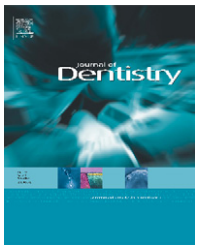
JOURNAL OF DENTISTRY 41 (2013) 143–147

Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: www.intl.elsevierhealth.com/journals/jden



# A preliminary investigation into the use of denture adhesives combined with dietary advice to improve diets in complete denture wearers

D.W. Bartlett [a,*], B. Maggio [b], D. Targett [c], M.R. Fenlon [a], J. Thomas [d]

[a] Prosthodontics, King's College London Dental Institute at Guy's, King's and St Thomas' Dental Hospitals, London Bridge, UK
[b] GlaxoSmithKline Consumer Health Care, Littleton Road, Parsippany, NJ, USA
[c] GlaxoSmithKline Consumer Health Care, Oral Care, St. George's Avenue, Weybridge, Surrey, UK
[d] The Department of Nutrition at King's College London, London Bridge, UK

ARTICLE INFO

*Article history:*
Received 31 August 2012
Received in revised form
8 October 2012
Accepted 25 October 2012

*Keywords:*
Complete dentures
Prosthodontics
Diet
OHIP

ABSTRACT

*Objectives:* To investigate how nutritional advice and denture adhesives may be associated with eating healthier foods.

*Methods:* 35 edentulous subjects (13 males and 22 females, mean age 73.9 years (55–84 years)), wearing complete dentures more than one year old, completed validated questionnaires analysing saturated fat, protein, Vitamin C, the number of servings of fruit/vegetables. In addition subjects completed the NDNS and OHIP Edent questionnaires. At baseline, nutritional information and the use of denture adhesive was provided. Subjects returned after 30 consecutive days and the questionnaires were repeated. A Wilcoxon signed rank test was used to test the effect of the denture adhesive on diet and on quality of life measures.

*Results:* The subjects increased mean intake from 2.2 portions of fruit/vegetables a day to 3.6. Fat and saturated fats were reduced from 23.2 g to 11.3 g and Vitamin C intake increased by 34.4 mg. All were statistically significant ($p < 0.0001$). There was a statistically significant improvement over the 30-day treatment period in subjects' ability as measured by using OHIP Edent scores to bite ($p = 0.017$) and chew a range of foods ($p = 0.007$).

*Conclusion:* Within the confines of the study, use of simple dietary advice and denture adhesives improved diet.

*Clinical significance:* The results of this pilot study suggest that denture fixatives may improve dietary behaviour of complete denture wearers.



## 1. Introduction

There is increasing recognition of the importance of healthy eating in all ages. Patients with complete dentures are potentially at risk of a less than healthy diet because of their reduced capacity to chew and eat healthy foods. Commonly, healthy foods contain more roughage and are more difficult to eat for complete denture wearers.[1] Masticatory efficiency falls with tooth loss, being worst in edentulous conventional complete denture wearers.[2,3] Complete denture wearers have markedly worse diets than dentate people.[4,5] Being edentulous with dentures appears to be associated with poorer intake across multiple nutrients[6,7] and there is strong evidence that

* *Corresponding author at*: Prosthodontics, King's College London Dental Institute, Floor 25, Guy's Tower, London Bridge SE1 9RT, UK. Tel.: +44 0207 188 5390; fax: +44 1207 188 5390.
E-mail address: david.bartlett@kcl.ac.uk (D.W. Bartlett).
0300-5712/$ – see front matter 
http://dx.doi.org/10.1016/j.jdent.2012.10.012

poor diet leads to ill health.[8] Whilst decreased masticatory efficiency of conventional complete dentures may adversely affect chewing ability and food choice, there is evidence that improving chewing ability, either by improving existing conventional complete dentures or by provision of mandibular implant supported overdentures, does not itself lead to any improvement in dietary choices.[9,10] Diet is complex, developed over a lifetime and influenced by many factors and is not easily modified for the better by dental interventions.[10] It has been shown that the use of a nutritional intervention in patients receiving new complete dentures can increase fruit and vegetable intake.[11]

There is disagreement between authors on the influence of quality of dentures on their success. Berg stated that no clinical or other factors were related to patient appreciation of complete dentures in a review paper that based its evidence on many small binary studies.[12] In patients with new complete dentures retention and stability was shown to significantly influence patient use of dentures for eating[13] and satisfaction with eating[14] in large multivariate modelling studies. These evidence-based-models explain how retentive and stable dentures provide patients with physical and psychological security. The apparent contradiction between these findings and those of others is explained because quality of complete dentures deteriorates rapidly in the mouth[15] and the fact that the effect of denture quality on satisfaction and outcome which was so strong at one week and at three months was completely abolished after two years.[16] The models also infer that improved retention and stability of maxillary dentures arising from use of a denture adhesive might result in improved chewing ability and patient reported satisfaction with, and use of, dentures.

