

The use of diet diaries in clinical dentistry

**Thesis submitted in accordance with the requirements of the
University of Liverpool for the degree of Doctor in Philosophy by
Arheiam Arheiam**

3rd April 2017

Abstract

Background:

Recently, there has been renewed interest in the importance of reducing sugar intake to control dental caries both in the UK and internationally. Although diet advice to promote oral as well as general health is recommended for all dental patients, those at high risk of dental caries are particularly in need of additional professional support tailored to their needs. For this reason, diet diaries have been recommended as a dietary assessment tool that enables the tailoring of effective dietary advice for individual patients in dental practice (Watt et al., 2003). However, despite the recognised merits of diet diaries as dietary assessment and self-monitoring tools in the general literature (Thompson and Subar, 2013), an early search of literature revealed that very little empirical work had been devoted to this topic in the dental context. The overall aim of this research is to explore the use of diet diaries in the dental clinical setting. It offers some important insights into the possible barriers and facilitators of their use to support dietary advice.

Methods

Four studies were undertaken to meet the general aim and the objectives of the thesis. A range of qualitative and quantitative research methods were used. Dentists' current practices and perceived influences of diet diaries usage in dental practice were investigated using a postal questionnaire survey to general dental practitioners (GDPs) (Study I). A case-vignette based on a diet diary was incorporated into this questionnaire to deepen understanding about how dentists interpret and use diet diaries to formulate dietary advice (Study II). A retrospective study was carried out to estimate the return rate of diet diaries and its associated factors among paediatric dental patients in a teaching dental hospital (Study III) - a different setting where

dental remuneration is less of an issue. Finally, a qualitative case study was conducted to investigate factors associated with patients' adherence to diet diaries issued to paediatric dental patients in a teaching dental hospital setting (Study IV).

Findings

Study I found that the majority of English GDPs did not use diet diaries to collect diet information (62%), mainly because of constraints related to finance and time. Other barriers identified were poor patient compliance and a perceived lack of necessary skill relating to dietary counselling. Diet diaries were more likely to be used in children than in adults, and for patients with high levels of caries.

Study II demonstrated that GDPs rely upon a strategy of intelligent selection to filter complex dietary information in order to generate dietary advice. Challenged with a large field of information, they select what they see as a subset of either the most useful or the easiest information for patients to understand and implement.

Study III found that the return rate of diet diaries by children and their families in a dental hospital setting was low (34%). Return rate was associated with patients' demographic and oral health maintenance habits. Content analysis of returned diet diaries showed that diet diaries did not consistently capture the full range of complexities of dietary aspects relevant to oral health. Information on sugar amount, consumption context, sequence of intake within meals, prolonged contact with teeth and sugars consumed near bedtime – all were partially or completely missing from the returned diaries.

Study IV concluded that adherence to diet diaries is a multi-contextual phenomenon associated with interacting factors which are generally related to the patient (parent/child), the dentist and the diet diary itself.

Conclusions

Diet diaries were not frequently used by dental practitioners, nor were they frequently returned or adequately completed by patients and their families. The use of diet diaries as a dietary assessment and monitoring tool is complicated by many factors related to the dentist, patients and the diet diaries itself. Therefore, multifaceted interventions targeted at patients, providers and the healthcare system are required if the use of diet diaries is to be enhanced. A motivated patient, a time-efficient tool as well as appropriate support from health care system appear to be necessary for the successful use of diet diaries.

Acknowledgements

I am very grateful to my primary supervisor Prof Rebecca Harris for being an excellent mentor throughout my PhD studies providing guidance with my research work as well as advice and generous support on different aspects of life. Her kindness and admirable academic and professional qualities are both impressive and inspiring. Thank you for making my PhD such a wonderful experience.

I would like to express my sincere thanks to my co-supervisors: Professor Susan Higham, Dr Stephen Brown, and Dr Sondos Albadri for their support, help and encouragement throughout my PhD.

I would also like to thank Dr Girvan Burnside, senior lecturer in Biostatistics, for his advice and help with data analysis. Many thanks to Dr Mark Goodall for his help, support, and advice throughout my PhD.

Thanks also go to Jayne Garner and Victoria Lowers, the personal assistant of Prof. Harris, for all their help and support during my PhD. My thanks also go to Dr Louise Laverty for her help in qualitative data analysis and generous support and help with peer reviewing.

I would also like to extend my warmest thanks to all staff members, researchers, and post-graduate students at the Department of Health Services Research of the University of Liverpool.

I would like to thank my wife (Rehab) for her patience and endless support throughout my studies.

Finally, I would like to dedicate this thesis to the soul of my mother who passed away in 2015. Her support and love was a great motive of pursuing high degrees.

Table of Contents

ACKNOWLEDGEMENTS	IV
TABLE OF CONTENTS.....	V
LIST OF FIGURES	X
LIST OF TABLES	X
ABBREVIATIONS	XII
CHAPTER 1. INTRODUCTION	1
1.1 INTRODUCTION.....	1
1.2 BACKGROUND	1
1.3 SCOPE OF THE THESIS	8
1.4 OUTLINE OF THE THESIS	9
CHAPTER 2. LITERATURE REVIEW	11
2.1 INTRODUCTION.....	11
2.2 DENTAL CARIES PROCESS.....	11
2.3 ROLE OF SUGAR IN DENTAL CARIES	14
2.3.1 Type of sugar.....	15
2.3.2 Frequency of sugar intake	16
2.3.3 Amount of sugar	18
2.3.4 Amount vs frequency debate.....	20
2.3.5 Consumption of sugar in a retentive form	21
2.3.6 Consumption of sugar mixed with starch	22
2.3.7 Between meals consumption of sugars	22
2.3.8 Near bedtime consumption of sugars.....	23
2.3.9 The sequence of sugar consumed within the meal.....	24
2.3.10 Prolonged exposure to sugars	24
2.4 APPROACHES OF CARIES PREVENTION	25
2.5 SUGAR AS A COMMON RISK FACTOR	28
2.6 CHILDHOOD IS A CRITICAL TIME FOR CARIES DEVELOPMENT.....	29
2.7 DIETARY ADVICE IN THE DENTAL CARE SETTING.....	30
2.8 DIETARY ASSESSMENT IN DENTAL PRACTICE:	33
2.9 A 3-DAY DIET DIARY USED IN DENTISTRY	36
2.9.1 The use diet diaries in clinical dentistry.....	38
2.10 THE USE OF DIET DIARIES OUTSIDE DENTISTRY	39
2.10.1 RECENT TECHNOLOGICAL ADVANCES IN DIET DIARIES USE	42

2.11 THE PROVISION OF DENTAL CARE IN THE UK	43
2.12 SUMMARY, RATIONALE, AND RESEARCH QUESTIONS	44
CHAPTER 3. AIMS AND OBJECTIVES	46
3.1 INTRODUCTION.....	46
3.2 OVERARCHING RESEARCH QUESTIONS.....	46
3.3 AIM.....	46
3.4 OBJECTIVES	46
3.5 OVERVIEW OF THESIS’S STUDIES.....	47
3.5.1 Study I: The use of diet diaries in clinical practice.....	47
3.5.2 Study II: How dentists use diet diaries to give diet advice	47
3.5.3 Study III: Adherence to diet diaries among paediatric dental patients in a hospital setting.....	48
3.5.4 Study IV: Factors affecting dental patient’s adherence to diet-diaries issued in a hospital setting.....	48
CHAPTER 4. METHODOLOGY	49
4.1 INTRODUCTION:.....	49
4.2 OVERVIEW OF RESEARCH DESIGN	49
4.3 DATA COLLECTION METHODS	51
4.3.1 Postal questionnaire survey.....	51
4.3.2 Case vignettes.....	54
4.3.3 Case studies.....	56
4.4 METHODS OF DATA ANALYSIS.....	61
4.4.1 Content Analysis.....	61
4.4.2 Thematic analysis.....	63
4.4.2 Quantitative data analysis	65
4.5 ETHICAL ISSUES.....	65
4.5.1 Approvals and permissions	65
4.5.2 Consent.....	66
4.5.3 Anonymity and confidentiality	67
CHAPTER 5.THE USE OF DIET DIARIES IN CLINICAL PRACTICE (STUDY I).....	68
5.1 INTRODUCTION.....	68
5.2 BACKGROUND	68
5.3 STUDY I OBJECTIVES	69
5.4 METHODS	70
5.4.1 Sampling.....	70
5.4.2 Questionnaire.....	72

5.4.3 Data management.....	73
5.4.4 Statistical analysis:.....	74
5.5 RESULTS:.....	76
5.5.1 Response rate.....	76
5.5.2 Sample description.....	76
5.5.3 Analysis of non-response bias.....	78
5.5.4 The provision of dietary advice	79
5.5.5 The prevalence of diet diaries usage.....	80
5.5.6 Clinical practices, influences and barriers of diet diaries usage	81
5.6 DISCUSSION.....	85
5.7 SUMMARY AND IMPLICATIONS.....	92
CHAPTER 6. HOW DENTISTS USE DIET DIARIES TO GIVE DIET ADVICE (STUDY II).....	94
6.1 INTRODUCTION.....	94
6.2 BACKGROUND	94
6.3 STUDY II OBJECTIVES.....	95
6.4 METHODS	95
6.4.1 The vignette.....	96
6.4.2 Data analysis and findings	96
6.5 DISCUSSION.....	112
6.6 SUMMARY AND IMPLICATIONS.....	115
CHAPTER 7. ADHERENCE TO DIET DIARIES AMONG PAEDIATRIC DENTAL PATIENTS (STUDY III).....	116
7.2 BACKGROUND	116
7.3 STUDY III OBJECTIVES:	118
7.4 METHODS:.....	119
7.4.1 Setting:.....	119
7.4.2 Sampling.....	119
7.4.3 Data extraction from clinical records:.....	120
7.4.4 Content analysis.....	121
7.4.5 Statistical analysis.....	123
7.5 RESULTS:.....	125
7.5.1 Sample characteristics.....	126
7.5.2 Return rate of diet diaries and its associated factors	126
7.5.3 Diet diaries yielded types of information.....	128
7.6 CONCORDANCE BETWEEN METHODS OF MEASURING SUGAR INTAKE FREQUENCY	129
7.7 DISCUSSION:.....	131

7.8 SUMMARY AND IMPLICATIONS.....	136
CHAPTER 8. FACTORS AFFECTING ADHERENCE TO DIET DIARIES AMONG PAEDIATRIC DENTAL PATIENTS (STUDY IV).....	137
8.1 INTRODUCTION.....	137
8.2 BACKGROUND.....	137
8.3 STUDY IV OBJECTIVES:.....	139
8.4 METHODS:.....	139
8.4.1 An overview of study design.....	139
8.4.2 Setting.....	140
8.4.3 Preliminary work:.....	141
8.4.4 Sampling and recruitment:.....	141
8.4.5 Data collection.....	142
8.4.6 Data analysis.....	146
8.4.7 Rigour and trustworthiness of qualitative analysis.....	147
8.5 RESULTS:.....	148
8.5.1 Informants' profile:.....	148
8.5.2 Themes:.....	151
8.6 DISCUSSION:.....	171
8.7 SUMMARY AND IMPLICATIONS.....	177
CHAPTER 9. CONCLUDING DISCUSSION.....	178
9.1 INTRODUCTION.....	178
9.2 HOW DIET DIARIES ARE CURRENTLY USED IN DENTAL PRACTICE FOR CHILDREN AND WHAT DO DENTISTS/ FAMILIES HOPE TO ACHIEVE BY THEIR USE?.....	178
9.3 STRENGTHS AND WEAKNESSES IN THE WAY DIET DIARIES ARE CURRENTLY USED IN DENTISTRY TO RECORD SUGAR INTAKES.....	183
9.4 CAN THE CURRENT FORMAT AND PROCEDURE BE MODIFIED TO MORE EFFECTIVELY PROVIDE A MONITORING TOOL?.....	186
9.5 DIET DIARIES AS A TOOL TO SUPPORT BEHAVIOUR CHANGE.....	191
9.6 SUMMARY OF CONCLUSIONS:.....	193
9.7 IMPLICATIONS FOR PRACTICE.....	195
9.8 RECOMMENDATIONS FOR FUTURE RESEARCH:.....	196
REFERENCES.....	197
APPENDICES.....	218
Appendix A. Diet diary example extracted from delivering better oral health guidelines.....	218
Appendix B. A systematic search of literature on diet diaries use in dental practice.....	219
Appendix C. Ethics approval, permissions and forms.....	222

Appendix D. Stratification of local authorities (las) in the northwest of england into three levels of caries prevalence (high, medium and low).....	235
Appendix E. Postal questionnaire used in studies I & II.....	236
Appendix F. Prevention pro forma and patient assessment form used in paediatric dentistry department at LUDH.....	243
Appendix G. Topic guides for interviews and observations guides used in study IV	249
Appendix H. Original research papers and conference presentations based on the thesis studies.....	252

List of Figures

Figure 2-1: Factors involved in caries development.....	13
Figure 5-1: Flow chart of questionnaire distribution phases and response rates	76
Figure 5-2: Diet advice practices as percentages of GDPs (n=250) reporting personally giving diet advice or referring to a DCP, and as average estimated proportion of their patients receiving or referred for advice.....	79
Figure 5-3: Distribution of methods used for collection of diet information (n=134) as percentages of GDPs reporting using each method, and for the average estimated proportion of their patients	81
Figure 6-1: The case vignette with the four questions posed to GDP participants	97
Figure 6-2: A summative approach to delivering diet advice based on dietary assessment	104
Figure 6-3: A selective approach to delivering diet advice based on dietary assessment....	104
Figure 6-4: Mean scores for perceived importance of dietary advice aspects when considering diet diaries analysis (n=220)	108
Figure 7-1: Pie chart shows the distribution of patients returned diet diaries.....	125
Figure 7-2: A Bland-Altman graph shows an overview of difference between prevention pro forma and diet diaries as a measure of sugar intake frequency, with mean differences (solid lines) and 2 limits of agreement (dashed lines).....	130
Figure 7-3: Bar chart comparing the distribution of dental patients' sugar intake frequency as low, marginal or high as measured using prevention pro forma and diet diaries (n=39).....	131
Figure 7-4: Bar chart depicting the concordance between prevention pro forma and diet diaries in categorising patients as low, marginal or high sugar consumers (n=39)	131
Figure 8-1: An overview of case study design.....	140
Figure 8-2: Flow chart of participants' recruitment and data collection.....	143
Figure 9-1: COM-B model of behaviour change	186

List of Tables

Table 2-1: Summary of diet assessment methods	40
Table 2-2: NHS bands of course of treatment and patients charges	44
Table 4-1: Design, research methods and data collection techniques used in the four studies of the thesis	50
Table 5-1: Characteristics of the study sample (n=250)	77
Table 5-2: Comparison of characteristics of early and late respondents.....	78
Table 5-3: Frequencies of GDPs reporting targeting diet advice to specific child and adult patient groups (n=250).....	80
Table 5-4: Usual practices by GDPs reporting use of diet diaries (n=70)	82

Table 5-5: Bivariate analysis of characteristics of GDPs reported using diet diaries (n=70) versus users of other methods of dietary assessment (n=64)	83
Table 5-6: Binary logistic regression models for diet diaries use participants reporting assessing diet (n=134).....	84
Table 5-7: GDPs' reasons for not using diet diaries for child (n= 168) and adult (n= 172) dental patients	85
Table 6-1: Coding framework with conceptual definitions and supporting statements outlining dietary information regarded as important by GDPs	101
Table 6-2: Coding framework with conceptual definitions and supporting statements outlining topics to be covered by GDPs giving dietary advice	102
Table 6-3: Dietary information regarded as important by GDPs	105
Table 6-4: Characteristics of the study sample (n=229)	106
Table 6-5: Frequencies of important dietary issues identified and diet advice chosen:.....	107
Table 6-6: The association between dentists' characteristics and diet advice topic which would be covered	110
Table 6-7: The association between given diet-diary information and their coverage as a diet advice topics.....	111
Table 7-1: Categories and conceptual definition of the coding framework used in the content analysis.....	122
Table 7-2: Reliability of extracting dietary information relevant to oral health recorded from completed diet diaries (comparing 2 examiners)	123
Table 7-3: Demographic and oral health characteristics of study sample (n=174).....	126
Table 7-4: Differences in the return rate of diet diaries according to sociodemographic and oral health characteristics of the study sample (n =174)	127
Table 7-5: Multiple regression analyses of sociodemographic and oral health predictors of diet diaries return rate (n =174)	128
Table 7-6: Frequency of information extracted from completed diet diaries (n=60).....	129
Table 8-1: Summary of data sources collected from the six cases included in the analysis.	148
Table 8-2: Summary of themes, subthemes and supporting quotations.....	152

Abbreviations

Abbreviation	Meaning
LUDH	Liverpool University Dental Hospital
NHS	National Health Services
PHE	Public Health England
WHO	World Health Organisation
U. K	United Kingdom
U. S	United States
GDP	General Dental Practitioner
BDA	British Dental Association
DMFT	Number of Decayed, Missing and Filled Teeth
NICE	National Institute for Health and Care Excellence
DBS	Disclosure and Barring Service
RCS	Royal College of Surgeons
USPSTF	U.S. Preventive Services Task Force
CCT	Controlled Clinical Trial
RCT	Randomised Clinical Trial
SES	Socioeconomic Status
CDS	Community Dental Services
HDS	Hospital Dental Services
GDS	General Dental Service
UDA	Units of Dental Activity
TA	Thematic analysis
CA	Content analysis
IMD	Index of Multiple Deprivation
CQC	Care Quality Commission
LA	Local Authorities
ICA	Inductive content analysis
DCP	Dental care professional
DCT	Dental Core Trainee
MI	Motivational Interviewing
MECC	Make Every Contact Count

Chapter 1. Introduction

1.1 Introduction

This section provides a brief overview of the genesis of this research project and how studying the use of diet diaries became the topic of this thesis. It then goes on to outline the structure of the thesis.

1.2 Background

Diet affects oral health in several ways. These are generally categorised as systematic and topical effects. The systematic effects are mediated by nutrients absorbed from foods and drinks. For example, early life malnutrition is linked to enamel defects and vitamin C deficiency is associated with gingivitis (Moynihan and Lingström, 2005). On the other hand, diet has topical effects on teeth. The latter plays a key aetiological role in many dental diseases; typical examples are dental caries and enamel erosion (Rugg-Gunn and Nunn, 1999). The main focus of the thesis is on dental caries although dietary advice related to erosion is touched on but beyond the main scope. It may also be worth noting here that the main focus of the thesis is on the use of diet diaries by dentists rather than the wider dental team. This is not because dental care professionals are not viewed as having an important role in this regard, but to limit the focus of thesis, recognising the paucity of studies in the area of addressing dietary causes of poor oral health in the clinical setting.

Dental caries is a significant global public health problem, particularly so among children from disadvantaged groups of the society (Petersen et al., 2005). Caries in primary teeth affects 9% of children and is the 10th most prevalent health condition worldwide (Marcenes et al., 2013). Untreated dental caries in children can cause severe pain (Selwitz et al., 2007, Tickle et al., 2008), sepsis and tooth extraction

(Pine et al., 2006), significant impact on school attendance (Jackson et al., 2011), self-esteem and quality of life (Goodwin et al., 2015).

In the UK, although dental caries in children has declined markedly over the past 40 years (Murray et al., 2015), recent data from the child dental health survey shows that children from low socio-economic backgrounds still carry a considerable disease burden (Steele et al., 2015). For a considerable proportion, this ends in tooth extraction. According to British Dental Association (BDA): “In 2014/15 over 179,218 teeth were removed in children aged nine and under in dental practices across England” (British Dental Association, 2016). Moreover, in 2013/2014 dental caries was reported to be the most common cause for admission to hospital among 5 to 9 year olds in England. This is a 14% increase between 2010–11 and 2013–14 (Royal College of Surgeons, 2015). The cost of these hospital admissions to extract carious teeth was estimated to be up to £35 million (British Dental Association, 2016). Dental caries in children is therefore still an important public health concern, with a need to consider cost-effective strategies for its control and lessening its impact on the quality of life, especially for those from deprived backgrounds.

Dental caries is a preventable disease provided that its causative factors are controlled (Selwitz et al., 2007). The harmful consumption of fermentable carbohydrates, particularly sugars, is recognised to be an essential pre-condition and an important behavioural and dietary aetiological cause. Some have queried the place of sugar in caries aetiology given the now widespread use of fluoride toothpaste (Marthaler, 1990, Burt and Pai, 2001, Selwitz et al., 2007, Moynihan and Kelly, 2014). However, there is a general consensus that sugar still has a role to play in caries occurrence and prevention. This rests on evidence such as the existence of a dose-response relationship between sugar and caries, even in areas where fluoridated water

and toothpaste are available (Marthaler, 1990, Bernabe et al., 2014, Moynihan and Kelly, 2014, Bernabé et al., 2016, Peres et al., 2016). Sheiham and James (2015), amongst others, have argued that one of the reasons for the failure in combating a high prevalence of dental caries in some populations, is that insufficient attention has been hitherto paid to its primary cause-namely high sugar consumption (Sheiham and James, 2015). Although others have counter-argued that fluoride, particularly in toothpaste, makes dietary sugar control less necessary, a prospective study following caries development in subjects aged from 11 to 22 years of age concludes that fluoride simply retards the initiation and progression of dental caries, by raising the threshold of sugar intake at which dental caries progresses to cavitation, and that fluoride does not provide absolute protection from caries (Mejare et al., 1997).

Recently, there has been renewed interest in the importance of reducing sugar intake to control dental caries both in the UK and internationally; because of efforts to limit dietary sugar consumption in order to address growing obesity problems (Public Health England, 2015, World Health Organisation, 2015). Recent data from the UK shows that the average amount of sugars consumed per person (Bates et al., 2014) exceeds the recommended reference value (>10% of daily energy (Department of Health, 1991)). This is particularly so among children from the lowest socio-economic groups (Rugg-Gunn et al., 2007, Bates et al., 2014). Recently, the Scientific Advisory Committee on Nutrition (SACN) in the UK, has recommended that the population average intake of free sugars should not exceed 5% of total dietary energy for age groups from 2 years upwards (Public Health England, 2015). Ambition to improve sugar consumption behaviour from a dental perspective therefore now increasingly corresponds with higher profile interests from a range of other health professions, public policy makers, and the media.

Healthcare settings are settings where multiple and recurrent contacts occur with the patients and hence are a natural place for delivering interventions to improve health behaviours for many individuals (Whitlock et al., 2002). The NHS has developed 'Making Every Contact Count (MECC)' policy which recognises the opportunity that practitioners have in supporting behaviour change by promoting healthier lifestyle as they come into contact with millions of people (NHS Future Forum, 2012). The National Health Services (NHS), in England, is now changing towards more emphasis on prevention and healthier lifestyle to tackle the increased health risks such as obesity and smoking, which are associated with increased risk of non-communicable diseases (NHS England, 2014). The 'NHS five year forward view' which represents a shared vision of NHS leaders, clinicians and patient groups for improving the health and services, highlights the importance of empowering the people to control their own health and to ensure that behavioural interventions are available for them (NHS England, 2014).

Dental professionals are in a position that enables them to take an active role in promoting healthy eating as well as the prevention and detection of many oral and general health problems (Palmer, 2005, Tavares et al., 2012). Therefore, in the context of a growing obesity epidemic in both developing and developed countries, tackling sugar consumption in dental care settings will ensure benefits for oral health as well as general health because sugar is a common risk factor for both dental caries and obesity (World Health Organisation, 2015). In fact, implementing lifestyle interventions that promote a healthier eating has been recommended in many international oral health promotion guidelines and policy documents (European Academy of Paediatric Dentistry, 2008, American Academy of Paediatric Dentistry, 2013, Public Health England, 2014a).

In England, the National Institute for Health and Care Excellence (NICE) published in December 2015, a guidance on oral health promotion in general dental practice. (National Institute for Health and Care Excellence, 2015). It recommended that dental practitioners should give dietary advice that promotes healthy behaviour patterns that benefit both oral health and general health, based on ‘Delivering Better Oral Health’ (DBOH). DBOH is an evidence-based toolkit released by Public Health England, which forms the backbone of recommended evidence-based preventive dentistry in English general dental practice. DBOH is developed by a working group of dental experts and distributed to dental practices in 2007 and one copy was sent to all health service dental practices. A second edition was published in 2009 to keep up with the up-to-date evidence in prevention. However, this time in order to enhance its wider use, it was sent to all NHS dentists rather than to the practices (Witton & Moles, 2013). A third edition was published online in 2014 and has been updated in March 2017 to include new patient fact sheets and new guidance on alcohol and diet advice according to the emerging evidence from SACN review (Public Health England, 2017).

It has been counter-argued that lifestyle interventions are ineffective in changing oral health related behaviours and also expensive (Watt, 2007). This is on the basis of evidence synthesised from multiple systematic reviews showing that traditional educational interventions have limited success in causing sustainable behaviour changes (Watt and Marinho, 2005). However, there is a valid counter argument that many dental education interventions included in these reviews were not based on behaviour change techniques and theories. Behavioural interventions have been shown to be more successful when theory is incorporated than when it is not (Abraham et al., 2009).

The evidence based recommendations for promoting healthy eating in primary health care settings, released by U.S. Preventive Services Task Force (USPSTF) states that “*Effective interventions combine nutrition education with behaviourally oriented counselling to help patients acquire the skills, motivation, and support needed to alter their daily eating patterns and food preparation practices*” (US Preventive Services Task Force, 2003). Evidence, based on a systematic review of randomised clinical trials (RCTs) and controlled clinical trials (CCTs) conducted in dental clinical settings, indicates that combining dietary interventions with psychological constructs such as the use of goal setting and self-monitoring would improve their effectiveness in changing oral health related behaviours (Newton and Asimakopoulou, 2015). A recent systematic review to inform NICE guidance on oral health promotion concluded that theory-based interventions in the dental setting are promising although evidence is sparse (Kay et al, 2016).

Nevertheless, despite the existence of evidence suggesting that sugar consumption behaviour is amenable to change, there is relatively little dental research in this area (Watt et al., 2003, Harris et al., 2012). Harris et al (2012) in their Cochrane systematic review, which assessed the effectiveness of one-to-one dietary interventions delivered in a dental care setting, identified only five intervention studies with outcomes related to dietary behaviour change. They concluded that there is some evidence to support one-to-one dietary interventions in the dental setting, however this evidence came from interventions aiming to change fruit/vegetable and alcohol consumption behaviours rather than to change dietary sugar consumption (Harris et al., 2012). In a more recent systematic review that included systematic reviews, CCTs and RCTs to assess the efficacy of health behaviour change interventions undertaken in the dental setting with adults, authors found that while

evidence existed to support brief interventions for tobacco use cessation, evidence for other lifestyle behaviours including sugars consumption was limited or non-existent. Authors recommended that more clinical research should be undertaken in order to evaluate and improve health behaviour change interventions in the dental setting (Ramseier and Suvan, 2015).

In dental practice, there is a consensus that dietary advice needs to be realistic, comprehensive, and tailored to patients' needs, in order to be effective (Rugg-Gunn and Nunn, 1999, Moynihan, 2002, Watt et al., 2003). In England, the current NICE guidance on oral health promotion in general dental practice recommends that diet advice should be tailored to patients' needs and circumstances in order to be effective (National Institute for Health and Care Excellence, 2015). This means that additional efforts from the dental team in respect of medical and social history and careful assessment of patient's dietary habits is necessary to understand their needs (Rugg-Gunn and Nunn, 1999) as well as readiness to change (Rosal et al., 2001). Detailed dietary assessment helps individualise and optimise dietary advice (Rugg-Gunn and Nunn, 1999, Watt et al., 2003, Marshall, 2009, Mobley and Dounis, 2010, Public Health England, 2014a), since it enables both the tailoring of advice and the enhancing discussions between dentists and their patient (Public Health England, 2014a).

