

An effective oral health promoting message?

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IN BRIEF

- Social inequalities in oral health are a reality today.
- Oral health education (OHE) has an important part to play in oral health promotion, particularly in order to reduce social inequalities.
- A clear, common, unambiguous dietary message is necessary in order to improve effectiveness of OHE.
- A message is presented that may facilitate improvements in communication.

This paper questions the effectiveness of current oral health promoting activities in reducing social inequalities in oral health. An attempt is made to address the needs of dental professionals and nutritionists in communicating an understanding of biological aspects of the aetiology of caries and erosion. With a clear understanding of the disease process oral health promoters can possibly reduce social inequalities in oral health. A clear common message which satisfies both dental and nutritional professionals is presented. The issues of commonality and ambiguity are fundamental to effective behavioural/teaching practice. Currently the evidence base suggests that dietary messages are inconsistent and ambiguous. Therefore, a clear common and unambiguous dietary message, based on science, could go some way to improving oral health inequalities.

INTRODUCTION

Social inequalities in oral health are apparent and increasing in the UK.^{1,2} The determinants of oral health have been identified as deprivation, age, gender, ethnicity, environment, psycho-social, poverty and lifestyle.³

Approaches to oral health improvement have been tackled at a collective level through dental public health services with the application of water fluoridation being high on the health promotion agenda as this improves the health of the community regardless of the behaviour of the individual.³ Strategies aimed at the individual are dependent on behavioural compliance, and historically these strategies have tended to increase social division.⁴⁻⁶ Shah *et al.* suggest that interventions to change behaviour have enormous potential to alter disease patterns.⁷ However, the same study identified conflicts in dietary messages having negative effects on the behaviour, motivation and attitudes of individuals.

More recently services have embraced a wider 'common risk factor' approach

to the delivery of oral health promotion in order to influence behaviour.^{8,9} In order for this to be effective consistent nutritional guidelines are essential to improve health.⁷ Stillman-Lowe stresses that commonality and ambiguity should be addressed in order to improve the effectiveness of oral health promotion activities.¹⁰ Inconsistencies are found not only between healthcare professionals (dental, dietetic and nutritional students)⁷ but also among dental professionals.¹¹

The common risk factor approach to health promotion is a sensible approach. This approach recognises that a host of chronic diseases can be prevented through a unified approach towards healthy behaviours. These include a balanced diet and regular exercise.

The Food Standards Agency's 'Eat Well Plate' shows the types and proportions of food that are needed to make up a healthy and well-balanced diet.^{12,13} The consumption of bread, especially wholegrain variety, as well as potatoes, rice and pasta should provide about one-third of the total volume of food eaten.^{12,13} However, the consumption of non-milk extrinsic sugars (NMES), the so-called added sugar, is still above the Dietary Reference Value (DRV) of no more than 11% of food energy intake.^{14,15} The recommendation to base a meal on starchy foods is undoubtedly a

step towards a healthy diet as carbohydrate is the principal source of energy as well as providing fibre, B vitamins, and to some extent calcium and iron.¹³

NUTRITIONAL BACKGROUND

The National Diet and Nutrition Survey (NDNS) aims to identify the food consumption, nutrient intake and nutritional status of people living in private households.¹⁵ The result of the first year of the national survey of British people aged 1½ years and older shows that total carbohydrates provided about 47% food energy in adults and 51% in toddlers and children four to 18 years old.¹⁵ The main source of energy for all age groups was provided by the group listed as cereal and cereal products with bread as the main contributor.¹⁵ Although the consumption of white bread in all ages group was reduced if compared with past surveys, toddlers' consumption did not show the same reduction.¹⁵ The Low Income Diet and Nutrition (LIDN) survey also identified that among the cereals food group white bread was the most popular choice (children 90%, adults 83%).¹⁶

Food behaviour and therefore food choices are affected by many factors: availability, cost and preferences; cultural values and cooking skills; eating patterns; parents' beliefs and practices;