The use of denture adhesive has been shown to improve retention and stability of complete dentures[17] and measures of quality of life.[18] However improved complete denture retention and stability does not necessarily result in improved diet.[19] There is a need to establish if a combination of denture adhesive and simple targeted dietary advice can improve diet. This study will test the hypothesis that use of a denture adhesive by complete denture wearers combined with simple dietary advice can beneficially alter nutrient intake. Possible changes in perception of biting and chewing ability, confidence and ability to eat more nutritious foods will also be investigated.

## 2. Materials and methods

Edentulous patients attending Guy's Hospital for consultations in relation to their existing complete dentures were considered for inclusion in this study. The inclusion criteria included experienced dentures wearers who were willing and able to give consent and to comply with the requirements of the study in self-reported good medical and mental health. The conventional complete dentures were free from major errors, one to seven years old, worn daily and for eating, the maxillary dentures were assessed to be well retained. The exclusion criteria included mucosal conditions or soreness/ulceration of the denture bearing tissues, immediate dentures of any age, denture intolerance or gagging tendency, history of allergy to denture or denture fixative constituents, xerostomia or use of xerostomia inducing medications, swallowing difficulties, current use of denture fixatives, objections to use of denture fixatives, severely resorbed maxillary or mandibular residual alveolar ridges.

Following consent, potential participants had a clinical examination. Dentures were assessed using the Olshan's modification[20] of Kapur retention and stability sum score.[21] Only those subjects with a retention and stability sum score of $\geq$6 (fair, good or very good denture fit) were included. Edentulous ridges were classified according Cawood and Howell scale[22] and those with a Cawood and Howell score of 5 and above were excluded (ridge forms of inadequate height and width and those with depressed ridge forms). This was done because those with existing complete dentures who have very reduced residual alveolar ridge form have been shown to be consistently unhappy with their complete dentures.[23]

Following the clinical examination suitable subjects were invited to participate and subsequently a dietary history was recorded using the health equality audit (HEA).[24] In brief, this computer-based-questionnaire recorded a full range of foods and drinks, together with an estimation of the quantity of each intake which was entered into a programme on a laptop computer (Table 1). The programme calculates, based on the range of food and drinks, the levels of fats, saturated fats, protein intake, and estimation of the Vitamin C intake and the number of servings of fruit or vegetables. Furthermore each subject was asked a series of questions from the NDNS (National Diet and Nutritional Survey) questionnaire which recorded the ability to eat a range of foods as ''could eat easily'', ''could eat with some difficulty'' or ''could not eat at all''. The questions included soft foods such as sliced bread, cheese, crusty bread, toast, oranges and roast potatoes; harder foods such as raw carrots, apples, nuts; thinly sliced foods such as lettuce, sliced cooked meats, crisps and chocolate. Finally, subjects completed the Oral Health Impact Profile questionnaire for edentulous patients, OHIP Edent.[25] For all subjects a single previously trained examiner asked and recorded the questions, assisting or clarifying when necessary. Subjects were then given two printed pamphlets providing information on healthy diets (''eat well'' [26] and the ''good life''[27]) and shown how to use the denture adhesive (Poligrip® Denture Adhesive Cream, GlaxoSmithKline Consumer Healthcare, Parsippany, USA). Participants were requested to use the adhesive every day for 30 days and to read the pamphlets. No attempt was made to provide dietary counselling. After one month subjects had a second clinical examination to assess oral condition and denture function using the same approach as used in the initial examination. All of the questionnaires used initially were repeated.

Data collected from the HEA3, NDNS and OHIP Edent questionnaires were analysed. For changes in number of servings of fruit and vegetables, the within-subject change from baseline was analysed using a one-sample t-test at the 5% significance level. For the other two primary variables, since the assumptions underlying the use of parametric tests were violated, a median change from baseline was calculated and analysed using a Wilcoxon signed rank test.