A 3-day diet-diary, also known as 'diet record' or 'diet history', where the patient is typically asked to keep a record of type, amount and timing of what they eat and drink for 3 consecutive days including at least one weekend day, is recommended as a dietary assessment tool to support dietary advice in dental practice (Rugg-Gunn and Nunn, 1999). Diet diaries are widely used in nutritional and dietary behaviour research for diet assessment and monitoring purposes (Burke et al., 2005, Thompson

and Subar, 2013). Diet diaries are recognised as a beneficial, real-time method of self-monitoring if used correctly (Glanz et al., 2006).

There is evidence that incorporating self-monitoring into dietary behaviour interventions significantly increases effectiveness more than interventions that do not (Michie et al., 2009, Michie et al., 2011a, Michie and Johnston, 2012, Prestwich et al., 2013). In addition, a systematic review evidence indicates that dietary interventions delivered by primary care providers appears to be more effective when they include interactive health communication tools (Pignone et al., 2003).

Therefore, in the light of the general recognition that tailored dietary advice may facilitate behaviour change (Noar et al., 2007); and the consequent necessity to obtain detailed dietary information to allow effective tailoring, diet diaries; whilst having an application as a tool to monitor and assess the diet; they may also act as a tool to facilitate behaviour change.

1.3 Scope of the thesis

Despite the recognised merits of diet diaries as dietary assessment and self-monitoring tools, an early search of literature revealed that very little empirical work had been devoted to exploiting the use of diet diaries in the wider field of giving dietary advice in dental clinical settings. A recent systematic literature review (see section 2.9.1), which was conducted to investigate the dietary advice practices as well as factors influencing its provision in dental settings, shows that this area is under-researched, with only one study identified investigating how frequently diet diaries were used by dental hygienists to support dietary advice, and concluded by identifying dietary assessment and analysis as an area of future research (Frank et al., 2014). The author subsequently undertook a focused systematic literature search in this area (Appendix A) which confirmed this finding. It is unclear how often diet diaries are

used by dental practitioners, nor how they are used to influence the dietary behaviour of patients.

Therefore, the genesis of this thesis can be traced back to the time the author spent on developing a proposal for a study to assess and develop diet diaries as a dietary intervention tool in the dental practice. It was hypothesised that diet diaries may facilitate the change of sugar consumption behaviour, based on evidence that diet diaries may be effective in prompting self-monitoring of behaviours (Burke et al., 2005). However, to the author's best knowledge and based on the finding of the aforementioned systematic review and search of literature, little is known about the use of diet diaries in dental practice. Such knowledge is intended to pave the way for future work to investigate and develop diet diaries as a tool to facilitate behaviour change in dental care settings. Therefore, the focus of this thesis is to explore, for the first time, the use of diet diaries in dental clinical setting. It offers some important insights into the possible barriers and facilitators of their use to support dietary advice.

1.4 Outline of the thesis

The overall structure of the study takes the form of nine chapters. The next chapter (chapter two) will be a review of the literature relevant to dental caries, sugar consumption behaviours and prevention strategies and the provision of dental care as well as dietary advice in UK dental practice. It will also provide an overview of the dietary assessment methods and the position of diet diaries within them. This chapter will also review the literature on diet diaries use outside dentistry and finishes with a summary of available knowledge and research gaps to draw out the research questions, aims and objectives. This is followed by the aims and objectives of the thesis and a general description of the studies used to meet these aims and objectives, in Chapter three. Chapter four is a description of the general methodology used across

the studies of thesis, giving overview of different qualitative and quantitative techniques employed. Chapter five presents a cross-sectional, questionnaire based survey of the prevalence, associated practices and dentists' perceived barriers of diet diaries usage in dental practice (Study I). Chapter six presents a case vignette-based study that investigates how dentists use diet diaries to frame dietary advice they give to the patients (Study II). Chapter seven will present a retrospective study of patients' records to assess the return rate of diet diaries, the quality of collected information and the predictors of patient's adherence to diet diaries (Study III). A case study to unravel factors associated with patient's adherence to diet diaries is presented in chapter eight (Study IV). Chapter nine provides an overall discussion of the findings and conclusions and recommendations for future research.

Chapter 2. Literature Review

2.1 Introduction

The purpose of this chapter is to review the dental literature on diet diaries and their position and rationale for use in dental practice. It is worth noting that the focus of this review is on the use of diet diaries in relation to dental caries prevention. It begins by setting the scene for this by describing the process of dental caries and how sugars have a primary causative role, before highlighting the significance of different sugar consumption patterns in increasing the risk of caries development. This chapter gives an overview of disease preventive strategies which applies in tackling the caries problem. A detailed description of the recommended practices of providing dietary advice and dietary assessment is then given. Since a systematic review on the provision of dietary advice by dental practitioners had been published recently (section 2-9-1), a systematic search of the literature focused on the area of the use of diet diaries was conducted (Appendix B). By searching electronic databases and textbooks as well as grey literature, the available literature on diet diaries use in dental practice as well as general practice is presented and knowledge gaps highlighted. Finally, a summary of the whole chapter is presented.

2.2 Dental caries process

Dental caries is a diet-bacterial disease caused by acid-forming bacteria in dental plaque that release organic acids as metabolic by-products of the fermentation of dietary carbohydrates (mainly sugars). This results in lowering the pH in dental plaque, loss of physiological equilibrium between the tooth surface and the surrounding environment and subsequently demineralisation (dissolution of tooth minerals) when the pH drops to levels below 5.5 which is the accepted critical pH in

the enamel (Arens, 1999). This drop in pH occurs within 3-5 minutes after the exposure to fermentable carbohydrates and remains below the critical level for 20 minutes before a full recovery to the resting levels after 45-60 minutes due to the buffering effect of saliva and fluoride if they are available (Rugg-Gunn and Nunn, 1999). This results in a remineralisation (precipitation of minerals) of tooth surface from calcium and phosphate and possibly fluoride ions in the oral environment (Featherstone, 2008).

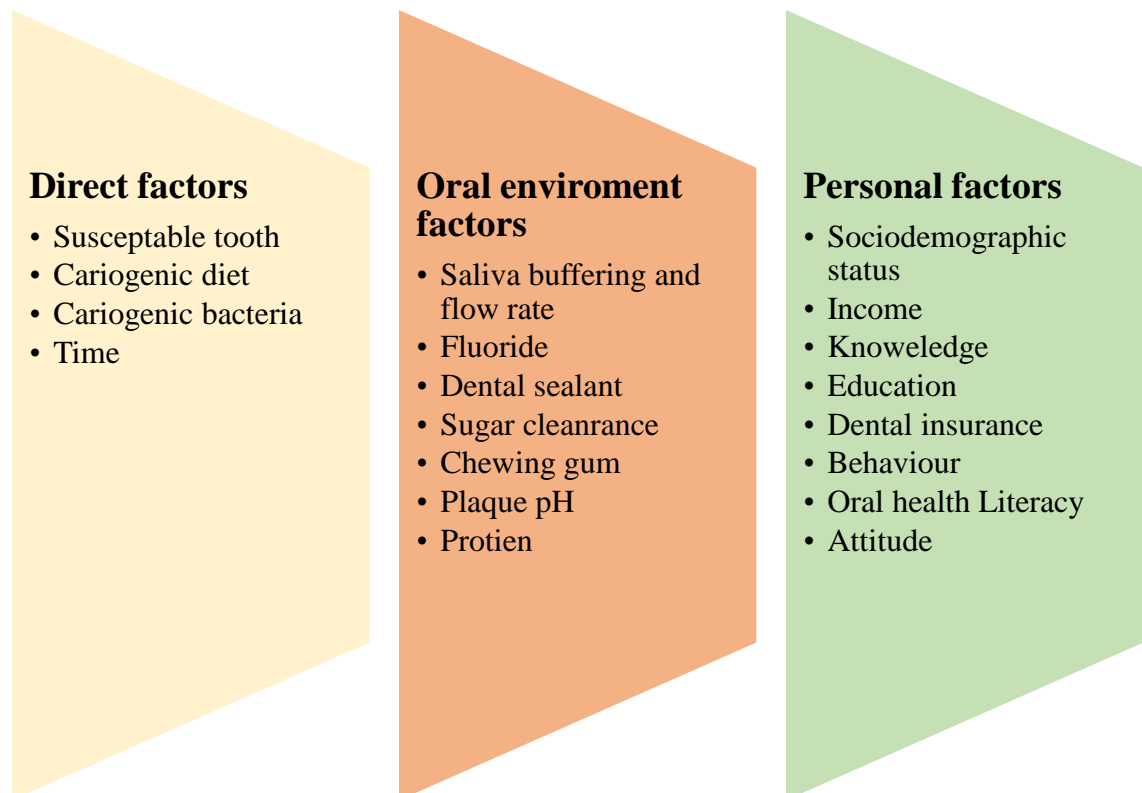
Dental caries is a continuous disease process, with alternating episodes of demineralisation and remineralisation of dental hard tissues. Visible caries (cavity formation) is the last and irreversible phase in this process. It occurs when demineralisation outstrips remineralisation. A sustainable pH below 5.5 results in net mineral loss. Until this point, an intervention can be made, the demineralisation can be reversed and cavity formation avoided, by interfering with or eliminating factors fostering the demineralisation (Featherstone, 2004, Featherstone, 2008).

The aetiology of dental caries is multifactorial. It involves a complex interplay of social, biological, environmental, and behavioural factors (Harris et al., 2004, Fisher-Owens et al., 2007, Selwitz et al., 2007). However, there are four conditions that must coexist to initiate dental caries. These are cariogenic bacteria, fermentable carbohydrates (mainly sugar), a susceptible host and sufficient time. Cariogenic bacteria and fermentable carbohydrates must coexist in a quantity and quality, sufficient to produce ample amount of acids and to cause a significant and prolonged drop in plaque pH (Moynihan, 1995, Rugg-Gunn and Nunn, 1999).

There are several modifying factors which can foster or counterbalance the effect of pH drop and hence tip the caries process toward either halting or progressing to cavitation (Selwitz et al., 2007). For example, while the availability of calcium and

phosphate in saliva is an important contributor in remineralisation and recovery of plaque pH to its resting level following the exposure to fermentable carbohydrates (Stookey, 2008), the diminished or impaired salivary flow increases food retention and encourages a cariogenic environment (Kidd, 2005). Similarly, the use of fluoride increases enamel resistance to acid dissolution by lowering the critical pH and enhancing remineralisation (Featherstone, 2008). On the other hand, teeth that have thin enamel, immature enamel or enamel defects such as hypoplasia are less resistant to bacterial demineralisation (Tinanoff et al., 2002).

Figure 2-1: Factors involved in caries development



(Adopted from Selwitz et al. (2007))

To put this into the perspective of this thesis, dental caries develops when the cariogenic potential of consumed fermentable carbohydrates and cariogenic bacteria in dental plaque outstrip the counterbalancing effect of preventative factors in the oral environment such as adequate levels of fluoride (Featherstone, 2000). Therefore,

fermentable carbohydrates are one of the aetiological factors behind the development of dental caries. Although other factors (such as fluoride, salivary flow, oral hygiene, and enamel defects) may alter its progression, unhealthy patterns of consumption of fermentable carbohydrates may be too extensive and result in demineralisation and the development of dental caries.

2.3 Role of sugar in dental caries

Carbohydrates are an essential food element which encompasses a range of sugars, starches, and fibres. They have a basic structure comprised of carbon, hydrogen and oxygen, though with varying linkages and chain lengths. According to the chemical complexity of their structure, carbohydrates are classified into mono- and di-saccharides, oligosaccharides and polysaccharides. Dietary sugars have a simple structure and comprise mono saccharides (glucose, fructose, and galactose) and di-saccharides (sucrose, lactose, and maltose). Sugars can be a natural component of the cellular structure of the food (grains, fruits), which are referred to as natural or intrinsic sugar, or they can be added to the food by the manufacturers (fruit juices, honey) or released during the processing of foods. The latter are referred to as free, added or extrinsic sugars (Moynihan, 1998).

The term 'fermentable carbohydrates' refers to sugars and starch which begin digestion in the oral cavity by the action of salivary amylase (Touger-Decker and van Loveren, 2003). The role of fermentable carbohydrates (mainly sugars) in dental caries is unquestionable and was established over fifty years ago, through epidemiological, laboratory and clinical studies. The consumption of fermentable carbohydrates is necessary to fuel bacterial acid production and promote a cariogenic microbial shift in dental plaque (Rugg-Gunn and Nunn, 1999, Zero et al., 2008). The continuous exposure to refined carbohydrates prolongs the duration of a pH drop

below the critical level, with a resultant shift in plaque microbial ecology, which favours the establishment of cariogenic bacteria which relish acidic conditions and tooth demineralisation dominates (Marsh, 1994). To put it more simply, consumption of fermentable carbohydrates is a prerequisite for the initiation and progression of any carious lesion.

Although there has been some debate about the place of sugar in caries aetiology in view of the now widespread use of fluoride toothpaste (Marthaler, 1990, Burt and Pai, 2001, Selwitz et al., 2007, Moynihan and Kelly, 2014), there is a general consensus that sugar still has a role to play in caries occurrence and prevention; resting on evidence such as the existence of a dose-response relationship between sugar and caries, even in areas where fluoridated water and toothpaste are available (Marthaler, 1990, Bernabe et al., 2014, Moynihan and Kelly, 2014, Bernabé et al., 2016).

Recently, there has been renewed interest in the importance of reducing sugar intake to control dental caries; Sheiham and James (2015), amongst others, have argued that one of the reasons for the failure in combating the dental caries epidemic, is that insufficient attention has been hitherto paid to its primary cause - namely high sugar consumption (Sheiham and James, 2015). Nevertheless, there are many behavioural attributes influencing the cariogenic potential of any sugar exposure. In the pages that follow, different dietary patterns of sugar consumption that have the potential to influence the sugar-caries relationship will be reviewed.

2.3.1 Type of sugar

Although dietary carbohydrates can be metabolised by plaque bacteria, sugars, mainly sucrose, are considered the most cariogenic (Department of Health, 1991, Sheiham, 2001). The low molecular weight and simple structure of these sugars allow for easier diffusion into dental plaque to be readily metabolised by cariogenic

bacteria, leading to speedy and plentiful acid production (Rugg-Gunn and Nunn, 1999, Kidd, 2005). Sucrose can be utilised by cariogenic bacteria to form extracellular polymers which enhance bacterial adherence, act as a reserve of bacterial substrate and limit the anti-cariogenic effect of saliva by reducing the permeability of dental plaque (Loesche, 1986).

While natural and milk sugars bear a trivial contribution to dental caries development because of the coexistence of protective factors such as salivary flow stimulation and calcium, free sugars and cooked starches are associated with increased caries risk considered harmful for teeth and therefore their consumption should be reduced or eliminated in order to prevent dental caries (Moynihan, 2016).

2.3.2 Frequency of sugar intake

Frequent exposure to sugars may promote demineralisation of enamel and dentine because it leads to prolonged production of bacterial acids and consequently an extended and substantial decrease in plaque pH (Rugg-Gunn and Nunn, 1999, Leme et al., 2006). It also limits the buffering capacity of dental plaque and saliva by draining their reserves of minerals (Pearce, 1998, Tahmassebi et al., 2006). What is more, the frequent consumption of sugars results in a constantly acidic pH in dental plaque, which results in a thriving and dominance of cariogenic bacteria with subsequent shift in microbial ecology to be in favour of dental caries (Stecksensblicks, 1987, Bradshaw and Lynch, 2013).

The evidence for the role of frequent consumption of sugar as a determinant of dental caries is conclusive (Sheiham, 2001, Zero et al., 2008). The primary evidence for the link between frequent sugar intake and caries comes from the Vieholm study which showed that the more frequent the consumption of sugars, the higher the risk of dental caries (Gustafsson et al., 1954). This association was confirmed later in

experimental animal studies (König et al., 1968, Bowen et al., 1980) as well as laboratory studies using an in situ caries model, which reported a significant positive correlation between tooth demineralisation and number of sugar exposures per day (Cury et al., 1997, Duggal et al., 2001, Leme et al., 2004). The positive association between frequency of sugar intake and dental caries prevalence has been reported in several studies (Holbrook et al., 1989, Holt, 1991). This has also been demonstrated longitudinally in a study of young children in Brazilian nurseries, where a clear positive association was found between the daily frequency of sugar intake and caries increment (Rodrigues and Sheiham, 2000).

However, the relationship between frequency of sugar consumption and the development of caries has not always been consistently reported in epidemiological studies, since some studies show a weak or no correlation (Sreebny, 1981, Newbrun, 1982, Burt and Pai, 2001). In a relatively recent systematic review, the significant association between the frequency of sugar consumption and dental caries was observed in 19 out of 31 included studies (Anderson et al., 2009). The explanation of that inconsistency possibly rests on the fact that the majority (22) of included studies in this review were cross sectional studies using epidemiological data. These data have inherent flaws because they fail to reflect the accumulative nature of dental caries (Newbrun, 1982, Marthaler, 1990), and suffer from a lack of consistency and reliability in measuring sugars intake. For example, Anderson et al (2009), noted that the frequency was inconsistently measured snacking and total frequency on a daily and weekly basis.

Nevertheless, other systematic reviews have concluded that frequent consumption of sugars is a powerful indicator of increased risk of dental caries despite the inherent difficulties of relating current sugar consumption practices to past dental

caries experience and weakened sugar-caries relation in the fluoride age (Burt and Pai, 2001, Touger-Decker and van Loveren, 2003). Increased frequency of sugar of more than four intakes per day has been suggested as the threshold for increased risk of dental caries (Kalsbeek and Verrips, 1994, Holbrook et al., 1995, Sheiham, 2001, Watt, 2003).

2.3.3 Amount of sugar

The evidence relating the amount of sugars consumed and dental caries is overwhelming (Rugg-Gunn and Nunn, 1999, Zero et al., 2008). The amount of sugar in the diet has been ascribed a crucial role in caries aetiology. The biological mechanism of action is clear (Hill, 1965). The amount of dietary sugar is found to be associated with the bacterial activity in dental plaque and the rate at which pH returns to the normal levels (Sheiham, 2001). An increased concentration of sugar results in greater decreases in pH; changing the ecological balance in dental plaque in favour of growth of cariogenic bacteria (Marsh, 1990, Leme et al., 2006). In addition, experimental studies in rats show that a high sucrose diet reduces dentine formation, thus increasing the cariogenic challenge on the enamel and dentine (Tjaderhane et al., 1995, Huuonen et al., 1997).

The correlation between the total consumption of sugar and dental caries has been observed extensively in epidemiological studies. Early population studies of dental caries patterns following changes in availability of dietary sugars have shown that dental caries incidence rate is associated with increased amount of sugar consumption (World Health Organisation, 2003, Moynihan and Petersen, 2004). A higher total daily intake of sugar was associated with greater caries increment in longitudinal studies among children. Rugg-Gunn et al. (1984) conducted a two-year cohort study to monitor the total intake of sugars and caries increment among English

children and found that for an increase of 83.3 g of sugar, the number of decayed tooth surface rose by 1.0. Another three year cohort study among US children, showed that increasing sugar consumption by 5g was associated with a 1% increase in the probability of developing new caries lesions in children with a low susceptibility to dental caries (Szpunar et al., 1995). In children who were followed prospectively from infancy to 10 years of age, the excessive daily consumption of sugars (higher than 10% of daily energy) was deemed to increase the risk of caries in children (Ruottinen et al., 2004).

A recent longitudinal study of caries increment in Finnish adults reported that the DMFT increased by 0.09 units for every 10 g in sugars consumption (Bernabé et al., 2016). Recently, a systematic review has been conducted to update evidence on the association between amount of sugars intake and dental caries, and to inform the World Health Organization (WHO) guidelines on sugars consumption. The review was extensive and searched a long list of databases. Of 5990 papers identified, 55 studies were eligible; and 11 of these were using longitudinal study design (3 interventions, 8 cohort). The positive association between the amounts of daily sugar intake was observed in 47 studies. The review found that there is a consistent evidence of moderate quality supporting a relationship between the *amount* of sugars intake and the development of dental caries. It concludes by recommending that the contribution of free sugars to total daily energy should be reduced to less than 5 % in order to reduce the incidence of dental caries; although it should be noted that the evidence for this actual cut-off point is relatively of low quality, being based on observational rather than randomised interventions (Moynihan and Kelly, 2014).

2.3.4 Amount vs frequency debate

Whether it is the amount or frequency of sugar intake that has the greatest significance to dental caries, and consequently should be targeted as part of caries prevention, is widely debated in dental literature. It generally concludes that both amount and frequency are strongly associated with dental caries and that the evidence for one is not stronger than the other, and that any attempts to control one will directly affect the other in any case (Arens, 1999, Moynihan, 2002).

A strong correlation ($r = +0.77$) between amount and frequency of daily sugar intakes was reported in a longitudinal study of dietary patterns associated with caries increment in 12-14 year old children in north-east England (Rugg-Gunn et al., 1984). Recent evidence from a longitudinal study of 10-year caries increment in Finnish adults doubts the collinearity between *amount* and *frequency* and indicates that dietary sugars *amount* may be more important factor related to caries development, than *frequency* of sugar intake (Bernabé et al., 2016). However, in this particular study, participants were asked to recall their dietary intake over the previous by completing a food frequency questionnaire, which brings the risk of memory bias and is a less rigorous method than the extensive diet diaries used to collect data (Rugg-Gunn and Nunn, 1999).

To summarise, systematic review evidence indicates that high sugar consumption, whether measured in amounts or frequency, is a strong indicator of caries risk in modern society (Burt and Pai, 2001). However, while focusing on reducing amount is more appropriate at the population level, since it allows setting common risk goals and monitoring health promotion programs, targeting the *frequency* of sugar consumption rather than the *amount* may be a more realistic approach when addressing individual dental patients (Moynihan, 2016).

2.3.5 Consumption of sugar in a retentive form

It is generally accepted that dietary sugars retained on the dentition for prolonged periods are the most cariogenic (Kashket et al., 1996, Vadiakas, 2008). It was the Vipeholm study that firstly investigated the influence of consuming refined carbohydrates of different degrees of stickiness (variable retention times) on the development of dental caries. Caries increments were measured for those who consumed refined sugar with: 1) lower retentiveness in the mouth at meal time only; 2) moderate retentiveness in the mouth at meal times only; and 3) high retentiveness in the mouth between meals. Higher rates of dental caries incidence were found to be associated with the consumption of refined carbohydrates in retentive form (sticky) (Gustafsson et al., 1954).

Retained food particles on tooth surfaces contribute to the caries process by consistently providing the bacteria with fermentable carbohydrates needed as substrates for acid production; hence prolonging potential demineralisation. It has been demonstrated that the level of soluble dietary sugars remains high within the entrapped food particles as long as they are retained on the teeth (Kashket et al., 1991, Kashket et al., 1996). The clearance of sugar from saliva has also been shown to be slowest for foods that are highly retentive (Kashket et al., 1991).

The retentiveness of any food is determined by its physical as well as chemical properties such as consistency, particle size, solubility, tackiness, cohesiveness and adhesiveness to the tooth surface (Caldwell, 1968, Caldwell, 1970, Speirs and Dean, 1989, Zero et al., 2008). Different foods exhibit different retentive properties and individual variability in their clearance from the mouth (Luke et al., 1999).

Although it is widely accepted that sticky foods are retained for long periods on teeth, stickiness is often measured subjectively and does not represent a true

measure of retentiveness (Moynihan and Petersen, 2004). Perceived stickiness was found to be weakly correlated with retentive properties of food stuff. In a study that compared perceived stickiness of 21 commercially available foods and the objective retentiveness of each of these foods (Kashket et al., 1991), caramels, raisins and jellybeans, were rated as the stickiest by participants though these foods showed the least retentive properties and were rapidly cleared from the mouth. Conversely, semi-solid foods, starchy food and baked products were the ones with the highest levels of retention on teeth. However, many other factors related to tooth morphology and saliva can also affect the retention and clearance of different foods (Oliveby et al., 1990, Luke et al., 1999).

2.3.6 Consumption of sugar mixed with starch

The combination of sugar and starch, as in baked and processed foods have found to be associated with an increased cariogenicity of sugar (Firestone et al., 1982, Rugggunn et al., 1987, Kashket et al., 1991, Lingstrom et al., 2000, Ribeiro et al., 2005, Llana and Forner, 2008). The physical properties of starch might increase the retention time of sugar on teeth (Grenby and Paterson, 1972, Zero et al., 2008). Kashket et al (1991) reported that high-starch snacks remained longer on the teeth than high sugar, low starch foods. A two-year cohort study among 12-13 year olds concluded that foods with relatively low sugar and proportionally high starch were predictive of dental caries risk. Starch has been identified as a significant effect modifier of the relation between sugar and caries (Campain et al., 2003).

2.3.7 Between meals consumption of sugars

Available evidence suggests restricting sugar consumption to mealtimes where possible (Watt et al., 2003). This is rooted back to the important conclusion of the Vipeholm study that the consumption of sugars between meals increases the risk for

dental caries (Gustafsson et al., 1954). The consumption of sugar between meals increases its cariogenic potential because it prolongs acid production and depletes the ability of the saliva to deal with the cariogenic challenge (Tahmassebi et al., 2006). The importance of between meals sugar consumption has been confirmed in many longitudinal studies. In a three year prospective study among US children, between meals intake of sugar was found to be risk factor of proximal dental caries in susceptible children (Burt et al., 1988). In another 3-year longitudinal study that assessed caries risk factors for the mixed dentition, the daily use of sugar containing drinks between meals was confirmed as a risk factors for developing a high caries increment in permanent first molars in (Vanobbergen et al., 2001). Marshal et al (2005), showed that consumption of sugar-starch containing foods as snacks had higher cariogenicity than when consumed with meal.

2.3.8 Near bedtime consumption of sugars

There is a considerable evidence that consuming sugars near the bedtime is associated with dental caries in children (Harris et al., 2004, Hooley et al., 2012). Rugg-Gunn et al (1984) found a statistically negative correlation between caries increment and the interval between eating a food containing more than 10 per cent sugars at bedtimes in a cohort of 11-14 years old British children. Levine et al (2007) followed English children prospectively and found a significant association between consumption of non-milk extrinsic sugars near bedtime and increase of caries at 11-15 years of age (Levine et al., 2007), which supported an earlier observation from cross-sectional survey in English children aged 2-16 years (Levine, 2001). In a retrospective study among 7-12 year old Australian children, a significant association was observed between caries and the evening sweet drinks (Lee and Brearley Messer, 2011).

Sugar exposure near bedtime causes a greater and prolonged decrease in pH of dental plaque (Rugg-Gunn and Nunn, 1999). This is because the salivary flow reduces dramatically during sleep and results in a reduction in the protective effects of saliva (Humphrey and Williamson, 2001, Dawes, 2008). Saliva plays a vital role in the development of dental caries, its buffering capacity and physical cleansing action contribute in clearing sugars from mouth and restoring plaque pH to the resting level after exposure to sugars (Lenander-Lumikari and Loimaranta, 2000).