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peers' influence; food marketing and so on.¹⁷ Income is one of the major determinants of children's eating and drinking habits.¹⁷ Comparison of the NDNS 2003 data with the LIDNS 2007 survey showed that consumption of non-diet, non-carbonated soft drinks was greater in children and young people four to 18 years old in LIDNS in comparison with NDNS.¹⁸ Children in the low income group had a significantly higher intake of non-milk extrinsic sugars (NMES)¹⁶ and obtained a greater amount of energy and nutrients from snacks.¹⁷

Between-meal eating and/or drinking habits are seen as acceptable health behaviours, providing the snack/drink is sugar free.¹⁹ However, it is reported that young people tend to skip 'proper meals' and 'snacking' and 'grazing' is becoming the 'westernised' way of eating.^{20,21} An understanding of food behaviour and choices by different social sub-groups is important if any inroads are to be made towards reducing social inequalities in oral health.

Bread is advised as one of the suitable snacks along with fresh fruit, vegetable sticks and cubes of cheese, especially for children 3-5 years old.^{13,22} Bread is promoted as a suitable between meal snack in an oral health promotion campaign.²² Bread is used as an example of a food that contains hidden sugars. As such there is potential for confusion when promoting sugar free snacks.

The evidence suggests that although ground and heat-treated starch is less cariogenic than sugar, it still induces dental caries.²³ The potential of cooked starch to induce caries increases as sugar is added.²³ Bread is rarely consumed alone but with different fillings. Surveys carried out by Evans *et al.*²⁴ and the School Food Trust²⁵ aiming at accessing the composition and nutritional content of packed lunches showed that the majority of children bringing a packed lunch had a sandwich and of those 20% had a sweet filling (jam, chocolate spread, etc) with a higher average intake of NMES.^{24,25}

AIMS

This paper utilises the promotion of bread as an acceptable between meal snack to demonstrate ambiguity in the message delivered by oral health promoters and rationalise the dental and nutritional

understanding of desired behaviours to enable improved oral and general health outcomes in populations. The paper also reports on sugar and salt content in commonly consumed breads.

SCIENTIFIC BASIS

The dental perspective

Caries

The biology of the mouth is such that tooth enamel is in a constant state of flux with regard to its mineral content. While the mouth is empty the minerals in the saliva are deposited into the tooth enamel; this process is termed remineralisation. However, when the mouth contains sugars these are metabolised in the plaque so as to cause the reverse, in that the minerals are lost from the enamel into the saliva; this process is termed demineralisation. Demineralisation occurs while the sugar is in the mouth and for a further period of about 30 minutes. This dynamic state allows the tooth structure to remain intact providing remineralisation exceeds demineralisation.³

Within this theoretical base, clinicians now understand that dental caries is no longer a non-self-repairing disease. In some circumstances early lesions can remineralise without the need for tissue removal and restoration. Baelum suggests that the diligent visual-tactile caries examination should be the main diagnostic tool for assessment, particularly focusing on lesion activity and tooth surface integrity.²⁶

Erosion

Another form of demineralisation can occur when tooth enamel is bathed directly in acids (carbonated drinks, fruit juices, acid reflux). This demineralisation is direct and occurs only while the acid is bathing the tooth.³

Therefore in order to maintain tooth health and structure the teeth need enough time for adequate remineralisation while managing a balanced diet.

The nutritional perspective

The recommendation to base meals on starchy foods is an attempt to change the traditional perception that meals should be based on protein-rich foods such as meat, fish or eggs.¹³ Meal pattern is also a key component of healthy eating

and spaced meals consumed at regular intervals are recommended to maintain energy levels.¹³

The glycaemic index (GI) or glycaemic load (GL) rate the potential of foods to raise blood glucose and insulin levels.²⁷ The GI ranks carbohydrates according to their effect on blood glucose levels. Low GI foods provide low to moderate fluctuations in blood sugar stimulating less insulin release.^{27,28} Recent studies and Cochrane systematic reviews have shown that low GI or GL diets have been associated with a lower incidence of cardiovascular disease, diabetes and certain cancers, a reduction of total and LDL cholesterol, a better management of diabetes and a greater loss of body fat.²⁸ However, the type of carbohydrate, the dietary fibre content, the cooking method, the composition of the meal have an effect on the speed of carbohydrate to glucose conversion.²⁷ Low GI foods such as pulses and apples²⁷ provide a slower and steadier release of glucose to the bloodstream whereas high GI foods such as white bread produce a much more rapid increase in blood glucose causing rapid insulin response.²⁸

As a result regular meals are recommended by nutritionists in order to maintain constant blood sugar levels.