**Table 1 – The food types recorded by the HEA tool. Each subject was asked how often they consumed and the size (estimated from medium serving). The programme then calculated the outcome.**

| | Medium serving | Size Small/ medium/ large | How often Day/week/ month |
|---|---|---|---|
| Bread | 2 Medium slices | | |
| Toast | 2 Medium slices | | |
| Crackers | 3 Crackers | | |
| Bun/roll | 1 Bun/1 roll | | |
| Pitta/chapati | 1 Small piece | | |
| Rice/pasta | 6 TBLSP | | |
| Plantians | 1 | | |
| Potatoes | 3 Egg sized | | |
| Veg | 2 TBLSP | | |
| Salad | 3 TBLSP | | |
| Stewed fruit | 3 TBLSP | | |
| Fresh fruit | 1 Apple, etc. | | |
| Fruit juice | 160 ml | | |
| Lean meat | 4 Oz | | |
| All other meat | 4 Oz | | |
| Sausage roll | 1 | | |
| Eggs | 2 Medium | | |
| Bean/lentils | 3 TBLSP | | |
| Nuts | 1 TBLSP | | |
| Doughnut/cake | 1 Piece | | |
| Pudding | 1 Average bowl | | |
| Biscuits | 3 Small | | |
| Chocolate | Small bar | | |
| Ice cream | 1 Scoop | | |
| Crisps | 1 Small bag | | |
| Sugar | 1 TSP | | |
| Squash | 1 Can | | |
| Diet can | 1 Can | | |
| Tea | 1 Cup | | |
| Coffee | 1 Cup | | |
| Alcohol | 1 Glass wine | | |
| Fried/fatty | Medium portion of chips | | |
| Margarine | 1 Pat | | |
| Cooking oil | 1 Level TBLSP | | |
| Mayo | 1 TBLSP | | |
| Milk | 1/3 Pint | | |
| Semi skinned | 1/3 Pint | | |
| Skinned | 1/3 Pint | | |
| Cheese | Small matchbox | | |
| Yoghurt | Small pot | | |

## 3. Results

Thirty-five subjects were recruited and who satisfied the inclusion criteria and were willing to participate in the study. The majority were white (80%), with 13 (37.1%) males and 22 (62.9%) females. Mean age was 73.9 (range 55–84 years). At baseline, the mean sum score for denture retention and stability was 9.4, and the mean denture bearing tissue Kapur index total sum score was 15.6. All subjects used the adhesive over the 30 days.

Table 2 shows the results of the HEA3 questionnaire. The number of servings of fruit and vegetable per day increased significantly (<0.0001), on average by 1.4. Consumption of fat and saturated fat respectively, was reduced significantly (<0.0001), a reduction of 23.2 g and 11.3 g per day. Vitamin C intake per day increased significantly (<0.0001), by median 34.4 mg.

Fig. 1 shows the cumulative scores relating to the ability to bite and chew foods the full range of foods. There was a statistically significant improvement over the 30-day treatment period in subjects' ability to bite ($p = 0.0175$) and chew ($p = 0.0074$) a range of foods. The results from the analysis of the NDNS questionnaire demonstrated that the only foods which subjects perceived they could eat more easily at day 30 compared to baseline ($p < 0.05$) were tomatoes (could eat easily at day 30 = 77% vs. baseline = 54%) and well-done steaks (could eat easily at day 30 = 63% vs. baseline = 37%). The proportion who perceived they could easily eat apples was 37% at day 30 compared to 14% at baseline but this difference did not reach statistical significance. No other food type reached statistical significance. Fig. 2 shows that there were statistically significant improvements in 5 of the 7 functional domains of the OHIP Edent questionnaire. Significant improvements were seen in functional limitation, physical pain, psychological discomfort, physical disability and psychological disability, as well as in the overall score.

The safety results reported five adverse events, two oral tissue injuries related to the denture, one dry mouth and two related to gingival symptoms all of which were of mild intensity. Of the five, two were determined to be treatment related (dry mouth and mucosal pain). No serious adverse events were reported.