2.3.9 The sequence of sugar consumed within the meal

The cariogenic potential of sugary food or drink can be affected by the sequence at which they are consumed during the meal (Rugg-Gunn and Nunn, 1999). It has been suggested that the last eaten item has the greatest effect on plaque pH (Geddes, 1994). Whilst finishing the meal with sugary food or drink results in greater and extended drops in plaque pH, doing so before or between non-cariogenic items leads to less reduction in plaque pH (Rugg-Gunn et al., 1981). Furthermore, finishing the meal with anti-cariogenic foods or those promote the secretion of saliva, can have caries protective effects because it neutralises the acidity caused by sugared food. For instance, finishing a meal with cheese will consistently raise pH and neutralise the acidity caused by sugar consumption (Geddes, 1994, Zero et al., 2008).

2.3.10 Prolonged exposure to sugars

The methods of consumption of sugared items are likely to affect the dental caries process (Marshall et al., 2003). Bacteria are capable of fermenting sugars as long as they are available in oral environment. Therefore, patterns of consumption which increase the exposure time to sugars can cause the plaque pH to remain low for a longer time, which favours the proliferation of cariogenic bacteria, and tips the balance towards demineralisation (Marsh and Martin, 2009). Habits such as constant

sipping or prolonged holding of sugar containing beverages in the mouth or ingestion of slowly eaten (sucking) snacks such as hard candies, lozenges, and lollipops, can prolong exposure time to sugars and increase caries risk (Tinanoff and Palmer, 2000, Touger-Decker and van Loveren, 2003).

In summary, therefore sugar-caries association is far from straight forward, with many factors related to sugar consumption patterns, form and general diet structure affecting the cariogenic potential of any sugar intake (Bowen et al., 1980, Selwitz et al., 2007). Since these factors can influence the cariogenic potential of any dietary intake, they should be accounted for when determining the effective cariogenicity foods and beverages (Burt and Ismail, 1986) and when considering caries control (Woodward and Walker, 1994).

2.4 Approaches of caries prevention

Rose (1992) identified two general approaches to tackle any public health problem. These are the ‘whole population’ and the ‘high risk’ strategies. The ‘whole population’ approach implies delivering a public health and comprehensive intervention to the entire community to prevent a specific disease regardless of individual’s risk status to that disease. The population approach is underpinned by the assumption that the disease is normally distributed and so the majority of the population belongs to the moderate risk category. It aims to address the determinants of incidence through delivering a radical intervention that reaches everyone in the community, which will shift the whole disease distribution towards a majority of low risk (Rose, 1992).

The ‘high risk’ strategy, by contrast, involves identifying those who are at high risk of a given disease to target them with appropriate prevention, which may take the

form of limiting the exposure to a risk factor or reinforcing protection against its effect (Rose, 1992). The high risk approach is centred on the premise that the intervention is individualised which makes it more sensitive to both patient and physician (Rose, 1992). It seeks to control causes of the cases by identifying individualistic risk factors for a given case and controlling them.

Both 'population' and 'high risk' approaches have their own advantages and disadvantages. While a high risk strategy is preferred by health professionals since it raises motivation of both the patients and their physicians, reduces the cost and has a favourable 'benefit-risk ratio', it has been criticised for being palliative and temporary in nature, reliant on the predictive power of screening tests, and ignoring the underlying determinants of the disease (Watt, 2005). On the other hand, a population strategy uses public health interventions which target the underlying causes of the disease and affects many people. However, such a mass approach may require huge resources to be delivered to the whole population and also suffers from a 'preventive paradox' where many must be targeted to lower the incidence of a disease affecting a relatively small number of people. In a population where there is a majority of low risk individuals, the majority will have only small benefits from the intervention (Rose 1985). In the view of aforementioned limitations, a 'targeted population' approach, which is a hybrid strategy of the population and risk approaches, has been suggested to combine the benefits of both approaches by targeting high risk groups or subpopulation identified through epidemiological data (Watt, 2005).

Identifying the most appropriate approach for caries prevention has been a source of debate for many years. On one hand, advocates of the high risk strategy rest their argument on the skewed distribution of dental caries, arguing that the majority of the population is caries free; (for example, only 25% of children bear 75-80% of

carious teeth surfaces (Kaste et al., 1996). A population approach in this situation is argued as adopting strategies affecting the disease-free majority which represent a waste of resources (Fejerskov, 1995). Consequently, in 2001 at the National Institutes of Health (NIH) conference on caries prevention, recommendation was made that high-risk individuals should be identified and in a timely way targeted with caries preventive strategies, in order to reduce needless care and cost (National Institutes of Health, 2001). On the other hand, it has been counter-argued that the development of some new cases with caries is not always limited to those readily defined by usually risk group classification; since there is no reliable test for caries risk. Hence they argue that high risk strategy is not sufficient by itself and therefore population strategies are more effective in tackling caries from the public health angle (Batchelor and Sheiham, 2002).

On the other hand, the relation between the two approaches may not be necessarily in apposition. Both approaches could be applied together as long as the incidence of new cases continues and the control of caries determinants has yet to be achieved (Rose, 1985). It is, therefore, increasingly accepted that targeting individuals at risk should be a complement to the population-based strategies for caries prevention (Batchelor and Sheiham, 2002, Watt, 2005). Pitts et al (2006), in their discussion of The 2003 Children's Dental Health Survey in the UK, recommended upstream strategies directed to the whole population alongside clinically effective preventive dental care tailored to those who are at high caries risk (Pitts et al., 2006). This allows the truncation of new cases incidence by controlling the determinants of dental caries and prevents further development of the disease through changing the risk factors in highly susceptible individuals (Fejerskov, 1995).

It has suggested that there are two kinds of patients to consider and care for. Firstly, patients with low or no risk of dental disease, who should receive generic interventions to allow maintenance of a healthy oral environment. Secondly, patients at high risk of dental disease, who should be targeted with individualised interventions to prevent progression of their disease and to prompt their oral environment to be a healthy one (Richards, 2013).

2.5 Sugar as a common risk factor

According to the common risk factor approach, many chronic diseases and oral diseases share the same risk factors and hence they can be targeted using the same prevention and treatment strategies (Sheiham and Watt, 2000). Excessive consumption of sugars is one of the common risk factors for both oral and systemic diseases: evidence from a recent systematic review has established a coexistence of dental caries and obesity epidemics in children from industrialised countries including the UK (Hayden et al., 2013). There is also strong evidence from other systematic reviews and meta-analyses that an overconsumption of sugars is associated with increased risk of dental caries (Moynihan and Kelly, 2014), as well as obesity and Type 2 diabetes mellitus (Han et al., 2010, Malik et al., 2010). Sugar-sweetened drinks and confectionery which are the main source of free sugar intake and a major contributor in the aetiology of dental caries, are found to be prospectively associated with childhood obesity (Ludwig et al., 2001, Han et al., 2010). Evidence from meta-analysis showed that children with the high intakes of sweetened soft drinks are at higher risk of being overweight than those with low intake (Te Morenga et al., 2013).

There is a conclusive evidence that diseases have a tendency to cluster within lower socioeconomic status (SES) groups (Pickett and Pearl, 2001). Likewise, a higher consumption of sugars has been reported in children from families with low

SES (Sheehy et al., 2008). Similarly, there is fairly strong evidence that SES is inversely related to the prevalence of dental caries and obesity among children (Reisine and Psoter, 2001, Neumark-Sztainer et al., 2002). Although different mechanisms are implicated for the role of SES in dental caries and obesity, its effect is believed to be brought about through the limited knowledge of healthy food choices and inability to offer healthy food (Marshall et al., 2007). Thus, interventions that promote healthy eating within a common risk factor approach would assist in preventing obesity and dental caries epidemics in children (Hayden et al., 2013). By developing structured eating and drinking patterns that maintain appetite and energy balances and reduce exposure to cariogenic food, the risk for both dental caries and obesity can be reduced (Marshall, 2003).

2.6 Childhood is a critical time for caries development

Caries experience during childhood is highly correlated with developing dental caries later in life (Burt and Eklund, 2005, Mejare et al., 2014). Whilst primary teeth have a short life span of less than 10 years, permanent teeth are meant to stay for life. The period of mixed dentition marks the transition from primary to permanent dentition. It starts after the age of five, and is a complex and critical time for caries development in permanent dentition (Lynch, 2013).

Epidemiological data and evidence from longitudinal studies show that dental caries is more likely to develop within the first few years after eruption (Burt and Eklund, 2005, Mejare et al., 2014), particularly among those who high risk groups of dental caries (Manji and Fejerskov, 1994). This is explained in the literature by several explanations related to teeth composition and position within the oral cavity. The newly-erupted teeth have immature enamel predisposing to a higher risk of developing caries (Lynch, 2013), and being out of function is thought to enhance

accumulation of dental plaque with potential cariogenic bacteria (Carvalho et al., 1989). Moreover, these teeth are not ideally aligned in the oral cavity and usually surrounded by tender gums which make it difficult to maintain proper oral hygiene (Lynch, 2013).

Childhood also represents an important stage of life in cognitive development and establishing dietary habits. It is a sensitive time for the development of food patterns and preferences (Illingworth and Lister, 1964, Cashdan, 1994). By the end of childhood, children's cognitive abilities will have passed through a series of periods of transition during which the cognitive underpinnings for independent food choice and acquisition emerge (Burrows et al., 2010). Recent national survey of diet and nutrition in the United Kingdom have suggested that the consumption of sugars among children increases as they move towards the end of their childhood (Bates et al., 2014), when the children are increasingly responsible for their own dietary choices (Rockett and Colditz, 1997). Therefore, promoting healthy dietary behaviour of children is of particular importance because healthy eating habits that are learned early in life, have not only immediate but lifelong nutritional advantages as well as impacting on a person's lifelong dental caries experience (Marshall, 2004).

2.7 Dietary advice in the dental care setting

While adopting a healthier lifestyle is considered the responsibility of the individuals, additional support from society and health care professionals is necessary (Resnik, 2007). One way of support is by offering the individual with the information and the skills that help make healthy choices easier (Craven and Kay, 2008). The dental team can play a key role in promoting oral as well as general health by incorporating the principles of oral health promotion and the 'common risk approach' in their practice to enable making easier choices relevant to both oral and general

health (Sheiham, 1992). Patients' education is even considered a moral duty for every dental practitioner (Stillman-Lowe, 2008), who are encouraged to routinely provide healthier dietary advice, that promotes good oral and general health, to all dental patients. This has been widely advocated in policy documents and practice recommendations and guidelines published by governmental and scientific organisations across the globe (European Academy of Paediatric Dentistry, 2008, American Academy of Paediatric Dentistry, 2013, Public Health England, 2014a).

In the UK, National Institute for Health and Care Excellence (NICE) guidance published, in December 2015, recommended that preventive advice (including dietary advice) be provided by all GDPs to all dental patients and there should be an individually tailored advice to patient's needs; working in partnership with their patients (National Institute for Health and Care Excellence, 2015). The NICE guidance also recommends that oral health messages be based on 'Delivering Better Oral Health' (DBOH). DBOH positions issuing dietary advice as central to the everyday clinical practice of general dental practitioners (GDPs); stating that: 'Healthier eating advice should *routinely* be given to patients to promote good oral and general health'. The guidance is explicit, that the main dietary messages given should be 'to reduce both the amount and frequency of consuming foods and drinks that have added sugar' (Public Health England, 2014a). It also mentions 'there is a consensus that avoiding sugar-containing foods and drinks at bedtimes is beneficial to caries prevention', and draws attention to what a generally healthy diet looks like, in the form of the 'eatwell' plate.

While raising awareness of healthy behaviours is considered sufficient when considering dental care for people at low risk of dental caries, it is recommended that patients at high risk of dental caries will need additional support for behaviour change

in a form of detailed diet advice tailored to their circumstances and needs (Rugg-Gunn and Nunn, 1999, Watt et al., 2003).

Watt, McGlone & Kay (2003) described a six-step model for dietary advice to support patients at high risk of dental caries and erosion, which includes: 1) conducting an initial risk assessment to identify patients at high risk of dental caries and erosion. High-risk groups may include children from socially deprived groups, medically compromised patients, and older people; 2) obtaining a detailed dietary assessment to identify dietary intakes and behaviours relevant to oral health. The authors suggest that this is done using diet diaries; 3) setting realistic behaviour change goals based on the analysis of gathered information and the discussion with the patient; 4) developing and implementing an appropriate action plan that is tailored to patient's circumstances, to achieve the agreed goals; 5) monitoring and reviewing the progress toward agreed goals and to provide feedback as part of the continuing support; 6) referring cases with specific dietary issues to a dietician for further support and guidance. They make the following recommendations for giving dietary advice in dental practice, citing the current level of evidence:

- '1. Dietary advice should primarily aim to reduce the frequency and amount of sugary foods and drinks consumed and should be in accordance with general diet guidelines (Type 3 Evidence).
2. A dietary history should be taken to identify the pattern of sugars consumption in patients at risk of developing future caries (Type 3 Evidence).
3. Appropriate goals and an action plan should be agreed with patients on the best means of reducing sugars consumption (Type 3 Evidence).

4. Progress with dietary changes should be monitored and reviewed. Any patients with special or complex dietary problems should be referred to their general practitioner or a state registered dietitian for detailed support (Type 3 Evidence).’

It is noteworthy that ‘Type 3 evidence’ here being from non-randomised longitudinal studies which is a relatively low level of evidence on which to base guidelines (Davies et al., 2003), pointing to the relative paucity of evidence in this field.

2.8 Dietary assessment in dental practice:

In primary health care settings dietary assessments are carried out to help identify patients’ needs, tailoring dietary advice, and monitoring changes in patients’ dietary patterns (US Preventive Services Task Force, 2003). Assessing patients’ dietary patterns and intake is also considered a vital part for appropriate dietary advice in dental practice (Rugg-Gunn and Nunn, 1999, Watt et al., 2003, Mobley and Dounis, 2010). It is said to provide the dental practitioner with an understanding of patients’ dietary patterns and needs (Bedi and Brown, 1983, Wilkins and Wyche, 2013), enable the tailoring of dietary advice for individual patient’s needs (Marshall, 2009), and prompt discussions between dentist and patient, thus making forming a therapeutic alliance more likely (Freeman, 1999b). The main areas to be addressed when assessing dental patient’s diet are identified as: frequency of dietary intakes per day, which of these exposures contain sugar, the consumption of sugar within one hour of bedtime and structure, consistency and manners of intake of meals and snacks (Watt et al., 2003, Marshall, 2009, Wilkins and Wyche, 2013).

Two levels of dietary assessment have been proposed for dental patients as part of their preventive care. These are exploratory and detailed dietary assessment (Fontana and Zero, 2006, Marshall, 2009, Mobley and Dounis, 2010). While

exploratory assessment is recommended to be routinely carried out for all dental patients, as part of their dental assessment to identify those at risk of dental caries, a more detailed dietary assessment is recommended as additional support to those identified at risk of developing dental caries (Fontana and Zero, 2006).

The exploratory screening is quick and usually undertaken in the form of an interview with follow up questions or checklist that is completed by the patient or the dentist. It focuses on key detrimental sugar consumption behaviours that are known to affect caries risk, such as high frequency, between meals and near bedtime consumption of sugars. Although it is not the focus of the thesis it is worth noting that some dentists may also screen for risk factors relevant to tooth erosion.

There are many dietary assessment tools and forms available to the dental team (Mobley and Dounis, 2010). However, different tools seek variable levels of dietary information. For example, 'The Diet Assessment of Caries Risk tool' which was designed at the University of Iowa, USA, to help dental practitioners to identify dietary factors contributing to caries risk (Marshall, 2009), collects information on frequency, amount, timing and manners of intake and supplemented with specific responses representing low, moderate or high caries risk. For instance, 'drinking style' is specified as using a straw, from open container and swishing in the mouth, which denotes low, moderate, and high risk, respectively. On the other hand, dietary screening can sometimes be limited to only the frequency of in-between meals sugar exposures, such as caries risk assessment tool (CAT) which is developed and advocated by the American Academy of Paediatric Dentistry (AAPD) which counts only the frequency of in-between meal sugar attacks and bedtime exposure from bottles (American Academy of Pediatric Dentistry, 2002).

Detailed and systematic dietary assessment is recommended for all patients who demonstrated a high caries risk or an unusual caries pattern (Kidd, 2005). Generally, detailed dietary assessments can be classified as retrospective and prospective methods.

The most popular retrospective methods are 24-hour dietary recall and diet histories (Boyd and Dwyer, 1997, Rugg-Gunn and Nunn, 1999, Kidd, 2005, Wilkins and Wyche, 2013). The 24-hour dietary recall is an interview administered by dental staff at the dental chairside to collect information about patient's dietary intake during the previous day (Marshall, 2009). In the diet history method, the patient is asked to recount their typical dietary intake and habits, usually over one week period (Welch, 2014). Retrospective methods are considered appropriate for patients with low literacy and older children. These methods require effective interviewing skills and therefore, may best performed by dieticians (Welch, 2014). They may also be time consuming and open to memory distortion (Rugg-Gunn and Nunn, 1999, Welch, 2014). Since the method of assessing dietary intake on one day may not be a representative of usual eating habits, a dietary history method is considered to be the retrospective method of choice (over 24-hour dietary recall) since it is concerned with information about typical eating habits (Rugg-Gunn and Nunn, 1999, Wilkins and Wyche, 2013).

An alternative way of collecting dietary information is to do this prospectively. This involves the use of diet diaries, also called diet records or diet sheets. These methods are considered to be of higher validity owing to their expected accuracy and representativeness of habitual dietary intake (Rugg-Gunn and Nunn, 1999). Patients are asked to keep a real-time record of what they drink and eat for a defined period of time, of maximum 7 days including at least one weekend day (Rugg-Gunn and Nunn, 1999, Wilkins and Wyche, 2013). Although this approach mandates that patients are

sufficiently motivated and cooperative enough to provide honest and real time records (Nizel and Papas, 1989, Kidd, 2005), a full compliance with its protocol would eliminate memory bias which comes with retrospective methods, yielding a full picture of patient's diet (Nizel and Papas, 1989, Rugg-Gunn and Nunn, 1999). A further benefit is also envisaged, that the diet diary can be an effective self-monitoring tool if used correctly (Glanz et al., 2006); this can, in itself, effect a positive change in behaviour; for evidence shows that incorporating self-monitoring tools into behaviour change interventions increases their effectiveness significantly (Michie and Johnston, 2012).

2.9 A 3-day diet diary used in dentistry

Dental literature around diet and nutrition assessment in dental practice frequently recommends a 3-day diet diary as the most reliable tool for dietary assessment (Nizel and Papas, 1989, Rugg-Gunn and Nunn, 1999, Moynihan et al., 2003, Kidd, 2005, Marshall, 2009, Mobley and Dounis, 2010, Wilkins and Wyche, 2013). The use of diet diaries is also recommended by various guidelines for preventive dental practices (Boyd and Dwyer, 1997, Scottish Dental Clinical Effectiveness Programme, 2010, Public Health England, 2014a). In the UK, although the current guidance in the form of 'Delivering Better Oral Health' (DBOH) does not heavily mandate the use of diet diaries to all patients, it states that 'In some cases it can be helpful to use a diet diary'. An exemplar is given with a 3-day diet diary template (Appendix A). The diet diary template includes space to record time of consumption, alongside a space for a free text entry describing the item consumed (Public Health England, 2014a). Diet diaries are also recommended by the British Society of Paediatric Dentistry guidelines which state that, for children at risk from dental caries (children from low SES backgrounds, medically compromised patients,

children with Special Needs and children on long term medication), ‘a 3-4 day diet diary should be completed and discussed, and dietary counselling should be given which is specific to the child and family, based on the dietary diary’ (The British Society of Paediatric Dentistry, 1999).

Issues concerned with the administration and analysis of diet diaries used in dental practice have been described in a few text books (Rugg-Gunn and Nunn, 1999, Kidd, 2005, Wilkins and Wyche, 2013). In general, the protocol for the use of diet diaries in clinical dentistry is as follows: Patients are requested to provide a detailed account of timing, type, and structure of everything eaten or drunk as well as the time of going to bed. Patients may also provide details of each dietary intake such as the brand names and any added items such as sugar or sauces as well as any liquid medicine and whether it contains sugar. Unlike their use in nutritional research where quantities need to be precisely measured or estimated (Thompson and Subar, 2013), the quantities of foods are not specifically requested. This should be done for at least three consecutive days, one of which should be a weekend day.

Patients should be encouraged to keep the diary with them all the time, instantly record any dietary intakes and avoid using atypical days that might be complicated by travel, illness, or unusual circumstances (Rugg-Gunn and Nunn, 1999). Verbal as well as written instructions on how to complete the diary and showing the patients examples of completed diaries are desirable (Kidd, 2005). The dentist should motivate the patient to fill in the diary by explaining its importance and how this would relate to their oral health status (Zero et al., 2008). Since honesty is a key for diet diary success, dentists should avoid giving any specific advice and emphasise the fact that the aim of this activity is to investigate what might be the cause of problem rather judging their behaviours (Kidd, 2005).

On receiving the completed dietary diary, patients should be praised first for doing it before reviewing the diary with them to clarify any ambiguities and to ensure the completeness of the diary and the adequacy of the information (Rugg-Gunn and Nunn, 1999). It is recommended that dental practitioners work, (preferably with the patient), on identifying sugary items and quantifying the number of sugar attacks and which of these were between meals and whether there is sugar exposure within one hour before bed (Rugg-Gunn and Nunn, 1999, Wilkins and Wyche, 2013). At this stage the dental practitioner can explain the relevance of frequency of sugar attacks to caries development. Other aspects to consider when analysing the diet diary are the consistency of food, the presence of sugary medication and general nutritional value of diet. It is that the dentist who administers, receives, analyses and gives the advice within short period of time between these steps (Kidd, 2005).

2.9.1 The use of diet diaries in clinical dentistry

There is little published information on the use of diet diaries in dental practice. A recent systematic literature review, which was conducted to investigate the dietary advice practices as well as factors influencing its provision in dental settings, shows that this area is under-researched (Frank et al., 2014). The author subsequently undertook a focused systematic literature search in this area, (for search strategy see Appendix B). This confirmed that there were no other studies in the literature exploring the use of diet diaries in clinical dentistry. The literature was regularly updated by using alerting features on databases (e.g. Google Scholar) and manually re-running the search at regular intervals.

Frank, Hayes & Taylor (2014) searched CINAHL Plus, Medline via OVID and the Cochrane Library for English written studies published between 1993 and

2013 and concerned with the provision of dietary advice. No limits were applied for the participants (dentists, dental hygienists and dental students), setting, age or gender. The authors did not include studies published before 1993 because they considered these as being covered in a previous literature review which was the only identifiable study with information on diet diaries (Levy and Raab, 1993).

The study conducted by Levy & Raab involved a self-administered questionnaire based survey which was undertaken to identify dietary counselling practices of 300 American dental hygienists in Oregon, USA. One of the survey questions asked participants to indicate how often they obtained diet records from their patients. This study concluded that diet diaries were seldom used, with only 4 % of the 208 respondents to this question reported that they often or sometimes obtain diet records from their patients. The data involved the reported practice in just one setting (United States Dentistry) and with one type of personnel (dental hygienists). There have been no previous studies of the use of diet diaries in clinical dentistry by dentists themselves, either in dental practice or clinical settings.

2.10 The use of diet diaries outside dentistry

Outside dentistry diet diaries are used to serve a variety of purposes at individual and population level (Welch, 2014). Although widely used in epidemiological and dietary intervention studies (Burke et al., 2005, Welch, 2014), diet diaries are not frequently used in clinical nutrition settings where quick assessment, rather than waiting for few days to get the record, is required and retrospective methods (24-hr recall and diet histories) are considered more preferable (Welch, 2014). In addition, dietary assessment in general primary health care settings is intended to assess specific aspects of dietary intake, such as dietary fat, rather than the patient's diet as a whole, for which specific measures are usually used (Calfas et

al., 2000). Thompson et al (2013) provided a comprehensive description of various methods used for dietary assessment in the general research and health care settings, a summary of these methods is presented in Table 2-1.

Table 2-1: Summary of diet assessment methods

Method	Advantages	Disadvantages
<p>24 hours diet recall Recalling food and drinks consumed within 24 hours</p>	<ul style="list-style-type: none"> • Does not alter food intake pattern. • Short time • Open ended 	<ul style="list-style-type: none"> • Trained interviewer • Recall bias • Not representative for dietary intake
<p>Food frequency questionnaire frequency of consumption of certain foods listed in a questionnaire for certain periods</p>	<ul style="list-style-type: none"> • Easy to administer and analyse • Does not change the usual food intake 	<ul style="list-style-type: none"> • Recall bias • Not open ended • Substantial amount of measurement error
<p>Brief Dietary Assessment The intake of specific dietary components such as fruits and vegetables is investigated</p>	<ul style="list-style-type: none"> • Useful in situations where the assessment of the total diet or accuracy is not required 	<ul style="list-style-type: none"> • lack of sensitivity to detect changes in dietary intake
<p>Diet history asks the respondent to recount his/her past diet</p>	<ul style="list-style-type: none"> • Assess meal patterns and details of food intake 	<ul style="list-style-type: none"> • Trained interviewer

The rest of this section focuses on diet diaries. The amount and precision of information which is requested to be reported by patients in diet diaries varies according to its purpose. This ranges from just listing of items to assess eating frequency, to a detailed description, including information regarding amount, ingredients, brand name and preparation method and left overs of consumed food/liquids, when assessing nutritional or energy intake (Thompson and Subar, 2008, Sherwood, 2009). On the other hand, when diet diaries are used to self-monitor eating behaviour, respondents are typically asked to record consumed food and beverages

and their amounts as well as contextual information such as timing, place, situation and emotions (Chambliss, 2004).

The amount can be weighed using digital scales (weighted records), or estimated using household measures like cups and tea spoons, photographs and models (estimated records) (Thompson and Subar, 2008, Sherwood, 2009). The number of days also varies from single to several days according to the purpose of use. For example: assessing the intake of nutrients with high variability such as vitamins may need up to 14 days of recording whereas lesser number of days is sufficient to capture the typical dietary habits in children (Lanigan et al., 2004). Three-day records have been accepted as the minimum number of days to account for dietary variability (Bloch, 2007). For children aged less than 12 years, keeping diet diaries is generally considered the responsibility of the parents or caregivers because of the limited abilities of the children to recall and provide details about the types and portion size of consumed foods (Livingstone et al., 2004).

The prospective nature and temporal proximity of recording dietary intake are considered the major strengths of diet diaries (Thompson and Subar, 2008). Diet diaries have the advantages of accuracy, measuring daily variation and are considered less reliant on respondent's memory (Anderson 1995). However, like all self-report methods, diet diaries are liable to bias (Thompson et al., 2010a). The method is time consuming; requiring subjects' cooperation, literacy, and numeracy skills, which effectively limits their use among certain groups such as low socioeconomic groups, poorly educated and minorities with English as a second language (Anderson 1995). Diet diaries are also labour-intensive which discourage many respondents from participating or induce reactivity where the participants change their habitual intake to simplify the recording and avoid its burden. In a qualitative study exploring the

experiences of keeping the diet diary, the participants reported that they would change their diet to simplify the recording process (Vuckovic et al., 2000).

2.10.1 Recent technological advances in diet diaries use

Incorporating technological advances, such as the reliance on audio recording or cameras to capture dietary intake rather than writing down on paper have showed promising findings in facilitating the reporting for the food record and overcoming their limitations (Thompson et al., 2010). In randomised clinical trials comparing the acceptability and feasibility of paper diaries with that of digital diaries, as dietary assessment and monitoring tools, electronic devices have shown superior acceptability, user satisfaction, and adherence to dietary self-monitoring (Yon et al., 2007, Carter et al., 2013).