Bread

Bread can be broadly divided into two categories, ones made without yeast and those made with yeast. The latter includes different types from white to wholemeal to brown with or without added fibre or oats. The bread can be in the form of sliced/unsliced loaves, baguettes, bread rolls, ciabatta, pitta bread and many more.²⁹

However, according to the 'Bread and Flour Regulations 1998', which regulate labelling and compositional standards for the breads and flours as well as the use of additives and the addition of certain nutrients, 'bread' is defined as:

'A food of any size, shape or form which is usually known as bread and consists of a dough, made from flour and water with or without other ingredients, which has been fermented by yeast or otherwise leavened and subsequently baked or partly baked, but does not include buns, bun loaves, chapattis, chollas, pitta bread, potato bread or bread specially prepared for coeliac sufferers.'³⁰

McCance and Widdowson provided comprehensive nutritional data of the most commonly consumed foods in the United Kingdom. Samples of different types of bread were analysed presenting the content of starch, total sugars, dietary fibre, fat and protein as well as micronutrients availability.³¹

Flour naturally contains 1-2 g sugars per 100 g of edible part. Sugars are also formed during the bread making process through fermentation by yeast; these sugars will be extrinsic sugars. Breads showing no added sugars on packaging ingredients lists may contain these extrinsic sugars. Some bread manufacturers also add sugar to bread to help the crust to brown or to speed up the fermentation process.^{29,31}

If bread has sugar on the ingredients list then NMES sugar will have been added to the bread. Bread without sugar on the ingredients list will also contain NMES as a result of the fermentation process of bread making.

DATA COLLECTION

The NDNS and the LDNS identified that white and wholemeal breads were the most popular brands consumed by participants. Therefore, a representative sample of pre-packaged sliced white and wholemeal breads were taken from the shelves of Tesco, Asda, and other stores.

However, most supermarkets offer special incentives to customers such as two-for-one deals or two at a reduced price on selected products. As a result, different types of bread (brown, seeded, 50/50, etc) on special offers were included in the sample.

A sample of 36 frequently consumed packaged breads were taken from the shelves of Tesco, Asda, and other stores. These stores were chosen so as to represent a broad social population. Each package was analysed to establish sugar and salt content.

RESULTS

Table 1 shows the sugar and salt contents of all 36 breads. There were 12 breads costing 60 pence or less. Six were white, five wholemeal and one brown. All breads costing sixty pence or less, apart from one, had >3.5 g sugar per 100 g. Five cheapest breads at 47 pence had >4 g of sugar per 100 g.

The salt content per 100 g did not show a great difference between the cheapest and more expensive bread loaves with an average content of 1.1 g per 100 g.

