 0.2	
Control		9.5 ± 0.3	10.3 ± 0.3	
Preferences (displayed on hedonic scale)†	30			0.034
Intervention		24.4 ± 0.4	23.5 ± 0.5	
Control		24.9 ± 0.4	24.7 ± 0.4	
Ranked preferences	5			0.042
Intervention		2.5 ± 2.0	2.1 ± 0.2	
Control		2.7 ± 2.8	2.7 ± 0.2	

SE – standard error; T2 measures made 9 months after T1 baseline measures.
* Non-significant findings are not reported; all variables are listed in Table 2.
† Differences relate to reduced preferences for high-sugar and high-fat snacks, not increased preferences for fruits and vegetables.

are probably successful at 'mitigating an age-related decline in consumption'[29].

It is important to note that the short intervention period (9 months) cannot be used to demonstrate life-long changes in eating habits, but does show the ability of an education programme to impact on diet at a crucial life stage when eating habits are being formed. All the responses are reported intakes and have not been independently validated. These results are therefore comparable with other studies using similar methods, but are less robust than those from studies that examined independent markers of dietary change (e.g. plasma vitamin C or other nutrients found in high quantities in fruits).

In a project aimed wholly at outcome evaluation, the results should be measured at the school level, not at the individual pupil level. However, such an approach would not have facilitated the development of the programme and ongoing process evaluations. Sample size of 60 in each of the intervention and control arms was estimated to be able predict with 80% confidence a modest increase in intake of F&V (e.g. rising from 200 to 230 g).

Specific foods that had not been tasted before the intervention were subsequently tried as a direct function of the intervention. It is understood from the work of Birch *et al.*[32] that mere exposure to some foods can lead to an enhancement or acceptance of similar food types. Therefore, the direct effect of the intervention in increasing the likelihood of tasting new F&V may help towards developing a practical interest in tasting other F&V. In a UK school-based study, improvements in preference and acceptance of F&V were obtained by Horne *et al.* when using compulsory, daily exposure[33].

The results for nutrient intake are similar to those reported by Gregory *et al.*[7], suggesting that overall food intakes were fairly typical for children of this age.

One of the major challenges in any child-oriented project is getting parents involved. In the USA, work by Baranowski *et al.*[29] highlights that 'impacting on home consumption practices remain[s] elusive'. Future work could usefully consider how the challenge of parental involvement might be addressed.

Table 7 Mean daily weight* of fruit, vegetables, and fruits and vegetables (F&V) consumed as measured by 3-day food diaries in intervention ($n = 64$) and control groups ($n = 65$)

Variable	Weight (g), mean ± SE		Intervention effect (*P*-value)†
	T1	T2	
Fruit			0.042
Intervention	133 ± 11.9	183 ± 17.0	
Control	100 ± 11.7	107 ± 14.2	
Vegetables			0.823
Intervention	69 ± 41.1	52 ± 48.6	
Control	70 ± 58.1	55 ± 42.3	
F&V			0.617
Intervention	202 ± 101.9	235 ± 151.2	
Control	170 ± 109.6	163 ± 109.6	

SE – standard error; T2 measures made 9 months after T1 baseline measures.
* The mean daily weights include conversions for fruit juice (dividing by a factor of 2.5) and for vegetable soups to include only vegetable content.
† The value shown is the significance of the difference in change in intake from T1 to T2 between the intervention and control groups.

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Table 8 Top 10 vegetables in terms of frequency of consumption by the intervention group

T1				T2		
Frequency	Mean portion (g)	Rank	Food	Rank	Mean portion (g)	Frequency
56	103	1	Baked beans	6	95	22
29	45	2	Carrots	5	42	27
28	39	3	Tomatoes	1	34	34
24	49	4	Sweet corn	2	51	31
24	52	5	Peas	7	56	22
21	21	6	Lettuce	4	13	29
15	28	7	Cucumber	3	32	30
15	13	8	Pepper	10	22	4
12	16	9	Mushrooms	12	27	3
12	18	10	Onion	15	25	2
6	55	15	Broccoli	8	54	7
10	53	12	Coleslaw	9	59	6

T2 measures made 9 months after T1 baseline measures.

Increasing vegetable intake in all ages across all social classes is probably the greatest challenge to nutrition educators. Increased provision of vegetables through the introduction of new nutrient standards for school lunches in Scotland[34] will be viewed with interest.

Finally, the cost-effectiveness of this study is hard to estimate. The actual capital and development costs were around £378 (not necessary for widespread transfer) plus consumable costs of around £13.50 per school plus staff time over the entire 9-month period. The benefits were related not only to dietary change, but also contributed to general education, good school–home relations (through newsletters) and the general promotion of the integrated school involving pupils, staff (all grades) and parents.