Certainly mobile-phone-based techniques such as ecological momentary analysis which can record information on behaviour and attitudes in a real-time way, in a smart-phone application, offer possibilities (Schuz and Ferguson, 2015). Lieffers and Henning (2012) reviewed 18 studies published between January 2000 and April 2011 and compared the ability of mobile apps to capture dietary intake in comparison with conventional methods including diet diaries. It was concluded that mobile apps resulted in better user's adherence than conventional methods. In recent years, the use of mobile apps has exploded in capability and popularity, with a wide range of dietary assessment apps now available to the public use. For example, in Australia, a mobile app known as 'Nutricam' has been developed to record dietary intake by taking a photograph of food before consumption and store a voice recording to explain the contents of the photograph. Subsequently, this information is sent to a website to be analysed by a dietitian (Rollo et al., 2011). Moreover, in Japan a mobile app known

as 'Wellnavi', is used to send digital photographs, taken before and after consumption, via a mobile phone card to the dietitians (Wang et al., 2006).

2.11 The provision of dental care in the UK

In the UK, most of the primary dental care is provided by general dental practitioners (GDPs) who run the practices as independent enterprises. The NHS offers free dental care to children under 18 years, pregnant and nursing women and full time students under 19 years old are exempt from any charge under NHS terms. In addition, the NHS provides Community Dental Services (CDS); for groups who have poor access to other dental services, such as disabled people. Specialist dental treatment is also provided in general hospitals and all dental teaching hospitals, for free as part of Hospital Dental Services (HDS), usually after referral from a dentist in the general or community dental services. Patients other than above-mentioned groups contribute to their treatment cost by paying fixed charges according to the treatment received, apart from certain groups exempt from charges such as pregnant women.

The general dental practice can be a solo practice with a single dentist or group practice with a principal practitioner and associates. Patients can access dental care through the NHS or privately by directly paying fees or through insurance companies. The GDPs are independent contractors with NHS England through Area Teams who are responsible for commissioning dental care (NHS Choices, 2016). GDPs provide NHS dental care according to General Dental Service (GDS) regulations, and are free to provide as much or as little NHS care and private care as they wish (Harris and Holt, 2013).

The NHS is largely funded through general taxation. However, only 40% of dental care is funded through taxation. Under NHS contractual terms the patient may contribute to the payment for the service. The dentists are paid according to Units of

Dental Activity (UDA). These can be one, three or twelve units according to the complexity of treatment (Steele, 2009). Patients have to pay fixed charges according to treatment bands shown in Table 2-1.

Table 2-2: NHS bands of course of treatment and patients charges

Band	Course of treatment	Patient charge
Emergency	Emergency care in a primary care NHS dental practice such as pain relief or a temporary filling.	£19.70
Band 1	Examination, diagnosis (including X-rays), advice on how to prevent future problems, a scale and polish if clinically needed, and preventative care such as the application of fluoride varnish or fissure sealant if appropriate.	£19.70
Band 2	Everything listed in Band 1 above, plus any further treatment such as fillings, root canal work or removal of teeth but not more complex items covered by Band 3.	£53.90
Band 3	Everything listed in Bands 1 and 2 above, plus crowns, dentures, bridges and other laboratory work.	£233.70

Extracted from NHS choices website (NHS Choices, 2016)

Following an independent review, UDA system has been found to have unintended consequences, an inadequately rewarded preventive work (Steele, 2009), new models of contracts are currently being tested, with changes in the contracts are expected in the coming years (Harris et al., 2015).

2.12 Summary, rationale, and research questions

This section has reviewed the relevance, context of diet diaries usage in clinical dentistry. Diet diaries have been recommended as the primary tool for detailed dietary assessment in dental clinical settings, which allows for individualising and optimising dietary advice in order to tackle unfavourable sugar consumption patterns. As highlighted in the introduction section, sugar consumption is a current public health problem that has received much attention because it is a common risk factor

for dental caries and other general health problems particularly among children from lower SES. It has been shown that intervening to promote healthy dietary behaviours of children during the period of transition from deciduous to permanent dentition is of paramount importance and will have lifelong impacts.

Dietary advice to restrict the amount and frequency of sugar intake and to promote general health is a recommended routine for all dental patients. However, the relationship between sugar and caries is far from straight forward since many aspects of dietary intake may influence the cariogenicity of sugar intakes. Therefore, dietary advice needs to be realistic, comprehensive, and tailored to patients' needs, in order to be effective. This is a key reason why the use of diet diaries may be very beneficial for individualising and optimising the dietary advice. They can also be an effective self-monitoring tool that have the potential to enhance behaviour change.

In this chapter, reviewing the dental and general literature on the use of diet diaries (see sections 2.9 & 2.10), it is clear that there are large gaps in the knowledge of how diet diaries are currently used in dental care settings. In the main it appears that what we know about diet diaries almost entirely comes from outside dentistry where diet diaries are mainly used for research purposes. This literature indicates that diet diaries have some disadvantages, particularly when they are used for young children or lower SES groups. However, this general setting is a completely different environment to clinical dentistry since most of the diet diaries are delivered and analysed by trained researchers or dieticians and completed by motivated individuals. Information on how diet diaries are currently used in dental practice, factors influencing their use and the actual experiences of those who use them in dental practice, is sorely lacking.

Chapter 3. Aims and objectives

3.1 Introduction

This chapter outlines the research questions of this thesis. These were developed from the review of literature which identified a gap in the knowledge related to the use of diet diaries in dental care settings (section 2-12). The thesis general aim and its subsidiary objectives are also outlined. This chapter also gives an overview of the four studies that were conducted in order to achieve these aims and objectives.

3.2 Overarching research questions

- I. How diet diaries are currently used in dental practice for children and what do dentists/ families hope to achieve by their use?
- II. What are the strengths and weaknesses in the way the diet diaries are currently used in dentistry?
- III. Should the current format and procedure be modified to more effectively provide a monitoring tool?

3.3 Aim

The overall aim of this thesis is to investigate the use of diet diaries in dental settings, in the UK. This thesis focuses on the use of diet diaries among children aged 5-11 years of age since it represents a critical time for both caries development and prevention, as demonstrated in Chapter 2 (See section 2-6).

3.4 Objectives

1. To investigate how often diet diaries are currently used in dietary counselling in general dental practice.
2. To explore factors influencing the use of diet diaries in general dental practice

3. To investigate how dentists currently interpret and use the diet diaries information to give dietary advice
4. To identify to what extent diet diaries are successful in capturing dietary behaviours associated with increased risk of dental caries
5. To explore opinions related to, and experiences of using diet diaries in dental settings.

3.5 Overview of thesis's studies

Four studies were undertaken to meet the general aim and the objectives of this thesis. The final section of this chapter gives a brief description of these studies.

3.5.1 Study I: The use of diet diaries in clinical practice

In this study, GDPs' current practices and perceived influences of diet diaries usage in dental practice were investigated. A postal questionnaire was sent to a random sample of GDPs in the Northwest of England. In addition to providing demographic and professional information, the GDPs were asked to report their usual practices with regards to the provision of diet advice, dietary assessment in general and the use of diet diaries in particular. Individual survey questions were used to assess frequency, considerations and barriers of using diet diaries in general dental practice.

3.5.2 Study II: How dentists use diet diaries to give diet advice

In order to explore how GDPs interpret and use diet diaries to formulate dietary advice, a case-vignette based on a diet diary was incorporated in the postal questionnaire used in study I. The vignette included a diet diary showing a range of dietary behaviours and open ended questions asking the GDPs what dietary information they consider as important and what diet advice they would give to the case presented in the vignette.

3.5.3 Study III: Adherence to diet diaries among paediatric dental patients in a hospital setting

This was a retrospective study which set out to estimate the return rate of diet diaries and its associated factors among paediatric dental patients who had preventive dental care at a dental teaching hospital during the period between 2010 and 2013. The extent to which diet diaries were successful in capturing dietary behaviours known to influence dental caries process was also assessed. The data used for this study was extracted from clinical records. Data on oral health behaviours and demographic characteristics were obtained and compared with information given in completed diet-diaries. A content analysis of returned diet-diaries was performed to get an idea on the quality of dietary information collected using the diet diaries.

3.5.4 Study IV: Factors affecting adherence to diet diaries issued to paediatric dental patients in a hospital setting

A qualitative collective case study was used to explore the use of diet diaries in a dental hospital setting as a phenomenon. Multiple sources of data were used, which included: observation of dentist-patient encounters, semi-structured interviews with child-parent dyads and dentists, and a documentary analysis of returned diet-diaries. Data from various sources were integrated in a thematic analysis to identify factors associated with paediatric patient's adherence to diet-diaries issued in this setting.

Findings from studies I, II & III are all now published as peer reviewed articles in peer reviewed journals and are appended in appendix (H).

Chapter 4.Methodology

4.1 Introduction:

The term methodology refers to the description and the justification of research methods rather than the actual steps as to how these methods were applied (Carter and Little, 2007). Therefore, this chapter aims to give an over-arching description of methods and critically explains the study design, research methods and various data collection techniques associated with various studies undertaken in this thesis (e.g. questionnaire, case study and a vignette). The description of the actual data collection and analysis procedures themselves is given in the relevant chapters describing separate studies undertaken. This chapter also outlines the overarching process of obtaining regulatory permissions and ethical clearance for these studies.

4.2 Overview of research design

The overall aim of this thesis is to address the knowledge gap with regards to the under researched topic of diet diaries use in dental care settings. To this end, a range of qualitative and quantitative research methods were used. Quantitative and qualitative approaches of research are the prevailing modes of inquiry used in human and social sciences (Smith, 2015). Each paradigm is appropriate for specific type of research questions but also has relative weaknesses and strengths. The integration of both approaches is sometimes recommended to mitigate the weakness of using each paradigm alone (Sechrest and Sidani, 1995). Empirical work in the thesis involves 4 studies altogether (Section 3-5):

1. Study I: The use of diet diaries in clinical practice
2. Study II: How dentists use diet diaries to give diet advice
3. Study III: Adherence to diet diaries among paediatric dental patients in a hospital setting

4. Study IV: Factors affecting adherence to diet diaries issued to paediatric dental patients in a hospital setting

Broadly speaking, 2 studies involved quantitative methods (studies I & III) and 2 studies involved qualitative methods (studies II & IV). In two studies mixed methods were applied (studies II & III) (Table 3-1).

Table 4-1: Design, research methods and data collection techniques used in the four studies of the thesis

Study	Research paradigm	Design and data collection techniques	Data analysis strategies
Study I	Quantitative	Cross-sectional, questionnaire based survey	Frequencies and bivariate data analysis
Study II	Qualitative/Quantitative	Case vignette/ questionnaire based survey	Inductive content analysis/ frequencies/ binary logistic regression
Study III	Qualitative/Quantitative	Retrospective study of clinical records and completed diet diaries	Deductive content analysis/ frequencies/ binary logistic regression
Study IV	Qualitative	Case study of diet diaries use in a dental hospital setting using interviewing, observation and documentary analysis	Thematic analysis

This chapter contains the main justification for the study design chosen for each of the 4 studies, and also a broad literature review covering these types of study design approaches.

Quantitative research is an empirical investigation of reality that is deductive in nature and based on pre-existing knowledge or hypothesis (Sale et al., 2002). It often relies on sophisticated analyses using statistical techniques to allow estimation of the extent of the problem under study and its association with the studied population. Therefore, quantitative techniques were used to objectively answer ‘how much’, ‘how many’, ‘how often’, and ‘to what extent’ questions. For example, a questionnaire survey was used to answer the question: ‘how often do dentists use diet diaries in general dental practice?’

The qualitative approach is considered the most suitable approach in situations where none or very little is known about the subject under the study, and where there is a need to answer ‘what’, ‘why’ and ‘how’ questions (Bower et al., 2007). In this thesis, qualitative methods were applied to aspects of this thesis which required an inductive investigation of diet diaries usage, since its use in dental clinical settings is a relatively unexplored area.

In places, a combination of the two paradigms was used. This enabled a triangulation of evidence in places. For example, in order to enable a statistical inference from the free text responses to the case vignette (study II), a sequential-mixed-method approach was used wherein qualitative analysis was initially performed to develop coding scheme and this was then applied to the whole sample to enable quantitative analysis (Onwuegbuzie et al., 2010).

4.3 Data collection methods

4.3.1 Postal questionnaire survey

Cross-sectional surveys are used to estimate the self-reported prevalence of an outcome variable in a given population at one point of the time (Levin, 2006). A questionnaire survey is a quick and cheap research technique that offers an objective

and a systematic means of data collection, and is highly reliable if conducted properly (Dillman et al., 2014). It can be used in descriptive as well as analytical population studies since it allows the collection of information about outcome variables and their possible covariates (Robson and McCartan, 2016). In health care research, questionnaire surveys are commonly used to investigate the attitudes and practices of patients as well as health professionals and the delivery and evaluation of health services (Mandal et al., 2000). Questionnaires can be completed in a variety of ways: in an interview; self-completed wherein respondents complete the questionnaire by themselves on internet, or by post (Robson and McCartan, 2016).

A cross-sectional survey using a self-completed postal questionnaire was used to investigate how often GPs in the Northwest of England use diet diaries and its associated factors (Study I), and how dentists interpret diet diary information to give diet advice (Study II). This method was selected because it enabled the collection of data from a large and geographically dispersed population (Curtis and Redmond, 2009). Self-completion of questionnaires also eliminates interviewer bias which can be a problem when face-to-face methods are undertaken (McColl et al., 2001, Curtis and Redmond, 2009). However, an inherent downside of postal questionnaires is that the investigator has limited control over responders and how they complete the questionnaire, and this potentially results in incomplete answers or the questionnaire being completed by the wrong person (Mandal et al., 2000).

A relatively low response rate is a common concern in questionnaire studies on topics involving personal issues or investigating people's views on systems (Curtis and Redmond, 2009). Low response rates are common in studies involving health care providers (Cummings et al., 2001). For example, recent surveys among UK

GDPs showed response rates ranging from 30% to 40% (Aggarwal et al., 2012, Yip et al., 2013).

Many strategies have been considered as potential ways in which the response rate of postal surveys may be increased. The following options are outlined in a comprehensive systematic review on interventions to increase response rates to postal questionnaires (Edwards et al., 2007). For each strategy identified, the authors estimated pooled odds ratios (OR) and 95% confidence intervals (CI) in a random effects model. The odds of response to questionnaires was found to be statistically significantly increase to or exceed the double when using a monetary incentive (OR= 1.99, 95% CI 1.81 to 2.18), recorded delivery (OR= 2.04, 95% CI 1.60 to 2.61), and when the questionnaire topic was interesting to the respondents (OR=2.44, 95% CI 1.99 to 3.01). A substantial increase in the Odds of the questionnaire response was also reported with: pre-notification (OR=1.50, 95% CI 1.29 to 1.74), follow-up contact (OR=1.44, 95% CI 1.25 to 1.65), unconditional incentives (OR=1.61, 95% CI 1.27 to 2.04), shorter questionnaires (OR=1.73, 95% CI 1.47 to 2.03), providing a second copy of the questionnaire at follow-up (OR=1.51, 95% CI 1.13 to 2.00), mentioning an obligation to respond (OR=1.61, 1.16 to 2.22) and university sponsorship (OR=1.32, 95% CI 1.13 to 1.54). Also, using non-monetary incentives, personalised questionnaires, coloured printing, stamped return envelopes, an assurance of confidentiality and first class outward mailing, were all found to increase the response rate. Conversely, including questions of a sensitive nature (OR=0.94, 95% CI 0.88 to 1.00), beginning the questionnaire with the most general questions (OR=0.80, 95% CI 0.67 to 0.96); or offering the participants the opportunity to opt out of the study (OR=0.76, 95% CI 0.65 to 0.89) reduced the odds of response.

In order to increase the odds of the response in questionnaire based studies (study I & II), the following strategies were applied. The questionnaire was printed in the form of a coloured booklet and mailed to participants, in a pre-paid return envelope along with a covering letter which was personally addressed, confirmed confidentiality, included a university crest, and which was signed by the Principal Investigator. Two follow up mailings were sent to the non-respondents 3 weeks apart. No monetary incentives were provided. The response rate to the questionnaire survey is discussed in the discussion of the questionnaire study (Section 5-6).

4.3.2 Case vignettes

A clinical vignette is a brief case scenario based a true-to-life situation, that is used to investigate people's responses to such situation in the reality (Veloski et al., 2005). It may take a written text or graphic form, and be presented within qualitative or quantitative research in conjunction with other data collection techniques such as questionnaires and interviews (Finch, 1987, Hughes, 1998). Vignettes have been used widely across scientific disciplines to address research questions related to interpretation of actions, decision making, and psychological constructs such as perceptions, beliefs and attitudes (Barter and Renold, 1999, Barter and Renold, 2000).

Case vignettes are particularly useful in assessing practice variations of health care professionals and to explain how they decide on appropriate courses of action when faced with sensitive situations such as handling ethical issues (Hughes, 1998, Barter and Renold, 1999, Hughes and Huby, 2002, Veloski et al., 2005, Evans et al., 2015). Vignettes have been previously used to explore dentists' decision making regarding issues related to reporting child maltreatment (Adair et al., 1997), clinical interventions (Dolan et al., 1992, Chambers et al., 2010), and pain management (Bartley et al., 2015) as well as patient involvement in decision making (Gilmore et

al., 2006). Vignette based interviews have also been used to assess barriers facing the implementation of evidence-based recommendations in dentistry (O'Donnell et al., 2013).

In the study II of this thesis, a case vignette was used to investigate how GDPs use diet diary information to formulate dietary advice to child dental patients. A case vignette rather than a direct observation was chosen for its quickness, easy administration, and cost-effectiveness (Gould, 1996, Veloski et al., 2005).

However, using a vignette methodology has important considerations that merit some reflection. First, it could be argued that vignette's responses are inherently different from potential actions in real life (Hughes, 1998). This was not an issue in this study because its aim was to reflect how dentists handle the diet diary information rather than what they actually do in real world. The latter would be better assessed by undertaking observations and interviews (Barter and Renold, 1999). In addition, Vignettes are also said to eliminate potential bias caused by direct observation such as "Hawthorne effect," where the participant in the research changes their behaviour as a result of being observed (Veloski et al., 2005).

Second, using multiple vignettes has been recommended to elicit responses to a range of conditions (Evans et al., 2015). Although this study used a single vignette, it was able to elicit responses to a varied range of eating habits and diet types and forms. For instance, on day 1 of the diet diary, the cheese was presented to be in middle of the meals whereas in day 2 it was the end of the meal, which has two completely different impacts on caries process.

Finally, it might be questioned why this study used a 2-day diet diary rather than a 3-day one that is commonly used in dentistry (Watt et al., 2003). However, there is no consensus on the number of days of diet diary and even one day can be

used in diet assessment (Thompson and Subar, 2013). In addition, the decision to use a 2-day diary was supported by observations from the initial piloting of the vignette, in which a 3-day diary was perceived to be very lengthy and complex. The 2-day diet diary was considered suffice to represent different dietary behaviours and hence enables the understanding of how dentists handle complex diet diaries information.

However, vignettes have downsides as well. The vignettes may not fully reflect reality, nor be able to capture interactions such as the way physicians communicate with their patients (Hughes, 1998). Yet, on the whole a vignette technique is viewed as sufficient at capturing the meanings, beliefs, judgements and actions in relation to given situations (Barter and Renold, 2000). Although social desirability bias is another possible drawback, this is less likely when open-ended questions are used, and when respondents are asked to report their usual practices and assured that the vignette aims to describe the actual practices and related variations rather than challenging their level of knowledge or standing in judgment on their practices (Veloski et al., 2005).

4.3.3 Case studies

A case study design is an established research design that is commonly used in social and health care disciplines to develop a comprehensive and detailed understanding of a phenomenon that is inseparable from its natural setting and which the researcher has little or no control over (Yin, 2014; Robson, 2011). A case study design enables a comprehensive assessment of the phenomenon of interest using multiple sources of evidence to explore the complex dynamic of interactions, relationships, perceptions, and values (Nisbet and Watt, 1984, Yin, 2014, Merriam and Tisdell, 2015). Therefore, case study design lends itself well to address ‘*why*’ and ‘*how*’ research questions, and is considered especially suitable for studies with an

exploratory nature (Stake, 2000, Crowe et al., 2011, Yin, 2014). A case study design was, therefore, used to assess the phenomenon of issuing and analysing diet diaries in a dental clinical setting (Study IV).

A major advantage of case study design is that it allows for the triangulation of evidence by collecting data from different sources (Baxter and Jack, 2008). This also enables robust data description and analysis, better understanding of the phenomenon of interest and sometimes theory building (Ghauri, 2004, Merriam and Tisdell, 2015). Data can be collected from a single or multiple cases, and using qualitative, quantitative or a combination of data collection techniques (Yin, 2014). The latter depends on the context of the study and the epistemological position of the researcher (Merriam and Tisdell, 2015). In study IV, a qualitative case study approach was used to fit the exploratory nature of this study and to enable the unfolding of the complex dynamic of interactions, relationships, perceptions and values (Nisbet and Watt, 1984). Multiple cases were studied jointly in ‘a collective case study’ which bears the advantage of generating a combined and better understanding of the phenomenon of interest (Stake, 2000). Different data collection strategies were used (interviews, observations and documentary data). These various data collection strategies are outlined more fully in the section that follows.

4.3.3.1 Interviews

Interviewing is a popular technique for collecting qualitative data, which explores people's awareness, understandings, interpretations, and experiences (Lewis-Beck et al., 2003). Interviews can be conducted over telephone, Internet, or face to face. According to the degree of control exerted over the responses of the interviewee, an interview can be structured (a standard set of close-ended questions with pre-determined answers); semi-structured (with a loosely structured topic guide with

principal open-ended questions outlining the general areas to be investigated); or unstructured (just an opening topic statement with no topic guide) (Russell, 1988, Britten, 2008).

Face-to-face semi-structured interviews were used in study IV. The decision on the type and mode of interviewing is a very important one that merits some reflection. The face-to-face interview was chosen in order to enhance communication by eliciting responses through both verbal and non-verbal communication (Kvale, 2007). A semi-structured interview type was preferred over the unstructured design which can be time consuming and difficult to manage. The structured type on the other hand, despite its easiness and quickness has limited application in exploratory types of studies (Gill et al., 2008). Semi-structured interviews allow flexible data collection necessary to explore more depth, emergent ideas as well as uncovering new theories that were not foreseen at the outset of the study (Russell, 1988, Britten, 2008, Gill et al., 2008). It also enables a controllable data collection through keeping the focus on research objective and efficient time management (Lewis-Beck et al., 2003).

4.3.3.2 Non-participant observation:

Observation is a highly valued qualitative data collection technique that uniquely provides non-verbal data (Napolitano, 2009). It offers a systematic and contemporaneous collection of contextual data through watching, listening and recording (Ritchie et al., 2013). Observation is very useful in case studies because it enables the researcher to capture the dynamics of social interactions within their natural setting, and to unveil sensitive information that might be difficult to obtain by using other data collection techniques, such as interview (Mills et al., 2009). In this way, observation data complements verbal accounts and offers a deeper understanding and better insight than data obtained from other methods alone (Paterson et al., 2003,

Simons, 2009). So observation is usually combined with other data collection methods such as interviews and focus groups, and are rarely used as a standalone method (Ritchie et al., 2013).

However, observation has its own pitfalls. There is an inherent risk of observer effect bias, also called 'Hawthorne effect' – participants may change their response because of an awareness of being observed (Napolitano, 2009). Although such caveat might be mitigated by applying a covert observation in which the observed individuals are not aware of the observation, such approach is not ethically sound (Mills et al., 2009).

Based on the level of investigator's involvement in the research setting, observation is generally categorised as either participant observation or non-participant observation. Participant observers immerse themselves in the research setting to become a part of the observed group (Mills et al., 2009). This enables the researcher to establish rapport and gain the participant's trust so that participants may reveal attitudes and behaviours that they usually hide from foreigners (Paterson et al., 2003). However, this is not always possible. The observer also needs to spend a long time in the research setting, and so the interpretations of the phenomenon may be subjective to researcher's own selectivity (Ritchie et al., 2013).

A non-participant observer aims to be unobtrusive while at the same time not involved in any activity apart from observing (Mills et al., 2009). Non-participant observation can be carried out directly through the physical presence of the observer in the research site or indirectly through a mirror or using a video camera (Mills et al., 2009). The latter, while offering the opportunity to verify the analysis by many observers, is still prone to observer effect, difficulties in recruitment and ethical approval, and a labour-some data collection and analysis process (Napolitano, 2009).

Unlike participant observation, non-participant observation in health care settings may reduce the observer effect (Pretzlik, 1994), as well as any changes in patients' behaviours when the practitioner becomes a researcher (Mulhall, 2003).

Bearing in mind the above discussion, non-participant direct observations were used in study IV. Observations were audio-recorded and supported by the taking of field notes, also called research diaries (Altrichter and Holly, 2005). These are written accounts of what the researcher saw, heard and experienced in relation to the phenomenon of interest as well as their thoughts of investigator during the observation (Bogdan and Biklen, 2007). Such amalgamation of data along with the researcher's interpretation and thinking at the time of data collection informs further data collection and analysis in an iterative way (Altrichter and Holly, 2005).

4.3.3.3 Documentary data

Analysis of participants' documentary data (diet diaries and clinical records) was employed as a method of data collection in study IV and study III. Documentary analysis is a cost-effective, unobtrusive and nonreactive research technique which aims to examine, judge and synthesise data contained in the documents (Bowen, 2009).

Case studies analysing participants' documents provides important contextual data that provides another dimension to the study findings and enables a triangulation with data collected from other sources. In study IV (case study) diet diaries completed by the participants were retrieved to conduct documentary analysis in order to supplement observations and interviews as a means of triangulation (Simons, 2009). This contributed to the analysis by identifying contradictions in accounts, suggesting issues to be explored in interviews and observations and to add to contextual data available.

Study III in this thesis, was entirely based on the analysis of documentary data extracted from patients' clinical records and completed diet diaries. The data was then manipulated and analysed according to their nature (textual vs numerical) and the aims of the study.

However, downsides of relying on documentary data is that it is subjective to the availability and accessibility, quality and purpose of the document (Bowen, 2009). Documentary analysis is therefore generally most commonly used as a complimentary data collection method in case studies, although it can also be used as a stand-alone method (Bowen, 2009).

4.4 Methods of data analysis

4.4.1 Content Analysis

Content analysis (CA) is defined as “a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use” (Krippendorff, 2012). CA can be used to systematically summarise and make inference from existing data such as written, spoken, or visual documents and media communications or research produced data such answers to open-ended questions (Weber, 1990, Kondracki et al., 2002). CA is an unobtrusive, context sensitive and cost-effective research method for reducing large volume textual data into mutually exclusive content based categories (Weber, 1990, Stemler, 2001, Krippendorff, 2012). Also, the data is unchangeable which allow reanalysis and reliability checks (Robson and McCartan, 2016).

CA can be approached either qualitatively or quantitatively or by blending both approaches together (Hsieh and Shannon, 2005, White and Marsh, 2006). Qualitative CA involves understanding, interpreting and summarising qualitative data into contents based categories (Sandelowski, 1995, Elo and Kyngas, 2008).

Quantitative CA involves numerical analysis that ranging from simply describing the frequencies of data categories (Potter and Levine-Donnerstein, 1999), to a more advanced analysis such as linking the occurrence of these categories to explanatory variables (e.g.: gender or age) (Robson and McCartan, 2016). In blended CA, qualitative CA is used to develop coding categories which are then subjected to quantitative analysis as a secondary stage (Neuendorf, 2002, Zhang and Wildemuth, 2009, Krippendorff, 2012).