Table 1 Sugar and salt content grams/100 g of various breads

Type of bread	Cost £	Grams sugar/100 g	Grams salt/100 g
Tesco Value Thick Sliced White Bread	0.47	4.3	1.0
Tesco Value Medium Sliced Wholemeal Bread	0.47	3.8	1.0
Tesco Wholemeal Medium Sliced Loaf	0.60	3.8	1.0
Tesco Medium Sliced White Loaf	0.69	4.5	1.0
Tesco Organic Thick Sliced White Bread	1.14	3.2	1.5
Brace's Medium White (Tesco)	1.14	4.2	1.2
Brace's Thick Wholemeal (Tesco)	1.14	2.4	1.1
Brace's Bread Malted Grain Classic (Tesco)	1.25	2.2	1.5
Hovis Soft White Medium (Tesco)	1.15	3.5	1.1
KingsMill Seeds and Oats (Tesco)	1.20	3.0	0.9
KingsMill 50/50 White Medium (Tesco)	1.25	3.4	1.0
Warburtons Crusty Premium White Loaf (Tesco)	1.35	2.3	1.1
Warburtons Toastie Thick Sliced White Bread (Tesco)	1.35	2.2	1.1
ASDA Smartprice Medium Sliced White Bread	0.47	4.4	1.0
ASDA Smartprice Medium Sliced Brown Bread	0.47	4.5	1.0
ASDA Medium Sliced Square Cut White Bread	0.60	3.9	1.0
ASDA Medium Sliced Square Cut Wholemeal Bread	0.60	3.3	0.9
ASDA Fresh for a Week Medium Sliced Wholemeal Bread	0.80	3.0	0.9
Kingsmill Sliced Soft White Farmhouse (ASDA)	1.10	4.1	1.1
Kingsmill Tasty Wholemeal Thick Bread (ASDA)	1.10	4.3	1.1
Kingsmill the Lightly Seeded One (ASDA)	1.49	3.3	0.9
Hovis Soft Thick Sliced White Loaf (ASDA)	1.15	3.5	1.1
Hovis Best of Both Thick Sliced White Bread (ASDA)	1.15	3.6	0.9
Hovis Wholemeal Medium Sliced Bread (ASDA)	1.15	4.1	1.1
Hovis Rich Et Roasted Seed Sensation (ASDA)	1.34	3.8	1.1
Warburtons Medium Sliced Wholemeal Bread (ASDA)	1.35	3.8	1.1
Riding Lodge White Bread (Thick Sliced) - LIDL	0.47	4.1	0.9
Rowan Hill Wholemeal (Medium Sliced) - LIDL	0.59	3.6	0.9
Rowan Hill Bakery White (Medium Sliced) - LIDL	0.69	4.0	1.0
Rowan Hill Bakery Malted Grain (LIDL)	0.85	2.9	0.9
Village Bakery Medium White (Aldi)	0.47	4.5	0.9
Village Bakery Square Sandwich Wholemeal (Aldi)	0.59	4.0	1.1
Village Bakery Soft Wholemeal (Aldi)	0.69	4.9	1.2
Village Bakery White Seeded Batch Loaf (Aldi)	0.99	2.1	1.1
KingsMill Wholemeal Medium (Costcutter)	1.26	4.3	1.1
Farmhouse Thick Sliced White Bread (Spar)	0.75 (400g)	3.7	1.5

The sugar in bread comes from two sources. It is either added by the manufacturer into the dough or it is liberated by the yeast from the flour.²⁹ Around one third of the bread analysed (28%) showed sugar added in the ingredient list and was described as sugar, dextrose or molasses sugar.

DISCUSSION

All the breads contained NMES at different levels; all of the breads would have a healthy green Food Standards Agency label as there were <5 g NMES per 100 g (Table 2). Whether or not the levels contained in the breads were adequate to be cariogenic is not significant to the argument of a clear concise unambiguous message, particularly for disadvantaged groups. Moynihan suggests that avoiding sugar-rich snacks between meals may be meaningless for those who do not follow a structured meal pattern. Westernised eating patterns for young people tend to be unstructured and this is particularly so for deprived sub-groups with higher NMES intake.¹⁹

Approaches to health promotion have advocated healthy snacks and bread is given as an example of a healthy snack.²² There is no doubt that bread is a healthy food but ambiguity arises in the message if sugary snacks are to be avoided when the snack promoted contains sugar, regardless of the amount. Furthermore, bread is rarely eaten alone.^{24,25} Increasing social inequality is a problem in the UK and therefore attempts to improve the oral health of populations considered to be deprived are fundamental to addressing this position. Particularly if the food behaviour and choices of the social groups is such that more of the food type is consumed and consumption tends to be more frequent.

The oral health of middle class children in the UK is now considered to be relatively good, with England demonstrating the best DMFT (decayed missing filled teeth) for 12-year-olds in Europe.³² The population pockets experiencing relatively high levels of caries, even though the disease is preventable, are generally but not exclusively from areas that are considered to be deprived.