## 4. Discussion

The results from the study showed that this cohort of patients who had complete dentures improved their diet over a 30-day period. The study was designed to make preliminary investigations into establishing whether a combination of denture fixative use and dietary advice led to improved intake of healthy foods. As such our results need to viewed with some caution in that no control group was used to truly test the

**Table 2 – Median values for various food types estimated from the HEA tool.**

| | Fruit/veg servings | Total fat (g) | Saturated fat (g) | Non-specific proteins | Vitamin C (mg) | Starchy foods (servings) |
|---|---|---|---|---|---|---|
| N | 35 | 35 | 35 | 35 | 35 | 35 |
| Baseline | 2.2 | 83.6 | 33.5 | 13.7 | 70.5 | 3.6 |
| Day 30 | 3.6 | 60.5 | 22.2 | 13.6 | 102.2 | 3.6 |
| Change (95% CI) | 1.4 (0.9 to −1.9) | −23.2 (−31.4 to −14.9) | −11.3 (−14.7 to −7.9) | 2.0 (−0.2 to 4.9) | 34.4 (18.8–52.0) | 0 (−0.6 to 0.6) |
| P-value | <0.0001 | <0.0001 | <0.0001 | 0.074 | <0.0001 | 0.992 |

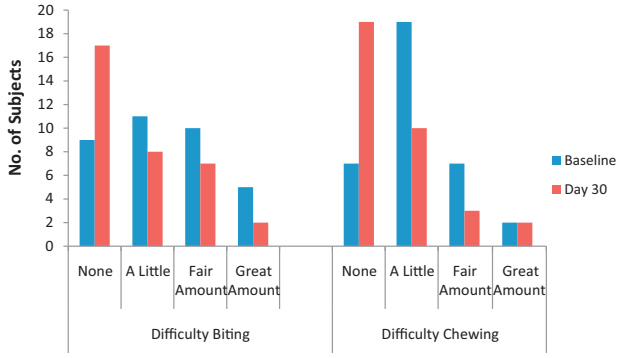



**Fig. 1 – The ability to bite and chew food at baseline and at 30 days estimated by the cumulative scores of a full range of foods derived from the NDNS questionnaire.**

hypothesis. However, the study showed an improvement, particularly in the number of portions of fruit and vegetables, but because of the preliminary nature of the study it was not possible to predict accurately whether it was the dietary information or the denture adhesive that was responsible for the improvement. The model of Fenlon, Walter and Sherriff predicts that more retentive and stable maxillary dentures should be associated with increased use of dentures for eating, better self-reporting by patients of improved chewing ability and ability to tackle a broader range of foods and of satisfaction with dentures.[13,14]

The authors choose dentures that were at least one year old. Dentures which had been recently delivered might have optimal retention and stability and consequently less perceived benefit from a denture fixative. The authors arbitrarily chose dentures between one and seven years old which were thought to be a compromise between newly fitting and potentially superior retention and older dentures with deteriorating fit and retention. The decision on dentures was also aided by the modified Kapur index,[21] and the Caywood and Howell scores.[22] Poorly fitting and unretentive dentures are less likely to benefit from a denture adhesive and

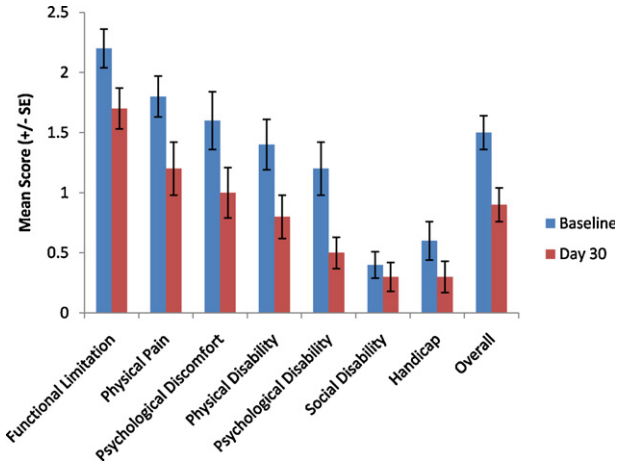



**Fig. 2 – Comparison of the subjective outcome over the 30 days assessed using the modified OHIP Edent questionnaire.**

any contribution of the adhesive might be overwhelmed by the challenges of the denture. Unfavourable alveolar ridge form has been shown to result in poor retention and stability and dissatisfaction in patients wearing complete dentures.[23] Use of Kapur, and the Caywood and Howell scores insured that broadly similar patients were recruited. Both evaluations were only conducted at the first visit to ensure the dentures wearers had the capacity to improve retention and stability. Whereas if the dentures construction and the denture bearing area were too compromised the fixative may not have had any perceived benefit.