CA can be performed at manifest and/or latent levels of meanings within data (Graneheim and Lundman, 2004). The manifest level of analysis deals with what text says literally; describing the external components of content, without implying any underlying meanings. The latent level of meaning, on the other hand, demands more analytical efforts on the part of the researcher in order to unearth underlying meanings of content. Latent level analysis involves identifying patterns to make projective interpretations of what the text talks about (Kondracki et al., 2002), without violating the meaning that the text was initially created to represent (Krippendorff, 2012). CA can also be applied simultaneously at both manifest and latent levels of analysis (Potter and Levine-Donnerstein, 1999, Kondracki et al., 2002); and is termed a summative CA (Hsieh and Shannon, 2005).

Data analysis aiming at identifying manifest and latent levels of meaning in the text can be approached by using a predefined coding system (deductive analysis), generating themes and categories from raw data (inductive analysis), or by combining both inductive and deductive approaches (Elo and Kyngas, 2008) (Potter and Levine-Donnerstein, 1999, Hsieh and Shannon, 2005, Schamber, 2000, Hsieh and Shannon, 2005).

Inductive CA is indicated when a priori knowledge about the topic under study is insufficient or completely lacking (Elo and Kyngas, 2008). For that reason, in study II, inductive CA was initially performed on a subsample of case vignette responses in order to generate a coding framework which was then used to perform deductive CA to the whole set of data. In study III deductive CA was used to categorise the contents of diet diaries. This was accomplished using a predefined coding system (categories with operational definitions) developed from relevant dental literature and the findings of inductive CA conducted in study II.

4.4.2 Thematic analysis

Thematic analysis (TA) is a popular method of qualitative data analysis that aims to identify patterns of meaning across an entire qualitative dataset (Howitt and Cramer, 2007, Ritchie et al., 2013). According to Howitt and Cramer (2007), the roots of TA are not clear but it is generally thought to have been developed in the 1950s as a qualitative form of content analysis of social media. It is worth noting that TA is commonly conflated with qualitative CA. However, despite the similarities between the two approaches, they serve different purposes. While TA aims to identify patterns and themes within the data to understand the phenomenon under study, qualitative CA aims to develop content based categories and themes to render the data amenable to quantitative analysis (Vaismoradi et al., 2013).

TA is a rigorous and systematic process of qualitative data encoding into themes and subthemes through data familiarisation, coding, theme development, revision and reporting (Boyatzis, 1998, Braun and Clarke, 2006). In this way, TA is capable of generating descriptive as well as an interpretive account of analysed data, at manifest and latent levels of meaning, in a deductive and inductive way (Boyatzis, 1998, Braun and Clarke, 2006, Fereday and Muir-C.E, 2006). Although the steps of

TA are shared by other approaches of qualitative analysis (e.g. framework analysis and grounded theory), TA is not tied to any theoretical underpinning, unlike, for example, grounded theory which aims to develop a theory which influences the subsequent sampling, data collection and analysis (Howitt and Cramer, 2007, Ritchie et al., 2013). The theoretical flexibility of TA allows for using it within different forms of qualitative research to address different types of research questions related to people's experiences, views and perceptions, related to understanding and representation, relating to the construction of meaning (Braun and Clarke, 2006, Ritchie et al., 2013). The loose theoretical orientation of TA has also been considered an advantage making it a widely used approach that is less demanding and particularly suitable for novice qualitative researchers (Howitt and Cramer, 2007).

TA has been criticised for the lack of a universally accepted and standardised guideline to what constitutes a good TA, and that many researchers do it effortlessly and with little transparency of how the themes were developed and whether covered the entirety of data. However, more clarity in reporting can mitigate the transparency issues and the key steps of TA are identifiable (Howitt and Cramer, 2007). Braun & Clarke (2006) describe a six-step model which can be used as a guide for conducting TA. This involves familiarisation with data, initial coding, searching for themes, reviewing themes, defining and naming themes and categories and finally writing the report.

TA following the version described by Braun & Clarke (2006) was used to analyse qualitative data collected for study IV (case study). The exploratory nature of the study and the lack of any pre-established theories in relation to the research topic mandated a data-driven inductive approach to create the knowledge from the bottom up (Ritchie et al., 2013). However, the analysis was not purely inductive and so a TA

that combines the inductive and deductive approaches in an iterative process was employed. Such iterative thematic analysis is commonly cited as the method of qualitative data analysis in case studies (Bell et al., 2004, Adams et al., 2014, Ayton and Hansen, 2016).

A framework analysis was considered as an alternative to TA. However, although allowing more organised and transparent analysis, framework analysis is naturally deductive which does not fit the exploratory nature of study IV (Mays and Pope, 2000). However, the finding of the study IV could be used as a basis for using framework analysis in future studies.

4.4.3 Quantitative data analysis

Quantitative data collected in studies I, II, III was managed and analysed using Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics such as count (N), percentage (%), mean, median and standard deviation (SD) were used to summarise numerical data such as the distribution and characteristics of the study sample and the frequencies of outcome variables such as the return rate of diet diaries (study III). Bivariate analyses using both parametric and non-parametric tests of statistical significance were employed to compare the outcome variables by participants' characteristics. Logistic regression analyses were also used to identify the covariates of diet diaries return rate in the study III and the predictors of dietary advice topics in response to the case vignette in study II. P value of less than 0.05 was set as the significance level for all statistical tests.

4.5 Ethical issues

4.5.1 Approvals and permissions

Prior to commencing the research project, regulatory permissions were obtained. Sponsorship for the research project was obtained from the University of

Liverpool. Application to obtain ethical approval and NHS research governance approval was made for all planned studies in the same application. The project received a favourable ethical opinion (REC reference: 14/LO/1204) from NRES Committee London - Camberwell St Giles in July 2014 (Appendix C). NHS trust approval was gained from the Royal Liverpool and Broadgreen University Hospitals NHS Trust in order to access the dental teaching Hospital where studies III & IV were carried out (Appendix C). The latter involved undertaking Disclosure and Barring Service (DBS) check. The investigator (student) was granted an honorary contract at the teaching dental hospital in order to undertake data collection in this NHS site.

4.5.2 Consent

Participants (dentists, children, and parents/carers) were informed about the nature of the study using the relevant information sheets explaining the purpose of the study and the potential responsibilities, benefits and risks triggered by participation. Information sheets also included clear statements ensuring the confidentiality of information and voluntary participation (Appendix C). Written informed consents, were gained from all participants before taking part in the study. The informed consent included statements of confirmation that the participant had been informed of and understood the purposes of the study, had been given the chance to ask questions, and had been assured about the confidentiality of information and that participation was voluntary. Two copies were signed, one for the participant and one for the researcher.

In addition to the parent/legal guardian information leaflet and consent form; children were informed about the nature of the study using a child-friendly relevant information sheet. To comply with current research ethics guidance in the UK (Health Research Authority, 2016), written informed assents were obtained from all children prior to participation in the study. All participants (child/parent) were reminded that

they could withdraw from the study at any point. All forms and information sheets were pre-tested for clarity and suitability among a group of 10 dental staff and 10 patients (child/parent) attending Liverpool University Dental Hospital (LUDH).

4.5.3 Anonymity and confidentiality

Data collected for all the 4 studies were treated as confidential material. The identity of participants was anonymised, so that no names were associated with their various forms of data. Participants' transcripts of interviews and observation collected in study (IV), questionnaire collected for the studies (I &II) and diet diaries and clinical records retrieved for study (III) were coded, to ensure anonymity. The decoding sheets were held separately to the data itself. The content of individual interviews and questionnaires was not disclosed to any third party. Audiotapes were transcribed and the original recording destroyed within one month. All data were stored on a password-protected computer or in a locked filing cupboard.

Chapter 5. The use of diet diaries in clinical practice (Study I)

5.1 Introduction

This chapter describes a questionnaire based survey of English dentists which was conducted to investigate prevalence, current practices and perceived barriers of diet diaries use in general dental practice. The study's background, rationale and specification of its objectives are given at the outset. Survey methods including the sampling strategy, questionnaire development and administration and statistical analysis are described in detail. This is followed by the findings as well as a discussion of these findings and their implications for both research and practice. This study is related to following research questions posed at the outset of the thesis (Page 43):

- I. How diet diaries are currently used in dental practice for children and what do dentists/ families hope to achieve by their use?
- II. What are the strengths and weaknesses in the way the diet diaries are currently used in dentistry?

5.2 Background

Diet diaries are highly cited as the primary means by which dietary information may be gathered in the dental care setting (Rugg-Gunn and Nunn, 1999, Watt et al., 2003, Public Health England, 2014a). A key advantage of diet diaries as opposed to other methods of dietary assessment, such as 24-hours recall and dietary history, is their instant and contemporaneous recording for a number of days, which is believed to add to their accuracy and representation of habitual food intake (Rugg-Gunn and Nunn, 1999). The use of diet diaries, therefore, has been favoured by standard dental textbooks in the area of diet and nutrition (Rugg-Gunn and Nunn, 1999, Wilkins and Wyche, 2013) as well as clinical guidelines and policy documents

for preventive dental practice (Scottish Dental Clinical Effectiveness Programme, 2010, Public Health England, 2014a). In England, for example, the current evidence based guidance for preventive oral care in general dental practice (Delivering Better Oral Health), recommends use of diet diaries for some patients (Public Health England, 2014a). This guidance has been incorporated into clinical care pathways which now form the basis of new models of commissioning and contracting which are being currently tested in prototypes in England (Harris and Bridgman, 2010).

However, as the review of literature shows, little is known about the prevalence of use of diet diaries in dental care settings (Chapter 2, Section 2-9-1). It is still not known how often dentists use diaries, for whom they use them and what influences their use. Such information is required because understanding the extent to which diet diaries are currently used in dental practice is essential to form a baseline against which the need to increase their use can be assessed and to understand modifiable factors that influence their use. Therefore, to fill this knowledge gap and to gain an insight into weaknesses and strengths of diet diaries from dentists' perspective, a postal questionnaire survey was conducted to investigate the prevalence of diet diaries use in English dental practices and to examine the factors which influence their use, particularly among children.

5.3 Study I objectives

1. To assess how often are diet diaries currently used in general dental practice compared to other dietary assessment methods
2. To understand which factors are perceived by GDPs as limiting the use of diet diaries in dental practice

5.4 Methods

A cross sectional study design was adopted to run a questionnaire-based postal survey of GDPs in the Northwest region of England, between September 2014 and January 2015.

5.4.1 Sampling

A sample size of 385 GDPs was identified as sufficient to allow an estimate of the proportion of GDPs using diet diaries in their everyday practice, with 95% confidence limits of at most ± 0.05 (Machin et al., 2011). Given that no previous investigations, to author's best knowledge, have addressed the issue of diet diaries use in English dental practices, the calculation of sample size was based on the assumption that 50% of GDPs would use diet diaries. In order to compensate for an expected 30-40% response rate which was based on findings of recent surveys among UK GDP (Chapter 4, section 4-3-1), the sample size was expanded to 965 participants (This figure was calculated using the following formula: $385 \times 100 / 40$).

A cluster sampling strategy was used to randomly select study participants from both NHS and fully private practitioners. Although the sample was drawn from a sampling frame of GDPs from the Northwest of England, GDPs were recruited according to a strata sampling system based upon caries prevalence in their catchment areas that was designed to assemble a sample that more closely resembles catchments throughout England. These were recruited in a two-stage cluster sampling process. In the first stage, a number of Local Authorities (LAs) in the Northwest of England was selected. This was performed using a stratified random sampling of LAs, which reflected the proportion of LAs having low, medium or high levels of caries prevalence across a national picture (Appendix D). Stratification of LAs into three levels of caries prevalence (high, medium and low), was done using the latest

available dental health data of a routine national survey of 5-year-olds (Public Health England, 2012). This survey collected data from the nine English governmental regions at the level of LAs.

The level of dental caries (defined by mean number of decayed, missing and filled teeth (dmft)) across the English regions was not normally distributed (normality tests showed statistically significant levels of ≤ 0.001). Therefore, national median and inter-quartile range of dmft means were calculated and used to decide on the cut-off points that define each stratum.

The strata were defined as following:

1. Low caries LAs: dmft scores below the national median= 0.77
2. Moderate caries LAs (dmft scores above the median but below the upper border of the inter-quartile range (between 0.77 and 1.23))
3. High caries LAs: dmft scores above the inter-quartile range (above 1.23)

In the second stage, all GPs practising in the selected LA areas were identified. Lists of the names and addresses of dentists practising in each LA were obtained from the Care Quality Commission (CQC) in combination with information displayed on the NHS Choices website (publicly available information giving reviews and information on all local dental practices), to allow both NHS and private practitioners to be included in the sample. All practitioners, including newly graduated dentists, in each practice, were included in the sample list, with GPs asked about their individual practise rather than that of their dental practice as a whole. Orthodontists and dentists providing service to prisons and providing care in dental access centres, dental hospitals and the community dental service were excluded. LAs from each stratum were listed and then randomly added to the sample frame until the optimum number of participants in each stratum was reached or exceeded. The total

sample size was evenly divided between the three strata. The final sampling frame comprised all 1060 GDPs from both NHS and completely private practice in the chosen catchments.

5.4.2 Questionnaire

A self-administered questionnaire was specifically designed for this study. It was informed by available literature on the giving of dietary advice (Rugg-Gunn and Nunn, 1999, Watt et al., 2003, Wilkins and Wyche, 2013). The question format and questionnaire layout were refined over extensive discussion among the supervisory team. A variety of open-ended as well as close-ended structured and yes/no, questions were used. A free text response section was included at the end of each structured question to enable participants to add any further responses.

The questionnaire was pre-tested for clarity and content validity among a convenience sample of 20 paediatric and restorative dentists at Liverpool University Dental Hospital (LUDH). These dentists were chosen for their expertise in paediatric and restorative dentistry. They were asked to complete the questionnaire and provide feedback regarding each question. They were particularly asked to indicate their understanding of each question, and to give suggestions regarding ways to improve wording and the categories given in close-ended answers. Their feedback given on copies of draft questionnaires was also supplemented by cognitive interviewing (Willis, 2004, Ritchie et al., 2013). Two participants were interviewed while completing the questionnaire, in a think-loud exercise to gain further understanding as how dentists would interpret each question responses (Beatty and Willis, 2007). Most of the feedback received was related to question wording. These items then re-phrased to tighten comprehension of the questionnaire. The participants in the questionnaire piloting process were not included in the final sample.

The final questionnaire (Appendix E), covered six topics:

Section A: GDPs demographic background and current employment

Section B: Information on dental practices

Section C: Provision of dietary advice

Section D: Collection of dietary information

Section E. diet diaries usage

Section F: Interpretation of diet diaries

Systematic reviews of literature have recommended many ways to maximise the response rate of postal surveys (Chapter 4, section 4-3-1). These include notifying people in advance, using first class post or recorded delivery, providing pre-paid return envelopes with personally addressed cover letter, short questionnaires with a pleasant appearance and using incentives as well as several reminders with enclosed copies of the questionnaire. The questionnaire was printed in the form of a coloured booklet and mailed to participants, in a pre-paid return envelope along with a covering letter which was personally addressed and signed by the Principal Investigator.

To minimise social desirability bias and non-response bias, the cover letter emphasised that no judgments were to be made by the recipients of the questionnaires about what represented 'best practice'(Dillman, 1991). GDPs were given up to 3 weeks to reply. After three weeks, a second mailing was issued to the non-responders. A final wave of questionnaires to non-responders was issued 3 weeks after the second mailing.

5.4.3 Data management

Collected questionnaires were checked for completeness where participants' answers were examined for inconsistencies across questions and contingency questions (Roberts et al., 1997). for example, some Yes/No questions were used as

filter questions with multiple options if the answer was 'Yes', the logical order of 'No' answer is to skip subsequent questions based on 'Yes'. Such illogical answers were excluded. Questionnaires with completely missing information on the use of diet diaries were excluded. Some contradictory answers were corrected to follow the logical order of the questions.

A socio-economic descriptor of the area in which the practice was located was included in the dataset by linking practice postcodes to area data on the Index of Multiple Deprivation (IMD-2010). The IMD-2010 combines area based measures of seven separate dimensions of deprivation (income, employment, health and disability, education, skills and training, barriers to housing and services, living environment, and crime) into a single composite measure (McLennan et al., 2011). IMD scores of national data are divided into quintiles with areas ranked in a five-point scale from the most deprived 20% of areas (first quintile) through to the least deprived 20% (fifth quintile). The dataset also included whether the practice was located in a high, medium or low caries prevalence area, by linking practice postcodes to locally collected epidemiological data on the caries experience of five-year-olds described by LA area.

5.4.4 Statistical analysis:

Data were analysed using statistical software SPSS Version 22.0. (Armonk, NY: IBM Corp.). Answers to open ended questions were categorised to enable quantitative analysis. Each answer was given a code till no more codes were needed. Descriptive statistics were used to describe the demographics and professional characteristics of the participants, the characteristics of their dental practices and the location of these practices according to known caries prevalence levels and IMD

quintiles. Counts and percentages were used to summarise GPs' responses to closed ended questions and categorised answers of open-ended questions.

Chi-squared tests, independent samples *t*-test and Mann-Whitney *U* test were used to compare the reported use of diet diaries versus reported other reported dietary assessment methods (such as 24-hour recall and dietary history) by demographic, professional characteristics and dental practice characteristics of the respondents. Binary logistic regression models were used to examine multivariate predictors of diet diaries use from a range of demographic, professional and dental practice variables as well as caries level and IMD quintiles as predictor variables. The binary outcome variable was the reported use of diet diaries usage vs reported use of other method of collecting dietary information. All multivariate analysis models were limited to GPs reporting that they engage in some form of collection of dietary information. For all statistical tests, statistical significance level was set at $p \leq 0.05$.

5.4.4.1 Analysis of non-response bias

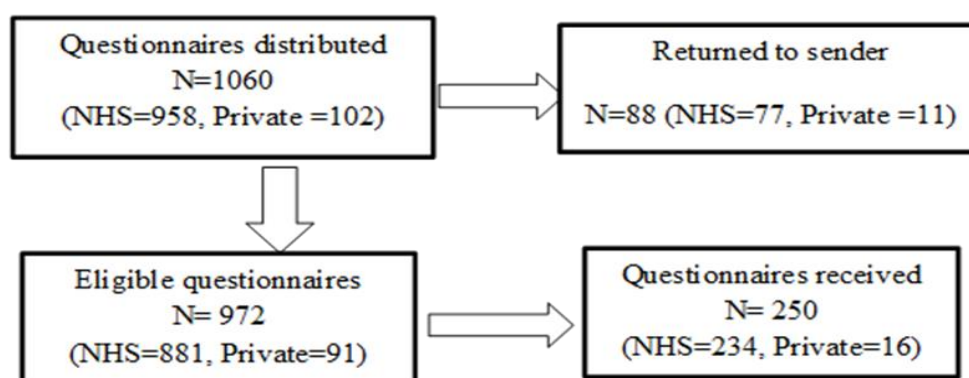
Participants in the survey were self-included, and there is no direct way of assessing response bias because the characteristics of dentists who did not return questionnaires could not be captured easily. Comparing the characteristics of early and late respondents is one possible way of assessing non-response bias which has been suggested as an indirect strategy to assess the threat of response bias on results generalisability (Lindner et al., 2001). Comparisons of respondents to the first, second and third mailings according to their gender, role in the practice, area's caries level, IMD quintiles and years practising since qualification were carried out using Chi-squared tests and one-way ANOVA test. Statistical significance level was set at $p \leq 0.05$.

5.5 Results:

5.5.1 Response rate

Of the 1060 questionnaires mailed to GDPs, 250 valid responses were received. A further 88 were received as 'returned to the sender' because the dentist had left the practice, had retired, or was on maternity leave, the practice had closed or the dentist had declined to participate. No completely incomplete questionnaires were received. The overall response rate was therefore 26% (250/972), (Figure 5-1).

Figure 5-1: Flow chart of questionnaire distribution phases and response rates



5.5.2 Sample description

Demographic, professional and practice characteristics of respondents are summarised in Table 5-1. Respondents had a mean 21.5 (SD 12.1) years since qualification. Ninety percent (234) of them undertook some NHS work. The majority were males (58 %, 146) and associate dentists (dentists sub-contracting to the practice owner) (60 %, 149). The most commonly reported dental auxiliaries in the practices were dental hygienists (61%, 153). Although the majority of respondents worked in practices located in first and second quintile IMD areas (most deprived), there was a relatively even distribution of the respondents' practices in terms of LA caries prevalence (high, medium and low). The reason for this difference is accounted by the fact that LA areas represent a generally larger catchment area than the electoral ward areas represented by IMD scores. On average, GDPs responding reported that 69.1%

(SD 35%) of their patients were NHS patients, and 24 % (SD 17%) were children (Table 5-1).

Table 5-1: Characteristics of the study sample (n=250)

Variables	Categories	Statistics	
		Count	(%)
Gender	Men	146	(58.4)
	Women	104	(41.6)
Role	Practice Owner	101	(40.4)
	Associate/other	149	(59.6)
Practice sector	NHS	234	(93.6)
	Private	16	(6.4)
Year of service		Mean	(SD)
		21.50	(12.13)
Dentists and surgeries in the practice		Median	(Range)
Number of dentists in the practice		4	(1-11)
Number of surgeries in the practice		4	(1-15)
Percentages of patients in the practice		Mean	(SD)
	NHS	69.15	(35.5)
	Private	31.05	(35.4)
	Case Mix children	23.85	(17.3)
Dental Auxiliaries in the practice		Count	(%)
	Hygienist	153	(61.2)
	Therapists	109	(43.6)
	Nurse giving dietary advice	146	(58.4)
	Nurse applying fluoride varnish	103	(41.2)
Practice area characteristics		Count	(%)
Caries level	Low	87	(34.8)
	Moderate	73	(29.2)
	High	90	(36.0)
Index of Multiple Deprivation quintiles	1(Most deprived)	82	(32.9)
	2	76	(30.5)
	3	33	(13.3)
	4	34	(13.7)
	5 (Least deprived)	25	(10.0)

5.5.3 Analysis of non-response bias

Comparisons of early and late respondents are presented in Table 5-2. There were no significant differences between those who replied to the first, second or third mailings according to demographic ($p=0.22$ for gender), professional ($p=0.97$ for years in service, $p=0.54$ for dentist's role in the practice) and practice area characteristics ($p=0.70$ for area's caries level).

Table 5-2: Comparison of characteristics of early and late respondents

Characteristic		First Mailing	Second Mailing	Third Mailing	P value
		N (%)	N (%)	N (%)	
Use diet diary		38 (27.0)	22 (33.3)	10 (23.3)	0.474
Gender†	Male	89 (61.1%)	32 (51.5)	20 (53.5)	0.222
	Female	52 (36.9%)	34 (48.5)	23 (46.5)	
Role†	Owner	54 (38.3)	26 (39.4)	21 (48.8)	0.459
	Associate	87 (61.7)	40 (60.6)	22 (51.2)	
Caries level†	Low	49 (34.8)	21 (31.8)	17 (33.3)	0.699
	Moderate	45 (31.8)	17 (25.8)	11 (42.4)	
	High	45 (33.3)	28 (25.6)	15 (34.9)	
Practice type†	NHS	134 (95.0)	62 (93.9)	38 (88.1)	0.350
	Private	7 (5)	4 (6.1)	5 (11.6)	
Index of Multiple Deprivation quintiles†	1 (Most deprived)	46 (32.6)	23 (35.4)	13 (32.9)	0.208
	2	43 (30.5)	19 (29.2)	14 (32.4)	
	3	25 (17.7)	7 (10.8)	1 (2.3)	
	4	17 (12.1)	8 (12.3)	9 (20.9)	
	5 (Least deprived)	10 (7.1)	8 (12.3)	6 (14.0)	
		Mean (SD)	Mean (SD)	Mean (SD)	
Year of service‡		21.3 (12.4)	21.9 (11.0)	21.6 (13.2)	0.971

† count (%), X² test, ‡ Mean (SD), one-way ANOVA test

5.5.4 The provision of dietary advice

Almost all GDPs (99%, 248) reported having personally giving diet advice of some sort to one or more patients, with 40% (100) reporting that they also referred patients to dental care professionals (DCPs) such as dental hygienists for diet advice (Figure 5-2). The general picture is that dietary advice was not provided to all patients, with GDPs estimating that they personally give diet advice to an average of 63% (SD 30%) of their patients, and that an average of 11.0% (SD 23%) of remaining patients being referred to DCPs in the same dental practice.

Figure 5-2: Diet advice practices as percentages of GDPs (n=250) reporting personally giving diet advice or referring to a DCP, and as average estimated proportion of their patients receiving or referred for advice

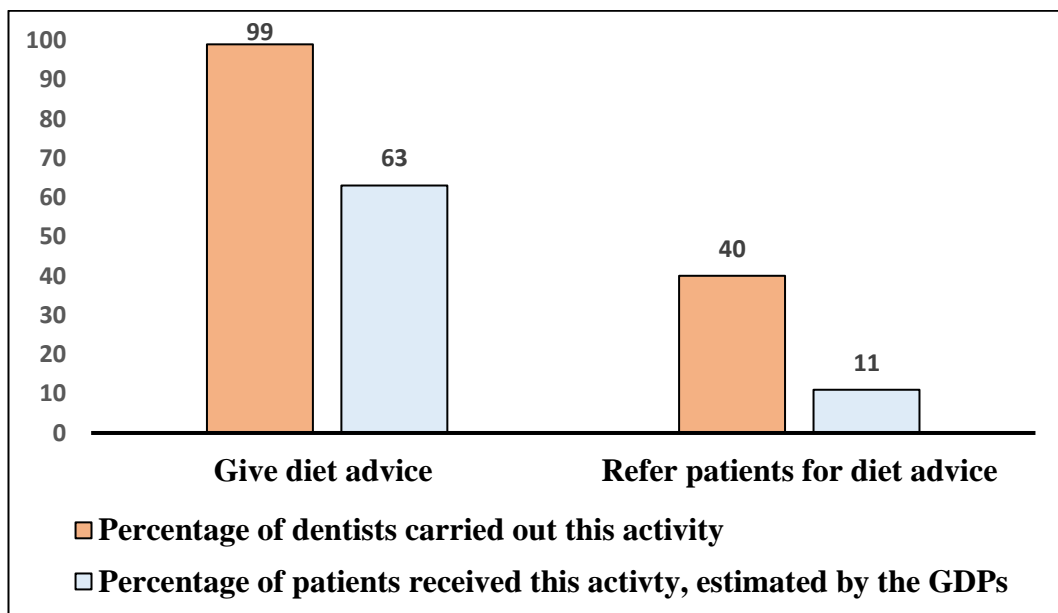


Table 5-3 describes self-reported frequencies of giving dietary advice to different children and adults. The most common groups targeted for diet advice were children in general, and any patient who had past dental caries experience or evidence of tooth wear. Almost equal proportions of GDPs targeted children of school age, and pre-schoolers. Other groups targeted were siblings of children with active caries, children undergoing orthodontic treatment and whose parents were concerned about

diet. In addition, GDPs identified that they used diet diaries especially for adult patients who were elderly with exposed roots, dry mouth, or for adults with active caries or attend for orthodontic treatment (Table 5-3).