Caries, as a disease that requires extensive operative intervention, is experienced mainly in deprived populations. Whole community approaches to dental public health publications often provide a simplified 'average' view of caries in the community. Data are often presented as a percentage of the community having disease experience regardless of severity. This can result in non-dental professionals perceiving high caries levels in the community. Although the specific

Table 2 The UK Food Standard Agency (FSA) guidance lists traffic lights as:

Food (per 100 g whether they are sold by volume)				
	Green (low)	Amber (medium)	Red (high)	
Fat	≤3.0 g / 100 g	≥3.0 g to ≤20.0 g / 100 g	>20.0 g / portion	>21.0 g / portion
Sat fat	≤1.5 g / 100 g	≥1.5 g to ≤5.0 g / 100 g	>5.0 g / portion	>6.0 g / portion
Sugar	≤5.0 g / 100 g	≥5.0 g to ≤12.5 g / 100 g	>12.5 g / portion	>15.0 g / portion
Salt	≤0.3 g / 100 g	≥0.3 g to ≤1.5 g / 100 g	>1.5 g / portion	>2.4 g / portion

proportions are disputed, in reality the skewed nature of disease distribution demonstrates a general 80:20 distribution with 80% of the disease observed in 20% of the population.³³ This means that only two out of ten have a high treatment need. Baelum suggests that the low levels of disease found in child populations are also found in adult populations.²⁶ The recent UK Adult Dental Health Survey also supports this view.³⁴ There is a positive correlation between deprivation and caries experience. It is often not understood that over half of 12-year-olds in the UK have not experienced non-reversible, cavitated dental caries.³⁵ Disease risk is higher in socially deprived populations and there is a challenge for health professionals to engage with individuals to change disease risk through their behaviours.

Therefore, there is merit in communicating a common message that is based on the science that adequate remineralisation is a prerequisite for sound enamel and disease inactivity. Simply and specifically this can be achieved by keeping the mouth empty for two hours between episodes of food and/or drink. There is some suggestion of this approach in the literature.^{36,37} Cameron and Widmer state 'Probably the best dietary advice of all is to "give teeth a rest" for at least two hours between every meal or snack.'³⁶ Moynihan also identifies the need for a more pragmatic approach to providing guidance on a numerical limit to the number of sugar intakes.¹⁹ However, this approach does need to identify hidden sugars in foods, something that is very difficult to achieve. We have utilised bread as an example of ambiguity in the health message in this paper but there are many perceived safe snacks that contain sugars, for example flavoured crisps. Furthermore, the oral retentiveness of foods such as crisps will have an effect on longevity of demineralisation.

Along with the management and prevention of caries, the management and prevention of erosion should be considered. The influence of socioeconomic variables on tooth erosion have shown contradictory results. Some investigations showed a significant positive relationship between tooth erosion experience and socioeconomically deprived areas.³⁸⁻⁴⁰ In contrast, other studies have observed more erosive lesions in children from higher socioeconomic groups.⁴¹⁻⁴⁶ Erosion is a problem more noticeable in caries-free dentitions and thus the middle classes. In this situation acidic sugar free drinks will be problematic if consumed frequently.

As long ago as 1989 Jacob and Plamping reported that behavioural goals should be: appropriate, realistic, measurable, positive, important, time related and specific.⁴⁷ The simple message of leaving the mouth empty for two hours fulfils these behavioural principles. The promotion of safe snacks condones grazing as an acceptable behaviour regardless of how the food/drink episode is defined. This is particularly dangerous in the context of snacks between small frequent meals. This is not only dangerous from a dental point of view but also in order to avoid obesity if a greater total amount of energy is consumed than required.⁷ This is particularly so when the consumption of NMES is above the DRV of no more than 11% of food energy intake.¹⁴ Focusing on a measurable time frame for remineralisation also allows individuals the freedom to define an episode of food/drink as a drink, meal or a snack.

Improvements in caries trends in young cohorts can only be made if improvements are seen in social inequalities as affluent groups (not exclusively) are already caries-free at 12 years of age. In order to reduce caries levels in deprived groups a clear and consistent message could go some

way towards achieving this. This is particularly so if cheaper breads with higher sugar contents are purchased by individuals considered to be deprived and on low incomes. This is pertinent when we know that the consumption of white bread, in all age groups, was reduced when compared with past surveys, except for in toddlers.¹⁵ Caries prevalence at five years is a key indicator for the UK governments. The promotion of allowing a period of time for remineralisation would generate an awareness regarding the consequence of constant use of bottles or feeders. Along with improvements in caries, a coincidental reduction in the risk of erosion is also likely if adequate remineralisation is allowed. The problem of frequent fizzy drinks (both sugar-free and sugared) in teenage groups would be addressed.