Table 9 Mean daily macronutrient intakes

Variable	Intake, mean ± SE T1	Intake, mean ± SE T2	Intervention effect (*P*-value)*
Energy (kJ)			0.327
Intervention	7922 ± 207	7926 ± 213	
Control	8268 ± 257	7920 ± 236	
% Energy as fat			0.929
Intervention	35.4 ± 0.0065	34.9 ± 0.0056	
Control	36.9 ± 0.0051	36.3 ± 0.0063	
% Energy as carbohydrate			0.368
Intervention	51.3 ± 0.0066	51.8 ± 0.0053	
Control	49.8 ± 0.0060	51.2 ± 0.0062	
% Energy as protein			0.097
Intervention	13.1 ± 0.0029	13.1 ± 0.0028	
Control	13.0 ± 0.0028	12.2 ± 0.0030	
Starch (g)			0.980
Intervention	128 ± 4.4	131 ± 4.0	
Control	131 ± 4.5	134 ± 4.3	
Sucrose (g)			0.578
Intervention	55.1 ± 17.5	54.6 ± 19.4	
Control	56.7 ± 20.0	52.7 ± 22.7	

SE – standard error; T2 measures made 9 months after T1 baseline measures.
*The value shown is the significance of the difference in change in intake from T1 to T2 between the intervention and control groups from a multiple regression model which included age and sex.

In conclusion, a novel, whole school intervention implemented over one academic year was associated with changes in knowledge, attitudes and practices relating to F&V consumption.

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References

1 World Health Organization (WHO). *Diet, Nutrition and the Prevention of Chronic Diseases*. Geneva: WHO, 2003.
2 Ness AR, Powles JW. Fruit and vegetables, and cardiovascular disease: a review. *International Journal of Epidemiology* 1997; **26**: 1–13.
3 Key TJ, Allen NE, Spencer EA, Travis RC. The effect of diet on risk of cancer. *Lancet* 2002; **360**: 861–8.
4 Byers T, Nestle M, McTiernan A, Doyle C, Currie-Williams A, Gansler T, *et al*. American Cancer Society 2001 Nutrition and Physical Activity Guidelines Advisory Committee. American Cancer Society guidelines on nutrition and physical activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA: Cancer Journal for Clinicians* 2002; **52**: 92–119.
5 Havas S, Heimendinger J, Reynolds K, Baranowski T, Nicklas TA, Bishop D, *et al*. 5 a day for better health: a new research initiative. *Journal of the American Dietetic Association* 1994; **94**: 32–6.
6 Department of Health. *The NHS Cancer Plan*. London: The Stationery Office, 2000.
7 Gregory J, Lowe S, Bates CJ, Prentice A, Jackson LV, Smithers G, *et al*. *National Diet and Nutrition Survey: Young People aged 4 to 18 Years. Vol. 1. Report of the Diet and Nutrition Survey*. London: The Stationery Office, 2000.
8 Wright CM, Parker L, Lamont D, Craft AW. Implications of childhood obesity for adult health: findings from the thousand families cohort study. *British Medical Journal* 2001; **323**: 1280–4.
9 Birch LL. Development of food preferences. *Annual Review of Nutrition* 1999; **19**: 41–62.

https://doi.org/10.1079/PHN2004721 Published online by Cambridge University Press