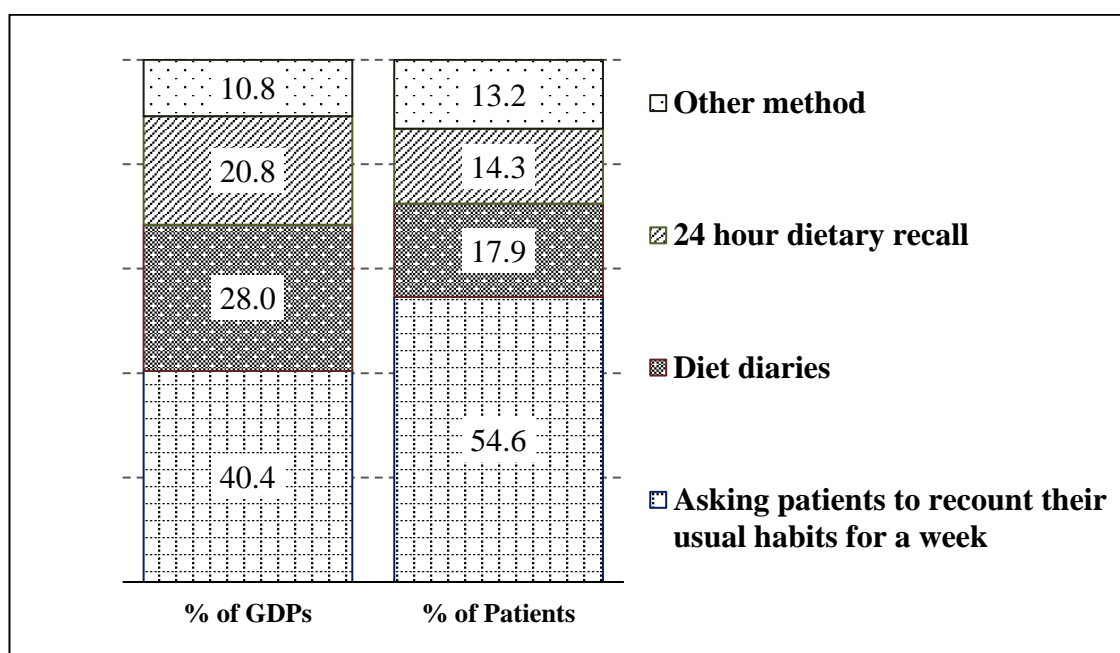
Table 5-3: Frequencies of GDPs reporting targeting diet advice to specific child and adult patient groups (n=250)

Target Group	% of GDPs reporting child groups	% of GDPs reporting adult groups
All	168 (67.2)	83 (33.2)
Past experience of dental caries	187 (74.8)	193 (77.2)
Low socioeconomic families	127 (50.8)	90 (36.0)
Medically compromised children	148 (59.2)	139 (55.6)
Patients with special needs	138 (55.2)	125 (50)
Evidence of tooth wear	155 (62.0)	163 (65.2)
Other groups	13 (5.2)	18 (7.2)
Children aged 5-11-year-old	125 (50)	NA
Children aged less than 5-11-year-old	123 (49.2)	NA

5.5.5 The prevalence of diet diaries usage

GDPs reported collecting dietary information in a number of ways in order to personalise the advice given. Overall, 134 (54%) indicated that they would use any of methods of dietary assessment to inform dietary advice. Among these, the most common way (41%, 101) was by simply asking patients to recount their usual dietary habits for a week. Diet diaries were reportedly used by 28% (70) of GDPs, for, on average, 18% (10) of their patients. Overall 134 GDPs reported they would collect dietary information using any of these methods (Figure 5-3).

Figure 5-3: Distribution of methods used for collection of diet information (n=134) as percentages of GDPs reporting using each method, and for the average estimated proportion of their patients



5.5.6 Clinical practices, influences and barriers of diet diaries usage

Responses from the 70 GDPs reporting to use diet diaries showed that they used diet diaries for an estimated average of 27% of their child patients and 14 % of adult patients. The main consideration reported when identifying suitable patients was whether the patient had a high risk of caries (Table 5-4). Their main purpose for use in these circumstances was to motivate behaviour change, followed by assessing disease risk (Table 5-4). A minority of GDPs said that they normally schedule a separate appointment to review the completed diary (41%, 29). Just over third of the GDPs (34%) would ask patient to record bedtime. Even though GDPs reported that analysis of diet diaries took an average of 10 minutes, the vast majority of GDPs reported they did this as soon as the diet diary is completed (91%, 64), with 59% (62) of GDPs reporting the diet diaries review as usually undertaken with the patient or parent (Table 5-4).

Table 5-4: Usual practices by GDPs reporting use of diet diaries (n=70)

	Mean	(SD)
Average percentage of children for whom diet diaries are used	26.7	(21.3)
Average percentage of adults for whom diet diaries are used	14.0	(16.5)
Reasons for using a diet diary	N	(%)
To assess patients' disease risk	45	(64.3)
To monitor patients' dietary behaviour	35	(50.0)
As a tool to prompt behaviour change	62	(88.6)
Other	5	(7.1)
Considerations when deciding to use a diet diary	N	(%)
A high severity of caries experience	63	(90.0)
An appropriate ability (literacy)	26	(37.1)
Sufficient motivation of parents	37	(52.9)
Sufficient motivation of the children patients	29	(41.4)
Sufficient motivation of the adult patients	25	(35.7)
Other	2	(2.9)
Routines when using diet diary	N	(%)
Ask patients to include at least one weekend day	67	(95.7)
Ask patients to record the time the patient goes to bed	24	(34.3)
Ask patients to record the context of eating/drinking	46	(65.7)
Ask patients to record the timing of eating/drinking	59	(84.3)
Review the diet diary with the patient/parent	62	(88.6)
Analyse the diet diary immediately when they returned	64	(91.4)
Schedule a separate appointment to discuss the diary	29	(41.4)
In the case of children aged 5-11 years' old	N	(%)
Ask the child to keep the diet diaries	0	(0.0)
Ask the parent/carer to keep the diet diaries	29	(41.4)
Ask both to keep the diet diaries	41	(58.6)
	Median	(Range)
For how long patients are asked to keep diet diaries (Days)	3	(1-7)
Time needed to a complete analysis of a diet diary (Minutes)	10	(1-23)

Table 5-5 presents bivariate comparisons of diet diaries usage versus other methods of dietary assessment, by demographic, professional and practice

characteristics of participant GDPs reporting assessing diet. The only statistically significant characteristic of GDPs ($P < 0.05$) was the reported proportion of their patients being financed by the NHS. GDPs with a lower proportion of NHS patients were more likely to use diet diaries (Table 5-5).

Table 5-5: Bivariate analysis of characteristics of GDPs reported using diet diaries (n=70) versus users of other methods of dietary assessment (n=64)

Variables		Use diet diaries	Other methods	P value
Dentists'	Women [†]	30 (42.9)	30 (46.9)	0.64
Gender	Men [†]	40 (57.1)	34 (53.1)	
Role	Practice Owner [†]	27 (38.6)	25 (39.1)	0.95
	Associate/other [†]	43 (61.4)	39 (60.9)	
Year of service [‡]		19.4 (12.9)	21.6(11.8)	0.28
N ^o of dentists in the practice ^{†‡}		4 (1-11)	4 (1-10)	0.81
N ^o of surgeries in the practice ^{†‡}		4 (1-13)	4 (1-13)	0.55
% of NHS patients in the practice [‡]		66.9 (35.0)	74.9 (30.9)	0.03*
% of Case Mix children in the practice [‡]		28.2 (19.4)	23.4 (13.6)	0.34
Practice has Hygienist [†]		46 (65.7)	36 (56.3)	0.28
Practice has Therapists [†]		40 (57.1)	27 (42.2)	0.12
Practice nurse gives dietary advice [†]		45 (64.3)	36 (56.3)	0.34
Practice nurse applies fluoride varnish [†]		31 (44.3)	39 (54.9)	0.81
Caries Level [†]	High	24 (34.3)	25 (39.1)	0.82
	Moderate	19 (27.1)	15 (23.4)	
	Low	27 (38.6)	24 (37.5)	
Index of Multiple Deprivation quintiles [†]	1 (Most deprived)	17 (27)	21 (30)	0.66
	2	23 (36.5)	27 (38.6)	
	3	10 (15.9)	8 (11.4)	
	4	6 (9.5)	7 (10.0)	
	5 (Least deprived)	7 (11.1)	7 (10.0)	

[†]Count (%), X²; [‡]Mean (SD), independent samples t test, ^{†‡} median (Range), Mann-Whitney U test, *P<0.05

Binary logistic regression models which were fitted to identify potential predictors of GDPs' usage of diet diaries versus other diet assessment methods. The

analysis revealed that having a *lower* proportion of NHS patients was predictive of clinical practice geared towards the use of diet diaries with patients, as well as a higher child patient case-mix. On the other hand, older dentists who spent more years in service were less likely to use diet diaries than younger dentists (Table 5-6).

Table 5-6: Binary logistic regression models for diet diaries use participants reporting assessing diet (n=134)

Demographic, professional and practice characteristics of GDPs		Unadjusted model		Adjusted model	
		OR	CI (95%)	OR	CI (95%)
Gender	Women [†]	1.00	Reference	1.00	Reference
	Men [†]	1.18	(0.60,2.33)	1.87	(0.77, 4.38)
Role	Practice Owner [†]	1.00	Reference	1.00	Reference
	Associate/other [†]	1.02	(0.51,2.05)	1.06	(0.29,3.01)
Year of service [‡]		0.97	(0.96,1.01)	0.96	(0.92,0.99) *
N ^o of dentists in the practice ^{†‡}		0.95	(0.82, 1.11)	1.23	(0.93, 1.62)
N ^o of surgeries in the practice ^{†‡}		1.00	(0.86, 1.15)	0.81	(0.61, 1.06)
% of NHS patients in the practice [‡]		0.99	(0.98,1.00)	0.97	(0.95, 0.99) ^
% of Case Mix children in the practice [‡]		1.02	(0.99,1.04)	1.05	(1.01,1.08) ^
Practice has Hygienist [†]		1.49	(0.74,2.99)	2.09	(0.81,5.34)
Practice has Therapists [†]		0.58	(0.23,1.16)	2.07	(0.89,4.80)
Practice nurse gives dietary advice [†]		0.71	(0.36,1.43)	1.50	(0.59,3.83)
Practice nurse applies fluoride varnish [†]		0.91	(0.46, 1.82)	0.95	(0.37,2.43)
Caries Level [†]	High [†]	1.00	Reference	1.00	Reference
	Moderate [†]	1.17	(0.54,2.57)	1.02	(0.34,3.04)
	Low [†]	1.32	(0.55,3.18)	1.59	(0.52, 4.88)
Index [†] of Multiple Deprivation quintiles	1 (Most deprived)	1.00	Reference	1.00	Reference
	2	0.94	(0.41,2.20)	0.87	(0.31,2.43)
	3	0.65	(0.21, 2.00)	0.82	(0.20,3.42)
	4	0.94	(0.27, 3.43)	0.61	(0.23,2.90)
	5 (Least deprived)	0.81	(0.38,2.76)	0.84	(0.77,4.39)

[†]Count (%), [‡]Mean (SD), ^{†‡} median (Range), *P<0.05, ^P<0.01 odd ratios (OR), 95% confidence interval (CI).

Data analysis also examined barriers of diet diaries use as perceived by GDPs.

Table 5-7 summarises the frequencies of different reasons given by GDPs for not

using diet diaries for children (168 responses) and adults (172 responses). Issues related to insufficient NHS remuneration to support the time spent appears to be singled out as the most predominant concern (48.8 % for children, 46.3% for adults), although about a quarter of GDPs also reported that, the tool was not useful. Other common issues identified were poor patient compliance and lack of needed knowledge to carry out the dietary analysis, each was reported by around 15% for both children and adults.

Table 5-7: GDPs’ reasons for not using diet diaries for child (n= 168) and adult (n= 172) dental patients

GDPs’ reasons for not using diet diaries	Children		Adults	
	N	(%)	N	(%)
The NHS remuneration is insufficient to cover my time spent on a diet diary	82	(48.8)	80	(46.3)
Lack of knowledge needed for diet analysis	27	(16.1)	26	(15.0)
I do not feel they are useful	42	(25.0)	48	(27.7)
No need for their use	22	(13.1)	18	(10.5)
Time consuming	13	(7.7)	11	(6.4)
Poor compliance	24	(14.3)	27	(15.7)
Feels patronising and intrusive	2	(1.2)	3	(1.7)

Counts (%)

5.6 Discussion

The first objective of this study was to investigate how often GDPs use diet diaries. This is the first study, to the best of author’s knowledge, to have investigated use of diet diaries among GDPs in England. This study gives an idea of what is happening in dental practice settings in England, and suggests that while diet advice is a role undertaken by the vast majority of GDPs, a relatively low proportion (28%) use diet diaries as a tool to support this activity. Bearing in mind that respondents are

likely to be that most interested in this research topic because it pertains to the quality of their professional practice (Tan and Burke, 1997, Kaner et al., 1998), and some degree of social desirability in responses may be present (Van de Mortel, 2008), this is likely to represent the maximum figure of the population of GDPs using diet diaries in their clinical practice. Nevertheless, this figure (28%) is higher than that reported among American hygienists (4%) using diet diaries (Levy and Raab, 1993).

Diet diaries appear not to be GDPs' primary choice of tool in collecting dietary information to inform dietary advice. GDPs appear to ask patients to recall their usual diet habits (a retrospective method), which is less time-consuming than introducing records, although arguably more subject to errors and distortions of memory (see section 2-8). This is in keeping with findings from a previous qualitative observational study involving 35 English GDPs, which identified that very little dietary information, was communicated between dentists and their patients (Barton, 2001). Although it is difficult to explain this observation in the view of the paucity of research investigating the use of diet diaries in clinical practice (Section 2-9-1), there is a general recognition that there are many chairside and organisational factors, mainly timing and financial consideration and dietary education of the dentists, which may hinder the appropriate provision of dietary advice (Moynihan, 2002, Marshall, 2009).

This study's findings suggest that the prime issue discouraging the use of diet diaries may be financial and associated with the perceived insufficient support for the acting under unmet NHS remuneration arrangements. This is supported by two strands of evidence. First, in the multivariate analysis of diet diaries use, where lower use was associated with a higher case mix percentage of NHS patients; second, GDPs directly stated this in a free text question or in a question about reasons for their not using diet diaries (although no textual data analysis was undertaken and reported). The

insufficient support for preventive dental care in the current NHS dental remuneration system has been documented in a previous national report (Steele, 2009). However, since the payment system in England moving towards focusing on quality measures, the introduction of preventive care pathways that tailor treatment according to patients' needs (Harris and Bridgman, 2010), this may improve the use of preventive dental care, potentially including diet diaries, in dental practice.

GDPs also reported a perceived lack of competence in analysing dietary information given. Patients' poor adherence to diet diaries was also given as a further barrier to diet diaries use. This study's data indicates that younger dentists were more likely to use diet diaries than those who have been qualified for longer time. The data did not allow analysis of the reasons behind the findings, and so more research is needed, but it suggests that trends either in undergraduate education or clinical practice may moving toward undertaking more detailed dietary assessment in dental practice. Alternatively, this may reflect a generational shift in clinical practice shaped by experience of remuneration arrangement.

The use of diet diaries was more likely in children than that in adults. This could be partly ascribed to the fact that many LAs in Northwest England were amongst areas with highest levels of caries experienced in children according to a recent national data (Public Health England, 2012, Steele et al., 2015). However, the study sample was stratified to give a mix of caries levels (Low, Moderate and High) and no statistically significant differences were observed in the use of diet diaries across these levels (Table 5-5). In addition, dental caries is a lifetime disease and recent epidemiological data indicates that dental caries is still an issue in adulthood (Kassebaum et al., 2015). Another possibility for such pattern of diet diaries use could be that it is easier to change and maintain favourable habits in children than in adults

(Epstein et al., 1995). Moreover, since healthy eating habits that are learned early in life are known to have lifelong nutritional advantages and impact on a person's lifelong dental caries experience (Marshall, 2004), GDPs may have prioritised them in younger age groups. Childhood represents an important stage of life in cognitive development and establishing dietary habits, with children become increasingly responsible for their dietary choices at the end of this period of the lifetime (Rockett and Colditz, 1997).

It is important to involve parents in any intervention that targets children (Wilfley et al., 2011), since parents influence child's social environment and contribute to modelling their children's dietary habits (Patrick and Nicklas, 2005). GDPs responding to the survey seemed to recognise the crucial role of parents in shaping their children dietary behaviours. The majority of GDPs asked both parent and child to keep the diet diaries (Table 5-4). It is noteworthy, however, that none of the GDPs relied solely on the child to fill in the diet diaries. No previous studies have explored this issue, but it may be that GDPs do not fully trust the cognitive abilities of children in completing the diet diaries. This issue was explored further in study IV which included interactions between patients (parents/child) and dentists (Chapter 8). It is generally accepted that children younger than 12 years have limited abilities to recall, estimate the amount and identify foods, which consequently limits their abilities to self-report their dietary intake without assistance from surrogates (Livingstone et al., 2004).

While most of diet diaries-related practices were compatible with available guidance from standard textbooks for dentists and dental hygienists, asking patients to record bed time was omitted by a large number of the GDPs. Recording bedtime is of paramount importance for tailoring an effective dietary advice (Chapter 2, section

2-3-8). It helps in identifying late consumption of sugars, which is one of the most detrimental behaviours to dental caries development and progression since it coincides with a reduction in the salivary flow during sleep and consequently limited protective effects of saliva (Humphrey and Williamson, 2001, Dawes, 2008). Although it might be argued that dentists could collect such information by interviewing the patient when analysing the diet diaries to give dietary advice, there is no evidence that this always happened. In addition, there is a liability for recall bias which undermines the value of using a contemporaneous diet diary (Thompson and Subar, 2013).

Almost all GDPs reported giving diet advice of some sort. Although this finding may reflect some social desirability, the participating GDPs highlighted that the provision of dietary advice was not a regular activity for every single patient. Similar findings were observed in other studies both nationally (Kelly and Moynihan, 2008, Elouafkaoui et al., 2015) and internationally (Yokoyama et al., 2013) where small proportions of dentists reported providing dietary advice on regular basis. In fact, this is not surprising since a recent systematic review of literature regarding the frequency of dietary advice in dental setting concluded that dietary advice is infrequently provided in dental practice (Frank, et al, 2014). Although routinely giving diet advice to all dental patients has been recommended by current evidence based guidance (Public Health England, 2014a), it is generally recognised that several organisational, as well as clinician-related barriers have given rise to a discrepancy between the implementation of evidence based recommendation and actual clinical practice (Grol and Wensing, 2004). In UK dental practice, evidence has shown that there is a wide variation in dentists' perspective and practice of preventive advice as well as several barriers of the proper provision of preventive dental care (Tomlinson

and Treasure, 2006, Fox, 2010). So it could be the case that GDPs, in this study, targeted with advice only certain patients at high risk of dental disease with diet advice or did not consider dietary advice part of their main duties. The findings of this study that high risk of developing dental caries was a frequently given reason for providing dietary advice, offer some support to the former justification.

Overall collecting dietary information appears to be undertaken routinely by, at best, only 134 (54%) of GDPs even though if this is recommended as best practice to enhance and support diet advice for all high-risk dental patients (Watt et al., 2003, Mobley and Dounis, 2010). This is in line with findings from the only other study in this area where although most of American hygienists provided dietary advice, less than the fifth of them reported conducting dietary assessment using different techniques (Levy and Raab, 1993). Although the current study's data did not offer explanations as to why some GDPs did not assess their patients' diet, it might be the case that dentists use simplistic approaches to a complex issue such as dietary advice (O'Neill, 1984), or that they believe delivering diet advice without assessing the diet is sufficient and effective (Bedi and Brown, 1983).

This study used self-administered postal questionnaire methodology which worth some reflection. While this method showed high effectiveness in collecting data from large and geographically dispersed population such as the Northwest of England, a well-known problem of postal questionnaires is the low response rate which decreases sample size with a subsequent risk of compromising the generalisability of survey's findings (Curtis and Redmond, 2009). This caveat is clearly noticeable in studies that involve health care professionals where response rate is a relatively low (Cummings et al., 2001), and following a downward trend (Cook et al., 2009).

Recognising this as a potential bias, a range of recommended approaches were taken to maximise response rate (Chapter 4, section 4-3-1). Yet, the effective response rate was relatively low (26%). Although this is not uncommon for studies of this type involving dentists (Yip et al., 2013), there are many possible explanations of such low response rate. First, this might be caused by circumstances out of the investigator's control, such as the health professionals selectivity in responding to postal questionnaires with interesting or relevant research topic (Tan and Burke, 1997, Kaner et al., 1998). GPs, as a group, may have placed a low value on the topic of using diet diaries. The value of research topic to the health professional has been singled as the most important determinant for response rate in questionnaire surveys (Tan and Burke, 1997, Kaner et al., 1998).

Second, the sample included private as well as NHS dentists with the response rate from the former being particularly low. The information from the NHS website which was used as a sampling frame proved to be neither accurate nor up-to-date. For example, it transpired that lists included retired dentists and also some duplicated names (for example, married and maiden names). Although we made efforts to correct for this in the administration of the questionnaire, the unreliability of the sampling list probably contributed to a low response rate. Third, no incentive was provided, which could have increased the response rate. Incentives are recognised as strong booster to response rate in questionnaire studies (Edwards et al., 2007).

Nevertheless, although most of literature focus on response rate in questionnaire surveys, it is not necessarily a key indicator of collected data quality (Shelley et al., 2012). A more important and direct indicator of response quality is the non-response bias which results from differences between respondents and non-respondents (Dillman et al., 2014), and this can occur equally in surveys with high

and low response rates (Groves and Peytcheva, 2008). A response bias analysis was undertaken to explore whether the low response rate has led to response bias. Although different approaches have been suggested to investigate the non-response bias, there is no golden standard method (Locker, 2000), and the choice between these approaches depends on the availability of data, time and resources (MacDonald et al., 2009).

Response bias analysis, in this study, was performed by comparing early responder with late responders, on the basis that late respondents would be more similar to non-respondents than early respondents. Using this approach our response bias analysis proved to be reassuring; showing the use of diet diary and demographic characteristics of early respondents and late respondents to be similar. Moreover, profile of our responders in terms of gender distribution (40% females) and NHS work (75%), is similar to the profile of GDPs according to these characteristics in nationally held statistics (Kravit and Treasure, 2009).

Above all, although the response rate was low, because of the large sample size, the number of responses received still gives relatively narrow confidence interval ($\pm 0.06\%$) around our estimate of the proportion of using diet diaries.

5.7 Summary and implications

In summary, although recommended as best practice, the majority of English dentists do not use diet diaries to collect diet information in dental practice, mainly because of constraints related to finance and time. Other barriers identified were poor patient compliance and lack of needed skill among dentists were perceived by the GDPs. Diet diaries were more likely to be used in children than in adults, and for patients with high levels of caries in general. Factors such as dentist's years of experience, type of practice and children case-mix appear to affect how often diet

diaries are used. This study also reflects issues to do with the remuneration in English setting and professional values of English GPs and so cannot be generalised to other settings which highlights the need of additional studies in different countries. The issue remains however that whilst this study shows that diet-related discussions are appropriately held in the dental practice setting, the tools to support this are currently underused and probably under-developed. The present study suggests that paper diaries are of low acceptability among English GPs and may not be the ideal approach for dietary assessment in the view of the constraints of current NHS dental remuneration system.

Chapter 6. How dentists use diet diaries to give diet advice

(Study II)

6.1 Introduction

This chapter presents study II which investigates how dentists interpret and use diet diaries to formulate advice, using a case vignette including a diet diary along with open ended questions. The chapter begins with a description of the rationale and objectives of this investigation. In the next sections a detailed description of methods and findings, followed by a discussion of these findings to draw up conclusions are all provided. This study addressed the following key research question posed at the outset of the thesis (Page 43):

- I. How diet diaries are currently used in dental practice for children and what do dentists/ families hope to achieve by their use?

6.2 Background

As the literature review (Chapter 2, section 2-3) indicates, sugar-caries association is not straightforward, with a range of sugar consumption behaviours influencing the cariogenicity of sugar intakes (Touger-Decker and van Loveren, 2003). This makes diet assessment using diet diaries a desirable activity to help dentists in developing an effective dietary advice since it offers a contemporaneous account of dietary intakes, that acknowledges the complexity of eating behaviours and allows for meaningful discussions between dentists and patient and the identification of appropriate behaviour change goals (Watt et al., 2003). However, in so doing diet diaries provide information that is complex, nuanced and multifaceted, whereas systematic review evidence indicates that behavioural change is most likely to be affected by simple, focussed and easily implemented advice (Wanyonyi et al., 2011).

Although some textbooks suggest how dentists should analyse information collected using diet diaries to give dietary advice (Chapter 2, section 2-9), it is unclear how dentists handle the task of reducing complex information to simple messages. Current dental literature provides little insight into this problem. Using complex information to best inform decision making is an issue that is common to many areas of clinical practice (Gafni et al., 1998, White and Maupome, 2001), but few studies have investigated how dentists process diagnostic information in order to provide clinical advice (Maupomé and Sheiham, 2000, Maupome et al., 2010). In dentistry, models that explain complex cognitive processes underlying dentists' decisions are lacking (Maupomé and Sheiham, 2000, Khatami and Macentee, 2011).

Given that no studies have been found which investigate how dentists use information obtained from diet diaries to formulate the dietary advice, this study aimed to explore how dentists navigate the problem of integrating complex information from diet diaries to deliver useable dietary advice to patients. Study II objectives

1. To develop a vignette methodology and coding system for responses to a vignette that can measure a) the dietary problems that dentists identify, and b) the dietary advice they give.
2. To understand how dentists formulate dietary advice for children and their parents from information provided in a diet diary

6.3 Methods

A case vignette comprised a 2-day diet diary of an eleven-year-old girl with dental caries. The case vignette was included in a wider postal questionnaire about dietary advice to general dental practitioners (GDPs) in Northwest England. The

methods of the questionnaire study are described in Chapter 5-section 5-4. A total of 229 questionnaires with completed vignettes responses were received.

6.3.1 The vignette

Dentists were presented with a single case vignette featuring the completed day diary record of an eleven-year-old girl (Figure 6-1). Contextual dental and medical history was given, and the diary was identified as being from an NHS dental patient at high risk of developing dental caries, who presented to the dentist with mild dental toothache due to dentine caries. She had insignificant medical history while her dental history included multiple extractions and regular dental visits in the last year. The 2-day diet diary was structured to allow a record which included type, amount and time of dietary intakes and time the patient went to the bed. Multiple problem behaviours were involved; eating immediately before bedtime, snacking, sticky and hidden sugars, amount and frequency of intake and alternate sequence of sugar intake with protective food as well as varies general eating behaviours. The vignette was followed by four open-ended questions with sufficient space to provide a detailed open text response to each. The GDPs were asked, in separate items with free-text responses, to specify what they thought were the problems in terms of caries risk in the vignette, and to state the advice that they would give to the patient (Figure 6-1). This was followed by a closed question asking the dentists to rank, by importance, aspects of any dietary advice that they would provide. This was at the end of the other vignette's tasks to avoid leading their answers to the vignette.

6.3.2 Data analysis and findings

This study is exploratory. To the best of the author's knowledge, no previous study has investigated how dentists use diet diary information to formulate diet advice. Thus, a sequential approach, comprising both qualitative and quantitative analyses,

was used. An inductive content analysis (ICA), described in Chapter 4-section 4, was carried out on an initial subsample of questionnaires, to understand how dentists used diet diary information to formulate their advice for patients and to develop a coding system for dentists' interpretations of the dietary information given in the diet-diary. The coding framework was then applied to the wider sample in a quantitative phase of the analysis.