In order to share a common professional message within dentistry Levine and Stillman-Lowe suggest four points should be made for oral health promoting: reduce the consumption and especially the frequency of intake of foods and drinks with added sugars; clean the teeth thoroughly twice every day with a fluoride toothpaste; fluoridation of the water supply; and have an oral examination at least every year. This edition does include the adoption of NICE guidelines regarding routine dental examinations.³

There is a danger that clinical dental practice may develop along a pathway that accepts the determinants of oral health as outside the control of the individual in deprived sub-groups. Therefore, it would be understandable that water fluoridation would receive high priority with policy makers. However, water fluoridation without an individual behavioural approach to creating a disease inactive oral environment (including diet control, plaque control and toothpaste with fluoride) is unlikely to impact on the high caries individual (20% with 80% of the disease) so as to modify caries status to low risk. It is interesting to note that the recent ADHS show adult disease trends in the West Midlands (fluoridated population) consistent with other similar demographic populations. Policy makers and clinicians must be mindful of this as caries is no longer seen as a disease of young cohorts.⁴⁸

Stillman-Lowe¹⁰ identified the fact that historic attempts at influencing behaviours

at a community level by clinicians had created negative scenarios because of variation in dentists' approach to the delivery of prevention; the messages given had been skewed by the subjective views of the deliverer and little reflection on outcomes had been undertaken when prevention had been delivered. As a result practitioners became disillusioned when people didn't listen or act on advice. Perceptions were formed that middle class patients were more motivated and therefore were more likely to receive advice. Other studies have demonstrated that dental practitioners tend to react to the presence of disease, tertiary prevention rather than primary prevention.^{7,49} In this situation the clinician may feel that it is unrealistic to expect compliance from individuals from labelled subgroups.

A behavioural approach to managing oral diseases is not like the restorative approach to which the dental clinician is familiar. The restorative approach is easily monitored on an individual basis as fillings or extractions can be quantified for that individual. A behavioural approach cannot be monitored easily on an individual basis as a behaviour change may be immediate or delayed. However, collective trends can be measured for the effect of behaviour change. An effective behavioural approach will impact on collective outcomes within clinical practice over a time frame. In order to avoid disappointment with outcomes clinicians need to review their definitions of success and move from an individual approach towards a collective approach in their practice profile.

Clearly it is important that lay persons understand the importance of allowing the mouth conditions to be such that adequate remineralisation of dental enamel is enabled.

Dental caries is a multi-factorial process and dental erosion is dependent on direct acidic conditions in the mouth. This paper has taken a behavioural approach to creating a simple unambiguous dietary message to the layperson. This message should be delivered in the wider context of regular dental care and the use of fluoride toothpaste of adequate strength without rinsing after brushing both morning and night. The context of a balanced diet should not be ignored and consideration should be given to obesity and fat and salt levels in

commonly consumed foods. Also the use of xylitol in chewing gums can be used to facilitate infrequent eating and/or drinking, as this can be promoted within the two hour time frame.

CONCLUSION

Interventions to change behaviour have the potential to alter disease trends. Conflicts in dietary messages can have negative effects on the behaviour, motivation and attitudes of individuals. Bread, a healthy food, has hidden NMES sugar (as have other food products) and therefore presents a potentially confusing message to the layperson when promoted as a safe snack. In an attempt to present an acceptable 'common and unambiguous' message to health care professionals a simple message of leaving the mouth empty for two hours between episodes of food and/or drink is suggested. This fulfils dental, nutritional and educational principles. Currently there is no evidence-base to support the effect of this simple message and therefore further research is necessary to test its efficacy, particularly for the incidence of caries in deprived populations and the incidence of erosion in the whole population.