10 Wardle J, Cooke LJ, Gibson EL, Sapochnik M, Sheiham A, Lawson M. Increasing children's acceptance of vegetables; a randomized trial of parent-led exposure. *Appetite* 2000; **40**: 155–62.
11 Lytle L, Achterberg C. Changing the diet of America's children: what works and why? *Journal of Nutrition Education* 1995; **27**: 250–60.
12 Young IM. Health eating policy in schools: an evaluation of effects on pupils' knowledge, attitude and behaviour. *Health Education Journal* 1993; **52**: 3–9.
13 http://www.foodstandards.gov.uk/interactivetools/educational/bashstreetdiet/
14 Ajzen I, Fishbein M. *Understanding Attitudes and Predicting Social Behaviour*. Englewood Cliffs, NJ: Prentice Hall, 1980.
15 Birch LL, Zimmerman SI, Hind H. The influence of social affective context on the formation of children's food preferences. *Child Development* 1980; **51**: 856–61.
16 Holland B, Welch AA, Unwin ID, Buss DH, Paul AA, Southgate DAT. *McCance & Widdowson's The Composition of Foods*, 5th ed. Royal Society of Chemistry and Ministry of Agriculture, Fisheries and Food. London: HMSO, 1995.
17 Holland B, Unwin ID, Buss DH. *Cereals and Cereal Products. Third Supplement to McCance & Widdowson's The Composition of Foods*, 4th ed. Royal Society of Chemistry and Ministry of Agriculture, Fisheries and Food. London: HMSO, 1988.
18 Holland B, Unwin ID, Buss DH. *Milk Products and Eggs. Fourth Supplement to McCance & Widdowson's The Composition of Foods*, 4th ed. Royal Society of Chemistry and Ministry of Agriculture, Fisheries and Food. London: HMSO, 1989.
19 Holland B, Unwin ID, Buss DH. *Vegetables, Herbs and Spices. Fifth Supplement to McCance & Widdowson's The Composition of Foods*, 4th ed. Royal Society of Chemistry and Ministry of Agriculture, Fisheries and Food. London: HMSO, 1991.
20 Holland B, Unwin ID, Buss DH. *Fruit and Nuts. First Supplement to McCance & Widdowson's The Composition of Foods*, 5th ed. Royal Society of Chemistry and Ministry of Agriculture, Fisheries and Food. London: HMSO, 1992.
21 Holland B, Welch AA, Buss DH. *Vegetable Dishes: Second Supplement to McCance & Widdowson's The Composition of Foods*, 5th ed. Royal Society of Chemistry and Ministry of Agriculture, Fisheries and Food. London: HMSO, 1992.
22 Holland B, Brown J, Buss DH. *Fish and Fish Products. Third Supplement to McCance & Widdowson's The Composition of Foods*, 5th ed. Royal Society of Chemistry and Ministry of Agriculture, Fisheries and Food. London: HMSO, 1993.
23 Chan W, Brown J, Buss DH. *Miscellaneous Foods. Fourth Supplement to McCance & Widdowson's The Composition of Foods*, 5th ed. Royal Society of Chemistry and Ministry of Agriculture, Fisheries and Food. London: HMSO, 1994.
24 Chan W, Brown J, Lee SJ, Buss DH. *Meat Poultry and Game. Fifth Supplement to McCance & Widdowson's The Composition of Foods*, 5th ed. Royal Society of Chemistry and Ministry of Agriculture and Fisheries and Food. London: HMSO, 1995.
25 Chan W, Brown J, Church SM, Buss DH. *Meat Products and Dishes. Sixth Supplement to McCance & Widdowson's The Composition of Foods*, 5th ed. Royal Society of Chemistry and Ministry of Agriculture, Fisheries and Food. London: HMSO, 1996.
26 Carstairs V, Morris R. *Deprivation and Health in Scotland*. Aberdeen: Aberdeen University Press, 1991.
27 Nicklas TA, Johnson CC, Myers L, Farris RP, Cunningham A. Outcomes of a high school program to increase fruit and vegetable consumption: Gimme 5 – a fresh nutrition concept for students. *Journal of School Health* 1998; **68**: 248–53.
28 Perry CL, Bishop D, Taylor G, Murray D, Mays RW, Dudovitz BS, *et al*. Changing fruit and vegetable consumption among children: The 5 A Day Power Plus programme in St Paul, Minnesota. *American Journal of Public Health* 1998; **88**: 603–9.
29 Baranowski T, Davis M, Resnicow K, Baranowski J, Doyle C, Lin LS, *et al*. Gimme 5 fruit, juice, and vegetables for fun and health: outcome evaluation. *Health Education & Behavior* 2000; **27**: 96–111.
30 Reynolds KD, Franklin FA, Binkley D, Raczynski JM, Harrington KF, Kirk KA, *et al*. Increasing the fruit and vegetable consumption of fourth-graders: results from the high 5 project. *Preventive Medicine* 2000; **4**: 309–19.
31 Agency for Healthcare Research and Quality. *Efficacy of Interventions to Modify Dietary Behavior Related to Cancer Risk* [online], 2001. Available at http://www.ahrq.gov/clinic/epcsums/dietsumm.htm
32 Birch LL, McPhee L, Shoba BC, Pirok E, Steinberg L. What kind of exposure reduces children's neophobia? *Appetite* 1987; **9**: 171–8.
33 Horne PJ, Lowe CF, Fleming PF, Dowey AJ. An effective procedure for changing food preferences in 5–7-year-old children. *Proceedings of the Nutrition Society* 1995; **54**: 441–52.
34 Scottish Executive. *Hungry for Success – A Whole School Approach to School Meals*. Edinburgh: The Stationery Office, 2000.