Figure 6-1: The case vignette with the four questions posed to GDP participants

Whether or not you use diet diaries, please read the following case vignette and answer the following questions

Case Vignette

An 11 year old girl is brought to your dental practice by her parents because of mild pain in her lower back teeth which is aggravated by hot and cold drinks and relieved by pain killers. She has been coming to the practice regularly for the last year. Her medical history has revealed nothing of significance and her dental history includes multiple extractions and fillings of primary teeth due to dental caries. Oral examination shows dentine caries in the permanent molars and white spots on the cervical third of maxillary incisors. She and her parents are NHS patients.

Day 1			Day 2		
Time	Food	Quantity		Food	Quantity
7.45 am	Glass of milk Coco pops Pear	1 1 1	9.45 am	Glass of milk Toast + Butter Pear	1 2 1
10.45 am	Ham sandwich Yoghurt Cheese strip	1 1 1	10.45 am	Tuna sandwich Cheese strip Actimel	1 1 1
12.30 pm	Actimel Blackcurrant Fruit Chocolate milkshake	1 3 1	12.30 pm	Orange juice	1
4 pm	Pizza (chees, tomato) Chips Beans	3 triangles 1 1 small saucer	4.00 pm	Chocolate Toffee caramel	3 1
4.30 pm	Apple juice	1	4.30 pm	Rice Chips Chicken wings	1 small saucer 1 small saucer 1
7.00 pm	Milkshake	1	7.00 pm	Apple juice	1
8.30 pm	Milkshake	1	8.30 pm	Cake Milkshake	1 1
8.45 pm	Bed		9.00 pm	Bed	

1. Please, circle 6 behaviours which in your view represent dental health issue, and number them 1-6 (1 being entry that concerns you most).
2. Are there any aspects of the above diary you would ask child/or the parents to give you more information about, and what would these be?
3. What would be the first dietary issue you would advise the child/her parents about?
4. Are there other areas of advice (if any) would you cover?

In the following sections the methods used for data analysis along with their findings are described according to the order in which data analysis progresses.

6.3.2.1 Qualitative analysis and findings

The analysis of case vignettes began with Inductive Content Analysis (ICA). This was carried out in a subsample of 40 cases (questionnaires) with completed open text responses. These were purposefully selected for their completeness and variability of the responses. All cases were anonymised using serial numbers and letters indicating the area's caries level (L=Low, M=Moderate, H=High) and practice type (N=NHS, P= private) associated with the GDPs practice area and type. Open text responses for all selected cases were transcribed verbatim and coded using a qualitative analysis software package, the NVIVO 9.2 (QSR International). A constant comparison method was used, where data were coded and concurrently compared for the occurrence and interrelation between codes across different cases (Bowen, 2008). The process of cases selection and coding was iterative until data saturation was reached (Ritchie et al., 2013). Data saturation was observed after 35 cases. A further five cases were analysed to validate the coding and ascertain the saturation.

ICA commenced with repeated readings through the data to gain thorough understanding and to make sense of the data. Data were then analysed inductively at the level of words, sentences and phrases. A coding system was generated and continually refined as an ongoing process during the course of the analysis, leading to the identification of emerging themes and sub-themes regarding what did dentists viewed as important information in the diet diary (identified problems) which was identified from responses to vignette's questions 1&2; and what dentists included in their diet advice, which was identified from responses to vignette's questions 3&4 (Figure 6-1). By investigating what dentists recognised as issues from the diet diary

information; and what they suggested as solutions in the diet advice they would give, the study explored how dentists approached formulating dietary advice from diet diary information presented to them.

To minimise the bias from a single researcher and to ensure validity and reliability of the qualitative analysis, the wider supervisory team was involved in discussing the coding and interpretation of data (Mays and Pope, 2000, Shenton, 2004).

6.3.2.1.1 The coding framework: important dietary issues & advice topics

ICA themes and subthemes with their conceptual definitions and supporting data are given in Tables 6-1 & 6-2. Many dentists approached their analysis of the diary by identifying items that they considered as harmful to oral health by the virtue of their cariogenic and erosive potential. The GDPs, also, addressed such items in their suggested dietary advice. They did so by simply listing the harmful items or by referring to their sugary or acidic content and/or their damaging effect on oral health.

“Apple juice, both sugary and acidic”

MN33: (Response to Q1- identified problem)

In many cases, dentists identified the ways in which sugar was consumed as problematic. The harmfulness of the items was linked to the accompanying contextual and consumption behaviours that were considered to be accounted for or exaggerated the damaging effect of these items. Information which was identified by GDPs as important included the amount, frequency, timing and duration of exposures to items with cariogenic potential, as well as the hidden sugars and sequencing of sugar with alkaline intakes. For example:

“Frequent eating and snacking of sugar leads to too frequent acid attacks”

HN20: (Response to Q1- identified problem)

Environmental factors and patient behaviours that were not strictly dietary which were thought to act to modify either the intake or the effect of harmful items (such as oral hygiene practices, parental attitude and motivation) were identified as important information and also were repeated as topics which would be discussed by GDPs when giving advice. For example, the GDPs, in their responses to question (3), indicated that they would ask the child/ parents about oral hygiene habits and how their child had access to sugary snacks.

“Who buys the chocolate + drinks?”

MN212 (Response to Q3- advice)

The importance of perceived family and environment influences was seen in some GDPs’ keenness on widely disseminating the dietary advice messages to parents and other members of family including grandparents

“Awareness of same advice to grandparents as well”

HN13 (Response to Q3- advice)

General dietary issues that have the potential to impact on general health, were also reported as important diet diary information and in the advice topics identified. An unbalanced diet, with generally poor nutritional value and irregular eating habits were considered problematic. Likewise, maintaining a balanced diet with enough fruits and vegetables and regular dietary habits was a recurrent theme in the given advice.

“Absence of guideline ‘5 –A-Day’ healthy fruit and veg foods concern over possible sequelae for general health”

MN212 (Response to Q1- identified problem)

Table 6-1: Coding framework with conceptual definitions and supporting statements outlining dietary information regarded as important by GDPs

Theme		Conceptual definition	Supporting Quotation(s)
Harmful items		Items which have cariogenic or erosive potential represent risk to oral health	MN33: “Apple juice, both sugary and acidic” HN 215: “The type of food consumed. acidic/cariogenic”
Consumption patterns		The way in which a harmful item consumed raises the risk of caries/erosion.	
Subtheme	Frequency	A high number of intakes per day	LN116“High frequency of sugar throughout the day”
	Amount	A large amount of sugar/ acid	MN201“How much sugar is in the milkshake she has?”
	In-between meals	Sugar consumption between meals	MP6“Milkshake high in sugar+ taken before bed”
	Near bedtime	Sugar consumption close to bedtime	HN6“milkshakes last thing at night”
	Prolonged exposure	Consumption manners and food form that extend the duration of sugar exposure	LN31“Caramel is sticky and chocolate is high in sugar” HN6“Are milkshakes consumed quickly in one go or lots of sips?”
	Sequence	The order of items intake within the meal/snack	HN31“7:45 am, day 2, is milk last thing after coco pops /pear?”
	Hidden sugars	Patient’s unawareness of sugar content in the diet	HN6“Are they aware of hidden sugars in food?”
Personal oral health care		Oral hygiene practices and use of fluoridated toothpaste may modify the effect of harmful items	HN6“Does she brush her teeth before bedtime?” LN311“Brushing habits (before or after breakfast) 2 x days”
Environmental influences		Patients’ ways of living, values and routine behaviours may influence the consumption of sugary/acidic items	HN31“Does the child take a packed lunch or have a school dinner?” MN212“Who buy the chocolate + drinks?”
General dietary issues		Unbalanced diet of poor nutritional value and irregular eating habits affect the general health	MN212“Absence of guideline ‘5 –A-Day’ healthy fruit and veg foods concern over some possible sequelae for general health”

Table 6-2: Coding framework with conceptual definitions and supporting statements outlining topics to be covered by GDPs giving dietary advice

Theme		Conceptual definition	Supporting Quotation(s)
Harmful items		A recommendation to reduce the intake of cariogenic/erosive items	MN35“Reduce sugary, acidic drinks to a minimum” HN 215: “reduce overall sugar consumption”
Consumption patterns		Reduce or avoid ways of consumption that raise the risk of caries/erosion.	
Subtheme	Frequency	Reduce the number of intakes per day	LN113“Sugar frequency should be limited to 4 a day or less”
	Amount	Reduce amount of sugar in diet	HN6 “Reduce the amount and frequency of consumption of sugar”
	In-between meals	Avoid sugar consumption between meals	MP6“Milkshake high in sugar+ taken before bed”
	Near bedtime	Avoid sugar consumption close to bedtime	LN306“Only have water or plain milk between meals”
	Hidden sugars	Raise patient’s awareness of unseen sugars in diet	MN256“Go through foods which contain hidden sugars, e.g. tomato sauce in beans “
Personal oral health care		Maintenance of good oral hygiene and fluoride use	HN6“Tooth brushing /oral hygiene/ fluoride use advice”
Environmental influences		Provide advice to child carers including those outside home	HN13“Awareness of same advice to grandparents as well” LN 316“Involve parents and other members of family”
General dietary issues		General diet, nutrition and eating habits recommendations	HP8“Choice of evening meal contains a lot of fat. Lack of fibre in diet” MN212“Balanced diet - more vegetables etc.”

6.3.2.1.2 Approaches to formulating dietary advice

Moving back and forth across the identified dietary problems and topics of dietary advice, two approaches of formulating advice from identified problems were identified. These were a) a summative approach, and b) a specific/selective approach.

a) A summative approach: (Figure 6-2)

Some GDPs made an effort to sum up the complex register of important dietary issues and deliver this in an all-encompassing set of advice (Figure 6-2). This appeared to be a reflection of GDPs' interpretation of what constituted a common factor among all the issues they had identified. Specifically, these GDPs recognised many different items and dietary behaviours in the diet diary as important (e.g. amount, frequency, hidden sugars and between meals and near bedtime intake of sugars), but did not focus on any particular issue. Some gave general advice, addressing a common aspect among various issues (usually sugar consumption). For example, dentists reported they would deliver an all-purpose statement with a core message to restrict all forms of harmful intakes (*e.g. reduce the intake of sugary foods and drinks or reduce the amount and frequency of sugar intakes/ reduce sugar intake to minimum*).

b) A selective approach: (Figure 6-3)

GDPs taking a selective approach were those who gave their advice by picking up one or two from many issues from the diet diary which they considered as important. In doing so, they addressed specific dietary problems; possibly what they considered the most important (Figure 6-3). Put more simply, these GDPs highlighted in their response to vignette's question (1) (Figure 6-1) a range of important issues (e.g. frequency, amount, near bedtime and sequence of sugary items intake), but when it comes to delivering advice (vignette's questions 3 & 4) (Figure 6-3), they took a very specific

approach and selected just one or two particular topics to address (e.g. *avoid near bedtime intake of sugars or reduce the frequency of sugar intake to less than 4 times a day*).

Figure 6-2: A summative approach to delivering diet advice based on dietary assessment

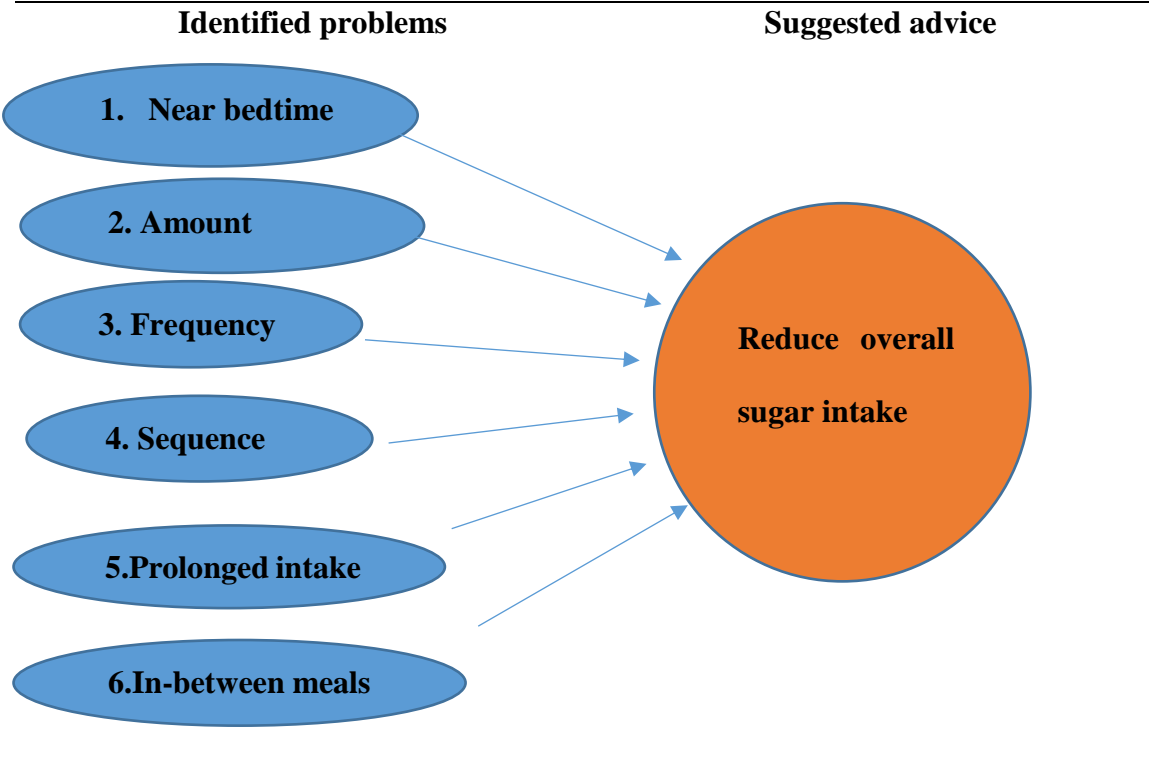
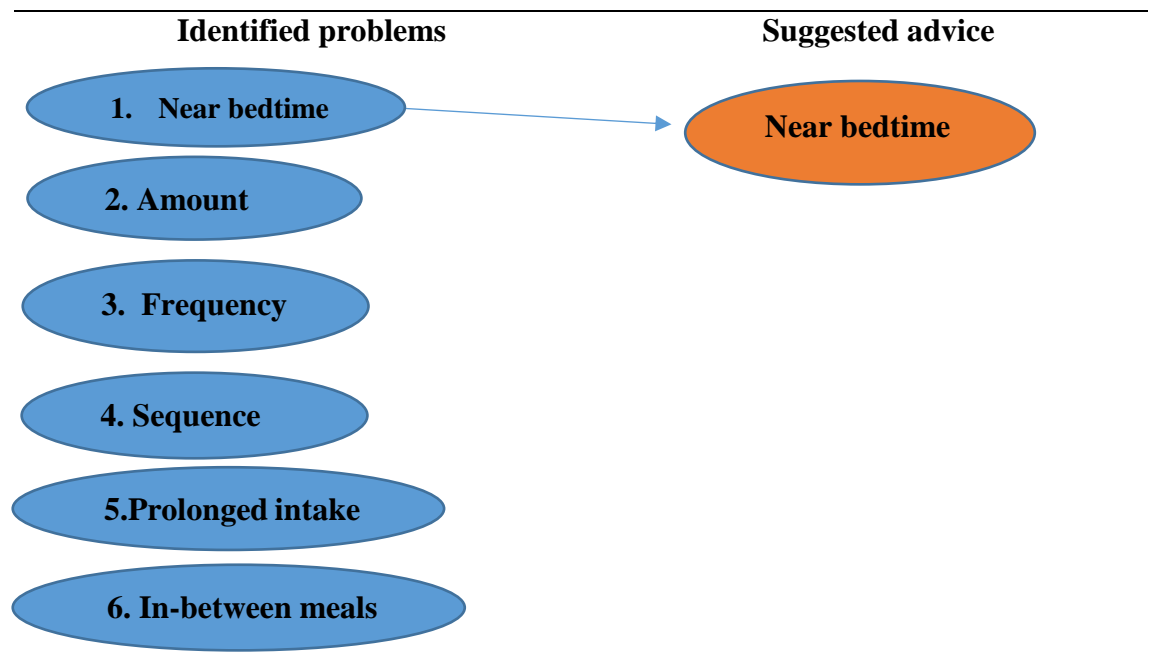


Figure 6-3: A selective approach to delivering diet advice based on dietary assessment



6.3.2.2 Quantitative analysis and findings

The coding scheme generated from the qualitative analysis (Tables 6-1 & 6-2) was then applied to all questionnaires with completed open text responses (n=229). The variables were coded as 1= the identified problem or advice was indicated by the dentist or 0=not indicated. The coding process was carried out by a single investigator (the student). This was then verified by an independent assessor for the first 20 questionnaires. Kappa coefficients between 0.8 and 1.0 and absolute agreements of 90% -100% were reached (Table 6-3).

Table 6-3: Dietary information regarded as important by GDPs

Variable	Agreement	Cohens kappa
Harmful items	100%	1
Frequency	92%	0.83
Amount	100%	1
Between-meals	96%	0.88
Near bedtime	100%	1
Hidden sugars	96%	0.88
General diet	100%	1
Additional prevention	100%	1
Sequence	100%	1
Environmental factors	100%	1
Contact time	96%	0.88

Data were analysed using statistical software SPSS Version 22.0. (Armonk, NY: IBM Corp.). Counts and proportions were used to describe the frequency of each code for what dentists identified as problems and what they included in their suggested dietary advice to the patient. Binary logistic regression models were used to explore associations between identified problems and advice. A multivariate model regressed each binary outcome (advice) variable (yes/no), onto the predictor (identified problem) variables. The regression model was adjusted for the dentists' demographic and professional

characteristics (gender, years in service and role in practice) as well as characteristics of their dental practice (area's caries level, Index of Multiple Deprivation quintiles and the proportion of practice case mix reported to be NHS or private).

6.3.2.2.1 Sample profile

Table 6-4 shows characteristics of the 229 participants who completed the vignette section of the questionnaire. These respondents had a mean 20 (± 12) years of service since qualification, most of them undertook some NHS work (97%, $n=219$). The majority worked in practices located in first and second quintile IMD areas (most deprived). There was a relatively even distribution of respondents by gender and by caries prevalence (high, medium and low), of areas in which their practices were located.

Table 6-4: Characteristics of the study sample (n=229)

Variables		Summary Statistic	
		<i>Count</i>	<i>(%)</i>
Sex	Men	126	(55.0)
	Women	103	(45.0)
Role	Practice Owner	96	(41.9)
	Associate/other	133	(58.1)
Caries Incidence	Low	84	(36.7)
	Moderate	67	(29.3)
	High	78	(34.1)
Index of	Quintile 1 (Most deprived)	69	(30.1)
Multiple	Quintile 2	76	(33.2)
Deprivation	Quintile 3	30	(13.1)
	Quintile 4	36	(15.7)
	Quintile 5 (Least deprived)	18	(7.9)
Practice sector	NHS	219	(96.6)
	Private	10	(3.4)
		<i>Mean</i>	<i>(SD)</i>
Years in service		20.9	(12.0)

6.3.2.2 Important dietary issues and diet advice topics

Generally, the number of diet advice topics addressed (advice) was fewer than the number of identified problems (Table 6-5). The most frequently identified problems were near bedtime sugar consumption (180, 79%) and frequency (59, 26%) of consumption of sugar as well as general dietary habits (54, 25%), whereas sequence and prolonged intake of sugars were the least frequently recognised dietary issue. On the other hand, the most frequently observed advice topics were near bedtime consumption of sugars (116, 51%), harmful items (97, 42%) and frequent sugar intakes (89, 39%). The amount of sugar intake was among the least common advice topics (21, 9%). Sequence of intake and prolonged contact time were absent in dietary advice topics which would be covered.

Table 6-5: Frequencies of important dietary issues identified and diet advice chosen:

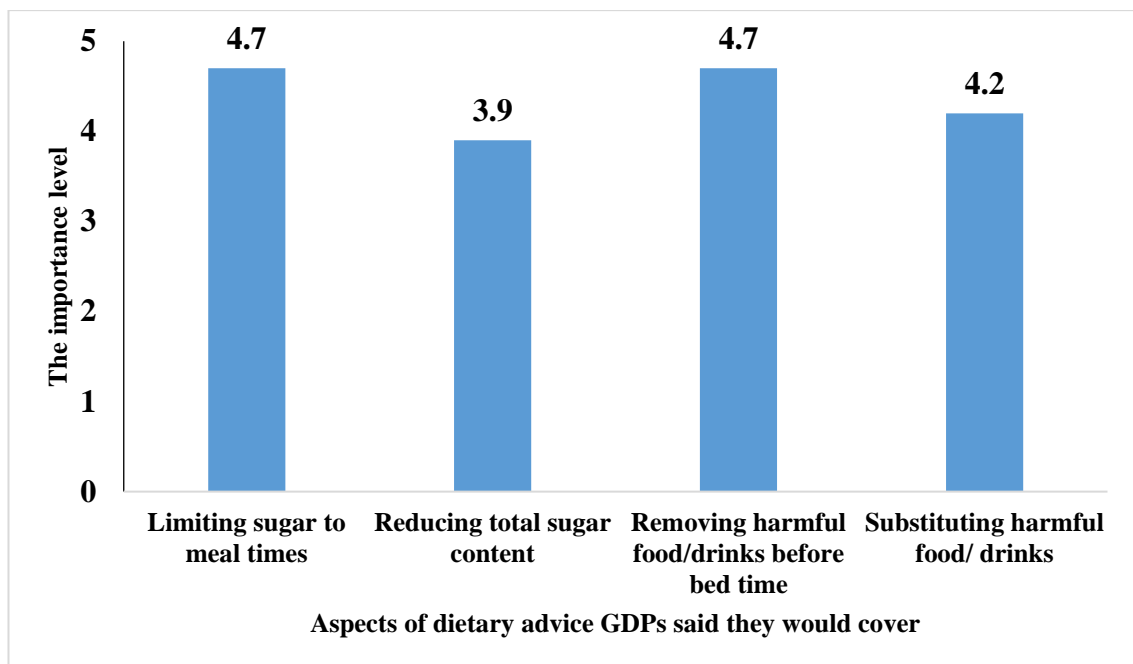
	Important issues	Advice topics
Harmful items	142 (62.0)	97 (42.4)
Frequency	59 (25.8)	89 (38.9)
Amount	44 (19.2)	21 (9.2)
Between-meals	125 (54.6)	87 (38.0)
Near bedtime	180 (78.6)	116 (50.7)
Sequence	13 (5.7)	----
Hidden sugars	31 (13.5)	15 (6.6)
Prolonged contact time	22 (9.6)	----
General dietary issues	54 (24.9)	67(29.3)
Personal oral health care	83 (36.2)	47(20.5)
Environmental factors	35 (15.3)	4 (1.7)

Counts (%), N=229

What stands out in Table 6-5 is that specifying sugar frequency and general dietary issues was *higher* in diet advice given than that in important dietary issues identified. By contrast, the attention given in the advice to all other dietary behaviours was *less* than that showed in identifying important behaviours.

In answering a closed ended task which asked the participants to rank the relative importance of selected dietary topics (see questionnaire Appendix E), limiting sugar intake to meal times and avoiding near bedtimes intakes were perceived as the most essential aspects of dietary advice (average score was 4.7/5); compared to the less important total amount of sugar in the diet (average score was 3.9/5) (Fig. 6-4).

Figure 6-4: Mean scores for perceived importance of dietary advice aspects when considering diet diaries analysis (n=220)



6.3.2.2.3 Predictors of diet advice topics

Initial logistic regression modelling established that there were very few associations between background variables and whether specific advice topics were given were observed (Table 6-6). Dentists working in quintile 3 were more likely to give advice related to between meals sugar consumption, whereas those from quintile 5 were more likely to give advice related to between meals and near bed time intake of sugars, ($p < 0.05$). Thus, the analysis did not statistically control background variables in the logistic regression modelling.

Summaries of binary logistic regression models are presented in Table 6-6 and 6-7. These show a high level of specificity in the correspondence between advice and

identified problems for nearly all analyses. The odds ratio (OR) of each item of advice being given were uniquely and significantly ($p < 0.05$) higher if the corresponding problem was identified. Further, the advice given was generally the only significant predictor. The only exception for this was the giving of advice about harmful items which was not predicted from its identification as a problem. Instead this was predicted from general diet and frequency and near bedtime consumption of sugars being noted in the identified problems (Table 6-7).