The improvement in the dietary intake showed the combined impact of dietary information sheets and improved ability to eat whilst using denture adhesives. All the measures except protein intake and starch foods were significantly improved. Total and saturated fats, fruit and vegetable and Vitamin C all improved significantly compared to the baseline values showing how the diet had changed over the 30-day period. This data suggests within this cohort that there was an effort to improve the dietary intake but the long-term impact of these changes is not possible to predict but in this cohort of patients without teeth there is a possibility that the diet may continue to be improved once the confidence to eat the healthier foods has evolved. Further testing on the value of the adhesive and the long-term effects need to be evaluated.

The dietary information given to the subjects were delivered within two government brochures. No additional information on diet was given. They were partly graphical in nature and emphasised the importance of maintaining a healthy diet giving illustrations of fruits and vegetables to highlight the importance. It is not possible to predict in what way the subjects took up information. The HEA tool also listed common dietary components and it is also possible by simply asking them how many pieces of fruit they consumed before the study stimulated them to eat more once the study commenced.[24] However, despite these potential flaws the results from the Edent OHIP score supported the principle that dietary behaviour had changed and that it was easier to consume healthier foods whilst using the fixative.

Of particular interest were improvements in patient reported chewing and biting ability found in OHIP Edent scores. As eating a healthy diet involves substantial amounts of fruit and vegetables which tend to be fibrous and therefore difficult for complete denture wearers to consume, many denture wearers have a poor diet. The increase in functionality conferred by using a denture adhesive may have increased the capability of denture wearers to consume healthy foods. However dietary preference is complex and ability to chew a healthy diet does not always guarantee a healthy diet.[4,5]

The HEA tool was a previously validated and observed to be a convenient method to record the daily intake of food from each participant. Participants reported their average daily diets for a series of common diet products. The validated programme then estimated the nutritional content of the foods to give a breakdown of fats, proteins, carbohydrates and vitamins. After a maximum of 30 days the same questions were repeated and then the programme compared the outcomes. It was therefore possible to analyse the dietary components before and after the intervention. By the very nature of the method it was an objective estimate of food

intake and relied on the subject to provide an accurate representation of their dietary intake. In common with all methods to record diet, it relies on the memory of subjects and their ability to provide accurate record of dietary intake. However, the advantage of the HEA tool was that the programme calculated the daily intake of fruit/vegetables, fats and Vitamin C. This allowed a more detailed analysis of the data. There is no way to accurately determine dietary intake and so these semi-objective methods provide some evidence of dietary change. The other assessments, NDNS and OHIP supported the findings presented by the HEA tool and they all suggested that in this small cohort of conveniently recruited subjects improved the diet improved. The challenge in further studies will be to elucidate whether the impact was from the fixative or from the dietary information.

## 5. Conclusions

The combination of denture adhesive and simple dietary advice in the form of diet leaflets produced significant improvements in food choices in edentulous adults.

Use of a denture fixative significantly improved OHIP Edent scores, implying an improvement in oral health related quality of life.

## Conflict of interest

Sponsored by GlaxoSmithKline Consumer Healthcare.

## Acknowledgement

The authors would like to thank GlaxoSmithKline Consumer Health Care, Weybridge, Surrey, UK for the financial support for this study.