- Office of National Statistics. *Adult Dental Health Survey. Oral health in the United Kingdom*. 1998.
- British Dental Association. *Oral health inequalities policy*. London: British Dental Association, 2009.
- Levine R S, Stillman-Lowe C R. *The scientific basis of oral health education*. London: BDJ Books, 2009.
- Kay E J, Locker D. *Effectiveness of oral health promotion: a review*. London: Health Education Authority, 1997.
- Schou L, Wright C. Does dental health education affect inequalities in dental health? *Community Dent Health* 1994 **11**: 97–100.
- Sprod A J, Anderson A, Treasure E T. *Effective oral health promotion: literature review*. Technical Report 20. Cardiff: Health Promotion Wales, 1996.
- Shah K, Hunter M L, Fairchild R M, Morgan M Z. A comparison of the nutritional knowledge of dental, dietetic and nutritional students. *Br Dent J* 2011; **210**: 33–38.
- Sheiham A, Watt R. The common risk factor approach: a rational basis for promoting oral health. *Community Dent Oral Epidemiol* 2000; **28**: 399–406.
- Watt R. Emerging theories into the social determinants of health: implications for oral health promotion. *Community Dent Oral Epidemiol* 2000; **30**: 241–247.
- Stillman-Lowe C. Oral health education: what lessons have we learned? *Oral Health Report* 2008; **2008(2)**: 9–13.
- Threlfall A G, Milsom K M, Hunt C M, Tickle M, Blinkhorn A S. Exploring the content of the advice provided by general dental practitioners to help prevent caries in young children. *Br Dent J* 2007; **202**: E9.
- National Health Service. The eatwell plate. <http://www.nhs.uk/Livewell/Goodfood/Pages/eatwell-plate.aspx> (accessed May 2011).
- Thomas B, Bishop J. *Manual of dietetic practice*. Oxford: Blackwell Publishing, 2007.
- Department of Health. *Dietary reference values for food energy and nutrients for the United Kingdom*.