REFERENCES

1. Goiato MC, Ribeiro Pdo P, Garcia AR, dos Santos DM. Complete denture masticatory efficiency: a literature review. *Journal of the California Dental Association* 2008;**36**:683–6.
2. Gunne H-SJ. Masticatory efficiency and dental state. A comparison between two methods. *Acta Odontologica Scandinavica* 1985;**43**:139–46.
3. Wayler AH, Muench ME, Kapur KK, Chauncey HH. Masticatory performance and food acceptability in persons with removable partial dentures, full dentures and intact natural dentition. *Journal of Gerontology* 1984;**39**:284–9.
4. Sheiham A, Steele JG, Marcenes W, Lowe C, Finch S, Bates CJ, *et al.* The relationship among dental status, nutrient intake, and nutritional status in older people. *Journal of Dental Research* 2001;**80**:408–13.
5. Nowjack-Raymer RE, Sheiham A. Association of edentulism and diet and nutrition in US adults. *Journal of Dental Research* 2003;**82**:123–6.
6. Wayler AH, Chauncey HH. Impact of complete dentures and impaired natural dentition on masticatory performance and food choice in healthy aging men. *Journal of Prosthetic Dentistry* 1983;**49**:427–33.
7. Joshipura KJ, Willett WC, Douglass CW. The impact of edentulousness on food and nutrient intake. *Journal of American Dental Association* 1996;**127**:459–67.
8. Heinrich M, Prieto JM. Diet and healthy ageing 2100: will we globalise local knowledge systems? *Ageing Research Reviews* 2008;**7**:249–74.
9. Sandstrom B, Lindquist LW. The effect of different prosthetic restorations on the dietary selection in edentulous patients. A longitudinal study of patients initially treated with optimal complete dentures and finally with tissue-integrated prostheses. *Acta Odontologica Scandinavica* 1987;**45**:423–8.
10. Ettinger RL. Changing dietary patterns with changing dentition: how do people cope? *Special Care in Dentistry* 1998;**18**:33–9.
11. Bradbury J, Thomason JM, Jepson NJ, Walls AW, Allen PF, Moynihan PJ. Nutrition counseling increases fruit and vegetable intake in the edentulous. *Journal of Dental Research* 2006;**85**:463–8.
12. Berg E. Acceptance of full dentures. *International Dental Journal* 1993;**43**:299–306.
13. Fenlon MR, Sherriff M, Walter JD. An investigation of factors influencing patients' use of new complete dentures using structural equation modelling techniques. *Community Dentistry & Oral Epidemiology* 2000;**28**:133–40.
14. Fenlon MR, Sherriff M. An investigation of factors influencing patients' satisfaction with new complete dentures using structural equation modelling. *Journal of Dentistry* 2008;**36**:427–34.
15. Bergman B, Carlsson GE, Hedegard B. A longitudinal two year study of a number of full denture cases. *Acta Odontologica Scandinavica* 1964;**22**:3–26.
16. Fenlon MR, Sherriff M. Investigation of new complete denture quality and patients' satisfaction with and use of dentures after two years. *Journal of Dentistry* 2004;**32**:327–33.
17. Munoz CADDS, Gendreau L, Shanga G, Magnuszewski T, Fernandez P, Durocher J. A clinical study to evaluate denture adhesive use in well-fitting dentures. *Journal of Prosthodontics* 2012;**21**:123–9.
18. Nicolas E, Veyrune JL, Lassauzay C. A six-month assessment of oral health-related quality of life of complete denture wearers using denture adhesive: a pilot study. *Journal of Prosthodontics* 2010;**19**:443–8.
19. Moynihan P, Thomason M, Walls A, Gray-Donald K, Morais JA, Ghanem H, *et al.* Researching the impact of oral health on diet and nutritional status: methodological issues. *Journal of Dentistry* 2009;**37**:237–49.
20. Olshan AM, Ross NM, Mankodi S, Melita S. A modified Kapur scale for evaluating denture retention and stability: methodology study. *American Journal of Dentistry* 1992;**5**:88–90.
21. Kapur KK. A clinical evaluation of denture adhesives. *Journal of Prosthetic Dentistry* 1967;**18**:550–8.
22. Cawood JI, Howell RA. A classification of the edentulous jaws. *International Journal of Oral & Maxillofacial Surgery* 1988;**17**:232–6.
23. Fenlon MR, Sherriff M, Walter JD. Comparison of patients' appreciation of 500 complete dentures and clinical assessment of quality. *European Journal of Prosthodontics & Restorative Dentistry* 1999;**7**:11–4.
24. Little P, Barnett J, Margetts B, Kinmonth A-L, Gabbay J, Thompson R, *et al.* The validity of dietary assessment in general practice. *Journal of Epidemiology and Community Health* 1999;**53**:165–72.
25. Allen F, Locker D. A modified short version of the oral health impact profile for assessing health-related quality of life in edentulous adults. *International Journal of Prosthodontics* 2002;**15**:446–50.
26. Eat well—a guide to healthy eating. London, United Kingdom: Food Standards Agency; 2005.
27. The good life. London, United Kingdom: Food Standards Agency; 2007.