- Report of the Panel on Dietary References Values of the Committee on Medical Aspects of Food Policy. No 41. HMSO: London, 1991.
15. Bates B, Lennox A, Swan G. *National diet and nutrition survey. Headline results from year 1 of the Rolling Programme (2008/2009)*. A survey carried out on behalf of the Food Standard Agency (FSA) and the Department of Health (DH). Available at: <http://www.food.gov.uk/multimedia/pdfs/publication/ndnsreport0809.pdf> (accessed May 2011).
 16. Nelson M, Erens B, Bates B, Church S, Boshier T. *Low income diet and nutrition survey*. A survey carried out on behalf of the Food Standard Agency. London: The Stationery Office, 2007.
 17. Patrick H, Nicklas T. A review of family determinants of children's eating patterns and diet quality. *J Am Coll Nutr* 2005; **24**: 83–92.
 18. Gregory J R, Lowe S, Bates C J *et al*. *National diet and nutrition survey: young people aged 4 to 18 years*. Volume 1: Report of the diet and nutrition survey. London: TSO, 2000.
 19. Moynihan P. The British Nutrition Foundation Oral Task Force Report – issues relevant to dental health professional. *Br Dent J* 2006; **188**: 308–312.
 20. Savige G, MacFarlane A, Ball K, Worsley A, Crawford D. Snacking behaviours of adolescents and their association with skipping meals. *Int J Behav Nutr Phys Act* 2007; **4**: 36.
 21. Anderson A S, Macintyre S, West P. Adolescent meal patterns: grazing habits in the west of Scotland. *Health Bull (Edinb)* 1993; **51**: 158–165.
 22. NHS Dental Programme funded by the Welsh Government. Designed to smile. <http://www.designedtosmile.co.uk/home.html>
 23. Moynihan P, Petersen P E. Diet, nutrition and the prevention of dental disease. *Public Health Nutr* 2004; **7**: 201–226.
 24. Evans C E, Greenwood D C, Thomas J D, Cade J E. A cross-sectional survey of children's packed lunches in the UK: food- and nutrient-based results. *J Epidemiol Community Health* 2010; **64**: 977–983.
 25. School Food Trust. Primary school food survey 2009 – School lunches versus packed lunches. Research Report, 2009. <http://www.schoolfoodtrust.org.uk/school-cooks-caterers/reports/primary-school-food-survey-2009-school-lunches-versus-packed-lunches> (Accessed June 2011).
 26. Baelum V. What is an appropriate caries diagnosis? *Acta Odontol Scand* 2010; **68**: 65–79.
 27. Thompson J, Manore M. *Nutrition: an applied approach*. 2nd ed. San Francisco: Pearson Education, 2009.
 28. Thomas D E, Elliott E J, Baur L. Low glycaemic index or low glycaemic load diets for overweight and obesity. *Cochrane Database Syst Rev* 2007; CD005105.
 29. Edwards W P. *The science of bakery products*. Cambridge: The Royal Society of Chemistry, 2007.
 30. Food Standards Agency. The Bread and Flour Regulations 1998 (as amended). Guidance Notes. Version 1, June 2008. <http://www.food.gov.uk/multimedia/pdfs/breadflourguide.pdf> (Accessed May 2011).
 31. Food Standards Agency. *McCance and Widdowson's the compositions of foods*. 6th summary ed. Cambridge: The Royal Society of Chemistry, 2002.
 32. WHO Oral Health Country/Area Profile Project 2005. Available at: <http://www.mah.se/CAPP>.
 33. Macek M D, Heller K E, Selwitz R H, Manz M C. Is 75 percent of dental caries really found in 25 percent of the population? *J Public Health Dent* 2004; **64**: 20–25.
 34. The Information Centre for Health and Social Care. *Adult Dental Health Survey 2009*. Leeds: The Information Centre for Health and Social Care, 2011.
 35. British Association for the Study of Community Dentistry. Dental caries experience of 5, 11, 12, and 14-year-old children in Great Britain. www.dundee.ac.uk/tuith/search/bdsearch.html.
 36. Cameron A C, Widmer R P. *Handbook of pediatric dentistry*, 3rd ed. Mosby Elsevier, 2008.
 37. Richards W. Shifting the focus in dental care. In Riley C, Warner M, Pullen A, Semple Piggot C. *Releasing resources to achieve health gain*. pp 124–131. Oxford: Radcliffe Medical Press, 1995.
 38. Milosevic A, Young P J, Lennon M A. The prevalence of tooth wear in 14-year old school children in Liverpool. *Community Dent Health* 1994; **11**: 83–86.
 39. Al-Dlaigan Y H, Shaw L, Smith A. Dental erosion in a group of British 14-year-old schoolchildren. Part I: prevalence and influence of differing socioeconomic backgrounds. *Br Dent J* 2001; **190**: 145–149.
 40. Patrick H, Nicklas T. A review of family determinants of children's eating patterns and diet quality. *J Am Coll Nutr* 2005; **24**: 83–92.
 41. Williams D, Croucher R, Marcenes W, O'Farrell M. The prevalence of dental erosion in the maxillary incisors of 14-year-old schoolchildren living in Tower Hamlets and Hackney, London, UK. *Int Dent J* 1999; **49**: 211–216.
 42. Van Rijkom H M, Truin G J, Frencken J E *et al*. Prevalence, distribution and background variables of smooth-bordered tooth wear in teenagers in The Hague, The Netherlands. *Caries Res* 2002; **36**: 147–154.
 43. Bardsley P F, Taylor S, Milosevic A. Epidemiological studies of tooth wear and dental erosion in 14-year-old children in North West England. Part 1: the relationship with water fluoridation and social deprivation. *Br Dent J* 2004; **197**: 413–416.
 44. Peres K G, Armênio M F, Peres M A, Traebert J, Lacerda J T. Dental erosion in 12-year-old schoolchildren: a cross-sectional study in Southern Brazil. *Int J Paediatr Dent* 2005; **15**: 249–255.
 45. El Karim I A, Sanhoury N M, Hashim N T, Ziada H M. Dental erosion among 12–14-year-old school children in Khartoum: a pilot study. *Community Dent Health* 2007; **24**: 176–180.
 46. Manguiera D F, Sampaio F C, Oliveira A F. Association between socioeconomic factors and dental erosion in Brazilian schoolchildren. *J Public Health Dent* 2009; **69**: 254–259.
 47. Jacob M, Plamping D. *The practice of primary dental care*. London: Wright, 1989.
 48. Mandel I. Caries prevention: current strategies, new directions. *J Am Dent Assoc* 1996; **127**: 1477–1488.
 49. Humphreys R, Richards W, Gill P. Perceptions of first year foundation dentists on oral health education and its role in general dental practice. *Br Dent J* 2010; **209**: 601–606.