Table 6-6: The association between dentists' characteristics and diet advice topic which would be covered

GDPs Characteristics		Diet advice							
		Harmful items OR (95% CI)	Frequency OR (95% CI)	Amount OR (95% CI)	Between-meals OR (95% CI)	Near bedtime OR (95% CI)	Hidden sugars OR (95% CI)	General diet OR (95% CI)	Personal oral health care OR (95% CI)
Years in service		0.97 (0.94, 1.00)	0.95(0.92, .1.00)	0.96 (0.91, 1.02)	1.00 (0.97, 1.03)	1.03 (0.99, 1.06)	0.97(0.91,1.04)	1.00(0.97,1.3)	1.01 (0.98, 1.05)
Gender	Male	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
	Female	1.18 (0.64, 2.17)	0.84 (0.45,1.5)	0.84 (0.21, 1.64)	0.73 (0.40, 1.35)	1.55 (0.84,2.8)	0.49(0.14,1.68)	1.01 (0.51, 2.00)	0.44 (0.19, 1.00)
Role	Owner	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
	Associate	0.88 (0.42, 1.84)	0.75 (0.35,1.6)	0.79 (0.21, 2.99)	0.89 (0.41, 1.93)	1.75 (0.81,3.7)	0.86 (0.18, 4.06)	1.34 (0.60, 3.25)	1.27 (0.48, 3.36)
IMD	Quintile 1	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
	Quintile 2	0.92 (0.44, 1.91)	1.05 (0.50,2.2)	1.10 (0.32, 3.83)	0.80 (0.38, 1.65)	1.87 (0.89, 3.91)	0.89 (0.19, 4.22)	1.57 (0.70, 3.54)	0.41 (0.16, 1.03)
	Quintile 3	0.69 (0.25, 1.88)	0.46(0.16,1.3)	0.16 (0.02, 1.58)	0.69 (0.24, 1.99)	4.90 (1.73,13.01)	1.71 (0.21,11.71)	0.46 (0.14, 1.52)	0.46 (0.12, 1.74)
	Quintile 4	0.36 (0.43, 2.27)	1.03 (0.41, 2.76)	0.71 (0.14, 3.67)	0.67 (0.25, 1.68)	1.32 (0.5, 3.31)	1.13 (0.17, 7.40)	0.41 (0.13, 1.26)	0.98 (0.33, 2.93)
	Quintile 5	1.28 (0.12, 1.63)	1.57 (0.49, 5.38)	1.34 (0.23, 3.58)	4.12 (1.12, 15.28)	4.55 (1.19, 17.00)	1.28 (0.20, 14.71)	0.56 (0.12, 2.76)	1.15 (0.26, 5.20)
Caries level	Low	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
	Moderate	1.04 (0.47, 2.32)	0.54 (0.24, 1.21)	0.28 (0.07, 1.10)	0.99 (0.44, 2.24)	2.42 (1.07, 5.47)	2.14 (0.43, 10.55)	0.70 (0.28, 1.76)	2.09 (0.77, 5.66)
	High	0.95 (0.43, 2.08)	0.75 (0.35, 1.62)	0.37 (0.10, 1.42)	1.39 (0.63, 3.05)	1.26 (0.57, 2.77)	1.24 (0.22, 7.12)	0.82 (0.34, 2.00)	1.54 (0.59, 4.00)

Bold: significant p value < 0.05

Table 6-7: The association between given diet-diary information and their coverage as a diet advice topics

Issues identified as important	Diet advice topics identified which would be covered							
	Harmful items OR (95% CI)	Frequency OR (95% CI)	Amount OR (95% CI)	Between-meals OR (95% CI)	Near bedtime OR (95% CI)	Hidden sugars OR (95% CI)	General diet OR (95% CI)	Personal oral health care OR (95% CI)
Harmful items	1.28 (0.65, 2.22)	0.89 (0.46, 1.75)	2.49 (0.68, 9.06)	0.76 (0.39, 1.49)	0.42 (0.21, 0.83)	1.70 (0.43, 6.76)	1.25 (0.57, 2.75)	0.67 (0.29, 1.54)
Frequency	0.48 (0.23, 1.00)	3.39 (1.39, 6.82)	1.61 (0.53, 4.92)	0.56 (0.27, 1.16)	1.00 (0.49, 2.04)	0.45 (0.08, 2.45)	0.84 (0.38, 2.81)	2.21 (0.97, 4.05)
Amount	0.67 (0.31, 1.46)	1.25 (0.57, 2.75)	2.37 (0.68, 8.33)	1.90 (0.87, 4.15)	0.94 (0.43, 2.05)	0.34 (0.04, 3.11)	1.17 (0.50, 2.76)	1.28 (0.51, 3.20)
Between-meals	0.65 (0.33, 1.27)	0.97 (0.49, 1.94)	0.80 (0.25, 2.55)	3.00 (1.49, 6.04)	1.11 (0.56, 2.21)	1.61 (0.39, 6.67)	1.81 (0.84, 3.91)	0.41 (0.18, 0.97)
Near bedtime	0.37 (0.17, 0.87)	1.05 (0.47, 2.37)	1.61 (0.40, 6.44)	1.64 (0.69, 3.89)	2.40 (1.05, 5.49)	1.80 (0.31, 10.47)	0.30 (0.12, 0.75)	2.11 (0.75, 5.94)
Sequence	1.19 (0.33, 4.24)	1.19 (0.34, 4.20)	----	0.91 (0.25, 3.30)	3.89 (0.94, 16.03)	1.63 (0.16, 17.18)	1.79 (0.43, 7.53)	2.59 (0.67, 1.02)
Hidden sugars	0.70 (0.29, 1.68)	0.62 (0.24, 1.57)	0.32 (0.03, 2.91)	1.13 (0.47, 2.70)	0.96 (0.40, 2.29)	3.56 (0.91, 13.93)	1.68 (0.63, 4.51)	0.95 (0.29, 3.20)
contact time	1.98 (0.74, 5.25)	0.88 (0.31, 2.53)	----	1.21 (0.44, 3.29)	0.95 (0.34, 2.70)	2.45 (0.54, 11.11)	0.17 (0.03, 0.88)	0.50 (0.12, 2.03)
General diet	2.35 (1.15, 4.80)	0.94 (0.41, 2.14)	1.55 (0.43, 5.64)	1.34 (0.65, 2.74)	0.73 (0.36, 1.48)	0.93 (0.21, 4.16)	8.88 (4.00, 19.71)	0.29 (0.11, 0.89)
Personal oral health care	1.68 (0.89, 3.16)	1.03 (0.55, 1.94)	1.39 (0.47, 4.14)	0.74 (0.39, 1.40)	0.92 (0.39, 2.15)	1.79 (0.45, 7.10)	1.11 (0.55, 2.27)	4.07 (1.87, 8.86)
Environmental factors	1.24 (0.54, 2.89)	1.61 (0.75, 3.64)	0.72 (0.18, 2.93)	1.08 (0.47, 2.51)	1.52 (0.81, 2.85)	0.09 (0.37, 1.53)	0.82 (0.32, 2.14)	0.90 (0.30, 2.69)

Bold: significant p value < 0.05

6.4 Discussion

To the author's knowledge, this is the first study which investigates how dentists handle diet diary information to frame dietary advice. The qualitative and quantitative components of this study showed that, when interpreting a child's diet diary and giving advice, dentists chose fewer issues on which to provide advice than the number of problems that they identified in the diary. The logistic regression analyses showed that the advice provided was highly specific to the problems that they had identified. Thus, these findings suggest that some dentists filter information in such a way that they focussed on what they saw as key areas at the time.

The reported dentists' behaviour is interpreted as an intelligent adaptation to a key practice dilemma; how to provide the best evidence-based advice to patients whose understandings of preventive dental health, attention to detail, and their motivations and opportunities to change their behaviour may be limited. Data analysis indicates that dentists do not try to deal with all of the problems that they see, but restrict the amount of advice that they could give, to provide a coherent and easily implemented recommendation that prioritises the key problems. In particular, dentists prefer to address specific and contextualised problems, such as frequency and timing of sugar consumption that they identified. For instance, the majority of dentists focus on near bedtime intake of sugars which, whether it is high or not, can increase caries risk because it is associated with reduced salivary flow during sleep and consequently lower protective effects of saliva (Humphrey and Williamson, 2001, Dawes, 2008).

In filtering information, dentists make it both more comprehensible and easier to implement for patients. Their efforts are supported by theory. For example, fuzzy trace theory demonstrates that a simple and coherent message is more likely to be remembered, retrieved and implemented than a more detailed message (Reyna, 2008).

The latter may be more comprehensive and accurate, but these advantages are lost because they are complex and difficult to remember and retrieve from memory for decision-making (Reyna, 2008). Dentists' filtering of information can be seen in much the same way; they presented a simplified message rather than a more comprehensive message that is less likely to have an influence. Such filtering rather than a comprehensive dietary advice can be seen as an economical strategy to accommodate the limited time and insufficient remuneration constraints that dentists experience in general dental practice (Study I, chapter 5). However, further research in the form of qualitative work is needed to explore the issue in more depth.

Two distinctive strategies of filtering out complex diet-diary information were identified in this study (summative and selective). The specific principles that dentists use to sum or prioritise and select information are currently unclear and require further research. However, studies also show that dentists' judgments are influenced by their knowledge, values and beliefs as well as available treatment options (McGlone et al., 2001, Harris et al., 2014). Therefore, it might be the case that using a summative or a selective approach of dietary advice depends on how the dentist assembles together their perception of what constitutes the problem with what they believe and value as the most appropriate to be covered in the diet advice. However, this remain an assumption and further studies using cognitive interviewing would help in understanding why particular dentists might opt for a summative or a selective strategy.

This study's findings suggest that dentists, when analysing diet diaries, consider different aspects of dietary intake including its type, accompanying practices and social context as well as general dietary issues, they appeared to pay more attention to specific issues when it comes to giving the diet advice. What is more,

some issues, namely frequency of sugar and general diet, were more likely to be covered in the advice than being identified as problems. These data was not able to explain this phenomenon but it may be due to the impact of the current guidance which recommends advising all dental patients to reduce amount, frequency and near bedtime intake of sugar as well as encouraging healthy eating in general (Watt et al., 2003). Therefore, this observation may bear some support for the notion that dentists' attitudes and values could influence their clinical decision, including what they include in the diet advice (McGlone et al., 2001, Harris et al., 2014).

Whilst dentists' choices of what advice to give appear to be logical, the issue of sugar amount was not popular among dentists. Doing so, they run partially counter to current guidance of diet advice in dental practice and public health messages that give attention to the amount of sugar in diet (Public Health England, 2014a, National Institute for Health and Care Excellence, 2015). A possible explanations could be that dentists are aware that their patients find it easier to visualise frequency and timing of sugar intake than amount, and that reducing the frequency of sugar intake is more practical than reducing amount (Moynihan, 2002). Another possibility may be that less attention has been given to sugar amount as compared to frequency, in dental education, when it comes to analysing diet diaries (Moynihan et al, 2003).

Whether it should be amount or frequency which is primarily tackled in order to prevent dental caries has spawned so much debate for long-time, with an equivalent evidence to support both views. For example, while recent evidence indicates that amount may be more important than frequency of sugar intake for controlling dental caries (Bernabé et al., 2016), amount has proven a poor indicator of food's cariogenic potential compared to a more specific focus on the frequency, timing and context in which it is consumed (Sanders, 2004). Debate aside, it is generally accepted that these

variables are closely linked and tackling one will affect the other anyway (Sheiham, 2001, Moynihan, 2002).

6.5 Summary and implications

At a broader level, this research contributes to a small but growing literature that examines the cognitive strategies that dentists use to make complex clinical decisions (Maupomé and Sheiham, 2000, Maupome et al., 2010).

This study demonstrates that, faced with the constraints of providing information that is both simple and easy to implement, dentists rely upon a strategy of intelligent selection to filter out complex dietary information. Challenged with a large field of information, they select what they see as a subset of either the most useful or the easiest information to understand and implement. This might also have something to do with time and remuneration constraints in the UK general dental practice.

Contrary to the current focus in dental literature, dentist pay a relatively little attention to amount of sugar in diet and instead deal with a wide range of sugar consumption related aspects. Further qualitative research is needed to explore in depth the reasons behind the filtering strategy and the specific principles underpinning the summative and selective choices reported in this study.

Chapter 7. Adherence to diet diaries among paediatric dental patients in a hospital setting (Study III)

7.1 Introduction

This chapter describes a retrospective analysis of paediatric patients' records in a dental teaching hospital to estimate diet diary return rate and its associated factors. This chapter begins with a background section presenting the rationale of conducting this study. Objectives, methods, and results are described in the sections that follow. Finally, discussion and conclusion are then provided. This study is related to all three of the research questions posed at the outset of the thesis (page 43):

- I. How diet diaries are currently used in dental practice for children and what do dentists/ families hope to achieve by their use?
- II. What are the strengths and weaknesses in the way diet diaries are currently used in dentistry?
- III. Should the current format and procedure be modified to more effectively provide a monitoring tool?

7.2 Background

Earlier in the thesis it was demonstrated, in a survey of English dentists (Chapter 5), that the use of diet diaries in English general dental practice is relatively low and that GDPs mainly use diet diaries for children at high risk of dental caries. In chapter 5 I also reported that patient's non-adherence to diet diaries was one of the key barriers hindering the use of diet diaries by GDPs. However, little is known about the extent of patients' adherence to diet diaries issued in dental clinical settings, or its associated factors. In addition, this issue appears overshadowed by a feeling that the use of diet diaries in NHS dental practice is insufficiently supported by the current

system of dental remuneration. Hospital dentists, on the other hand, are salaried and so do not experience the same financial pressure as GPs. In the view of this, a retrospective analysis of clinical records was conducted primarily to investigate the extent of adherence to diet diaries in a teaching hospital setting where clinician remuneration was not an issue and where diet diaries are routinely used for children at high risk of dental caries.

It is necessary here to clarify exactly what is meant by the term ‘adherence/non-adherence’. Adherence is a general term used to describe patient’s congruence with the health professional’s recommendations in relation to treatment, advice, or preparation for procedures (Inkster et al., 2006, Jin et al., 2008). The term non-adherence, therefore, describes the patient’s failure to follow health behaviours and treatment advice recommended by the clinician (DiMatteo et al., 2012). In medical literature, ‘adherence’ has often been used interchangeably with the term ‘compliance’ (Inkster et al., 2006). Lassen (1989) defined patient compliance in general practice as “the extent to which a person’s behaviour coincides with medical or health advice”. Although both terms may appear very similar, adherence is more preferable since it places less emphasis on professional paternalism (Inkster et al., 2006).

In the general literature, non-adherence is identified as taking many forms; from carrying out the task incorrectly, overlooking parts of it, to not doing the task at all (Jin et al., 2008). Completing diet diaries prospectively and in timely manner over several days is essential to ensure the accuracy of the record and representativeness of the habitual intake (Burke et al., 2005). Therefore, non-adherence to diet diaries covers whether the patient does not return the diary and also the situations where the patient presents an incomplete dietary record (for example, omitting a few details) or completing the diet diary retrospectively. Although it might be counter argued that

missing information can be recollected retrospectively, this undermines the prospective and contemporaneous nature of the dietary record which are the key advantages of using diet diaries (Chapter 2, section 2-8).

Yet, there is no guarantee that an apparently complete dietary record has been completed in a prospective and timely manner. A retrospective rather than a prospective completion of diaries has been observed in previous studies of using paper diaries in self-monitoring of pain and dietary intake (Stone et al., 2003, Green et al., 2006). Therefore, the quality of information provided in diet diaries may be similar to that obtained from other retrospective dietary assessment methods, such as asking the patients to recount their habitual intake, which have been found to be more popular among GDPs, since they are more time efficient than diet diaries (Chapter 5).

Care protocols in Liverpool University Dental Hospital (LUDH), where the study has undertaken, mandate the use of diet diaries as well as retrospectively collecting information of selected dietary habits using a prevention pro forma, for all children identified to be at high risk of dental caries. This offered the opportunity to compare the variation in self-reported frequency of sugar intake using both prevention pro forma (retrospectively) and diet diaries (prospectively).

7.3 Study III objectives

1. To investigate the return rate of diet diaries issued to child patients aged 5-11 years old in a teaching hospital setting, and whether this was associated with certain demographic or oral health-related factors.
2. To look at what type of information was yielded by diet diaries which had been completed and returned, in order to investigate the extent to which this tool is capable of capturing the variety of dietary behaviours relevant to developing dental caries.

3. To assess concordance between prevention pro forma and diet diaries as tools to assess self-reported sugar intakes.

7.4 Methods

7.4.1 Setting

This was a retrospective study of clinical records, was carried out in the department of paediatric dentistry at LUDH—a teaching hospital which provides secondary dental care to children referred from dental practice in the area. The children first seen for consultation, so that an appropriate treatment plan is designed. At this very initial visit, children who are identified as at high risk of dental caries are booked on a prevention appointment to receive preventive dental care. They also handed a 3-day diet diary to complete and bring back on the prevention appointment.

On the prevention appointment, the completed diet diaries are analysed and advice is given accordingly. Clinicians (undergraduate students supervised by dental staff, consultants in paediatric dentistry, or speciality trainee in paediatric dentistry) also routinely complete prevention pro formas (information of social and dental history and oral health behaviours) for all these patients as part of the process. The pro forma is used to collect information specifically about number of sugar intakes per day, whether the patient perceive his/her sugar intake is high or low and whether the patient usually consume sugars within one hour of their bed time. If the patient fails to complete the diet diary, then standard dietary advice is given. Following the completion of treatment at LUDH patients are referred back to their GDPs.

7.4.2 Sampling:

A random sample of records of children aged 5-11 years attended prevention clinics at LUDH between January 2010 and December 2013, was retrospectively evaluated. According to the hospital database, a total of 519 eligible children

attended during this period. Based on previous audit information from the paediatric dentistry department suggesting that 30% of these patients returned the diet-diaries, a sample size of 200 records was identified as sufficient to allow an estimate of the proportion of returned diet diaries to within 5%, given predicted 95% confidence intervals. Using record tracking codes, a random sample of 200 clinical records was selected. The existence of a prevention pro forma in the clinical record, was taken as an indicator that a diet diary had been issued.

7.4.3 Data extraction from clinical records

The new patient assessment form and prevention pro formas in case notes (Appendix F) were used to extract sociodemographic characteristics and oral health data on patients. The following information was retrieved: child's age, gender and post code of residence, number of siblings and parents in the household; and whether the grandparents lived with them in the same home; DMFT- dmft (number of decayed, missing and filled permanent and primary teeth); oral hygiene practices (tooth brushing was considered regular if reported to be twice or more per day); dental attendance (if patients reported a dental visit of any kind within the last 6 months, this was considered regular; if not, dental visiting was considered irregular); and self-reported dietary habits (frequency of sugar intake). Information on self-reported frequency of sugar intake behaviours was also extracted from the prevention pro forma. Post codes were used to identify the corresponding Index of Multiple Deprivation quintiles (IMD) (McLennan et al., 2011), ranging from Quintile 1 (the most deprived) through to Quintile 5 (the least deprived). Any completed diet-diaries included in clinical records were photocopied after anonymising the patient's identity.

7.4.4 Content analysis

A content analysis was applied to dietary information contained for all completed diet diaries (Hsieh and Shannon, 2005). This was a deductive content analysis (Elo and Kyngas, 2008), using a coding framework which had been previously developed from dental literature (Rugg-Gunn and Nunn, 1999, Moynihan, 2002, Touger-Decker and van Loveren, 2003, Watt et al., 2003, Morgan et al., 2009) and an earlier study involving GDPs responses to a diet diaries vignette (Chapter 6, table 6-1).

Content from the photocopies of diet-diaries was transcribed verbatim before transferred into NVIVO software-version 10, to facilitate coding and analysis. The coding framework used contained 11 aspects of dietary assessment previously identified (see chapter 6) to be potentially relevant to the giving of dietary advice by GDPs (Table 7-1).

To ascertain whether a food/drink item should be coded as harmful, or containing hidden sugars, information in the diary was supplemented by referring to UK food tables and nutritional labels on market websites. Each of the 11 aspects of dietary assessment was coded as being missing from the diary when there was either no description (defined as complete lack of relevant information) or insufficient description (defined as limited information rendering the data misleading or judgement impossible) contained in the diary for that aspect. In addition, the number of sugar intakes for each day was computed and the average number of intakes over the reported days calculated.

Data were coded by one investigator (Arheiam) and verified by another independent assessor for the first 15 (25.0%) of diet-diaries. Both assessors were qualified dentists. Cohen's kappa (κ) for each code was calculated to determine the

level of agreement between the two coders. There was strong agreement in most of the codes, $\kappa = (0.7 \text{ to } 1.00)$, $p \leq 0.05$, indicating a substantial to almost perfect agreement (McHugh, 2012), (Table 7-2).

Table 7-1: Categories and conceptual definition of the coding framework used in the content analysis

Code	Conceptual definition
Harmful items	Items were categorised as harmful based on their cariogenic potential. These are foods with high sugar content: sweetened dairy (yoghurt, milk drinks), confectionery (sweets, chocolate), cereals (Coco Pops, cereal bars), baked goods (cakes, biscuits), soft drinks and juice (sweetened carbonated beverages), and fresh as well as dried fruits (apples, banana, raisins).
Sugar Frequency	Possible to identify how many times per day the child was exposed to sugar/ acid items.
Sugar Amount	The quantity of sugar/ acid exposure per intake presented as number or portion size of items, servings or spoons.
Between meals sugars	A Meal defined as: An intake representing a substantial contribution of daily energy, comprised many food groups and more than one course including at least one savoury course. It usually requires preparation and eaten at recognised meal-times
Prolonged contact	A prolonged exposure to sugary/acidic items which involves the consumption of sticky food, slow intake and sipping of drinks. This included also sugary foods mixed with starch (e.g. bread)
Sequence	The order of items intake in each intake
Hidden sugars	Type of foods and brands with unseen sugar content and which have the potential of being perceived as sugar free or very low in sugar. (e.g. fruit juices, salad dressings, soups and ketchup, yoghurt, ready meals, marinades, chutneys and crisps)
Combination	Items eaten together which may aggravate or alleviate the cariogenic/potential of one of them
Context	The setting or the social event of sugar consumption
General diet	Unbalanced diet of poor nutritional value and irregular eating habits
Bed-time	Recording the time, the child goes to the bed is necessary

Table 7-2: Reliability of extracting dietary information relevant to oral health recorded from completed diet diaries (comparing 2 examiners)

Variable	Agreement	Cohens kappa
Harmful items	100%	1
Sugar Frequency	92%	0.83
Sugar Amount	100%	1
Between meals sugars	96%	0.88
Prolonged contact	90%	0.81
Sequence	96%	0.88
Hidden sugars	85%	0.71
Harmful items	100%	1
Combination	100%	1
Context	100%	1
General dietary issues	100%	1
Bed-time consumption	100%	1

7.4.5 Statistical analysis

Data management and statistical analysis of quantitative data were performed using statistical software SPSS Version 22.0. (Armonk, NY: IBM Corp.). Descriptive statistics were used to profile the study sample and to describe the return rate of diet-diaries. Comparisons across socio-demographic characteristics (age, gender, IMD quintile 1 vs quintiles 2-5, family size and parents in household), oral health related practices (tooth brushing and dental attendance) and dental caries experience (number of decayed, missing and filled teeth index of deciduous and permanent teeth) of the study sample were performed using the Chi-squared test and the Mann-Whitney U test. Unadjusted and adjusted logistic regression models were used to examine potential predictors of returning diet-diaries. A significance level of 20% in unadjusted analyses was used as a cut-off point to include variables in the adjusted model.

Quantitative content analysis of returned diet diaries was performed by simply counting the observations of each code defined in Table 7-1. Frequencies and proportions were then used to describe the prevalence of each code.

Nearly 25% of values related to family size and household parents, tooth brushing habits, dental attendance and self-reported sugar intake were found to be missing from prevention pro formas. Whilst a cut-off for the acceptable proportion of missing data in a data set that allow valid statistical inferences is not established yet, it has been suggested that missing more than 10% of data is likely to cause biased analysis (Dong and Peng, 2013). In order, to compensate for missing values, additional analysis using multiple imputations (MI) was performed. MI is defined as “a general approach to the problem of missing data that is available in several commonly used statistical packages. It aims to allow for the uncertainty about the missing data by creating several different plausible imputed data sets and appropriately combining results obtained from each of them” (Sterne et al., 2009). Five imputations (Allison, 2000), departing from the assumption that values were missing at random, were created using multivariate imputation and fully conditional specification method (Hayati Rezvan et al., 2015).

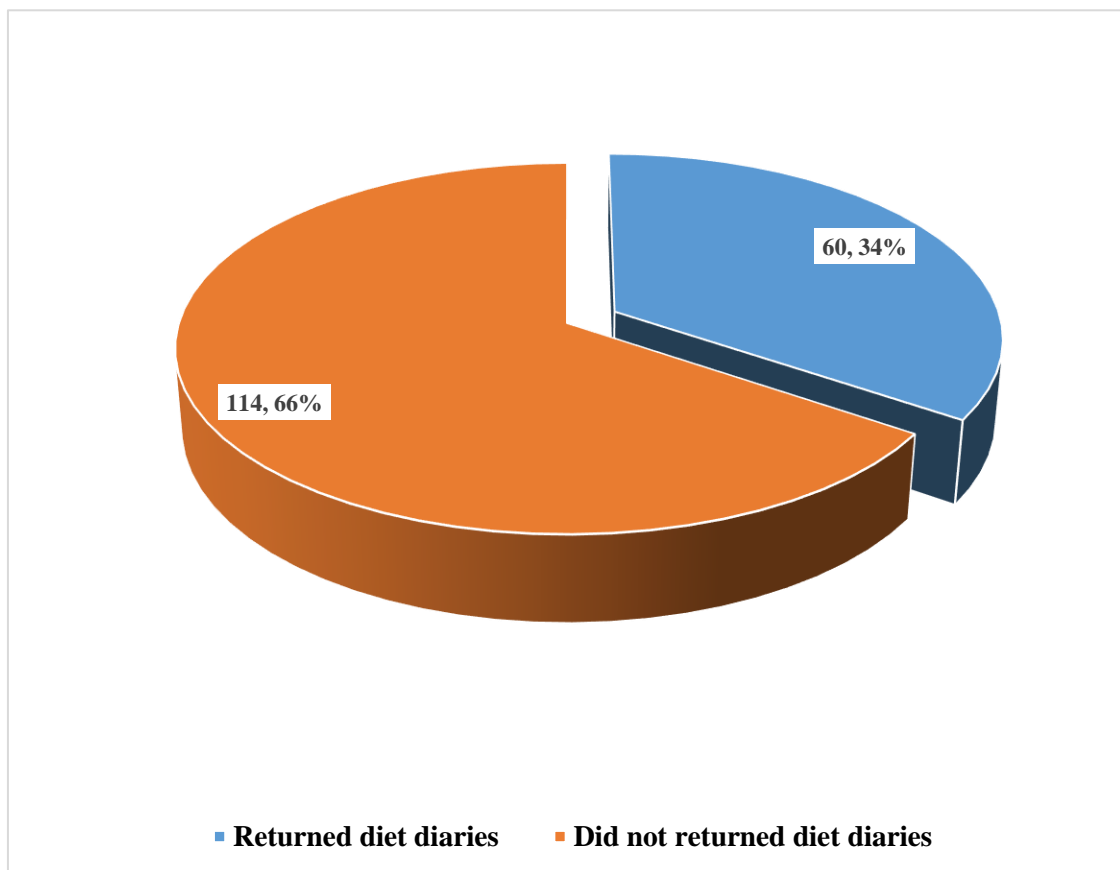
Information on self-reported frequency of sugar intake was the only information available to compare across prevention pro forma and diet diaries. A Bland-Altman plot was used to compare differences between measuring self-reported frequency of sugar intakes via diet diaries (average of 3 days) and prevention pro formas (Martin and Altman, 1986). This plot was constructed by plotting differences in measurements (prevention pro forma – diet diaries) on Y axis, against the means of each pair of measurements (prevention pro forma + diet diaries/2) on X axis. Limits of agreement were the mean difference between the two methods’ measurements ± 1.96

standard deviation of the mean difference. A weighted Cohen's kappa (κ) was used to investigate how the concordance of the two means of recording dietary information in categorising sugar intake of dental patients as low (≤ 3), threshold ($= 4$) or high (≥ 5) (Kalsbeek and Verrips, 1994, Holbrook et al., 1995, Sheiham, 2001).

7.5 Results:

Of 200 records sampled, 174 had prevention pro formas, and were included in the analysis. Figure 7-1 depicts the proportions of return rates of diet diaries according to the assessed clinical records. Diet diaries were found in 60 out of 174 records, giving a return rate of 34.4 % (95% confidence interval 27.4% to 41.6%)

Figure 7-1: Pie chart shows the distribution of patients returned diet diaries



7.5.1 Sample characteristics

The socio-demographic and oral health-related characteristics of the sample are shown in Table 7-3. The final study sample comprised records of children with a mean age 7.2 (± 1.69) and mean DMFT- dmft of 6.14 (± 2.78). Whilst the majority of the sample were from areas in the most deprived IMD quintile (121, 69.5%), the majority of the sample also regularly visited the dentist (129, 74.1%) and reported that they regularly brushed their teeth (132, 75.9%). The sample also had an even gender balance; with a roughly equal balance also, between single parent and dual parent households.

Table 7-3: Demographic and oral health characteristics of study sample (n=174)

Variables		N (%)
Gender	Male	82 (47.1)
	Female	92 (52.9)
IMD	Quintile 1	121(69.5)
	Quintiles 2-5	53 (30.5)
Perceived high sugar intake		120 (89.7)
Regular dental attendance		129 (74.1)
Regular tooth brushing		132 (75.9)
Parents in household ¶	Single parent	66 (50.4)
	Both parents	65 (49.6)
		Mean (SD)
Family size ¶		3.2(1.1)
Age		7.2 (1.7)
DMFT- dmft (decayed, missing and filled teeth)		6.1 (2.8)

¶ N=131, IMD denotes Index of Multiple Deprivation Quintiles, DMFT- dmft means decayed, missing and filled permanent and primary teeth

7.5.2 Return rate of diet diaries and its associated factors

Table 7-4 shows difference in the return rate of diet-diaries by demographic and oral health characteristics of the study sample. No significant differences were

observed with respect of children’s gender, dental attendance, and perception of high sugar intake. Statistically significant differences were found in relation to regular brushing habits and family size. Higher return rates were observed among children who reported regular teeth brushing habits (p=0.016) and those from small families (p=0.035). These differences disappeared in the adjusted multiple regression models including covariates showing significant level ≤ 0.2 (caries experience and whether a single or both parents in the household). Yet, when the multiple imputations were applied to compensate for the missing data, adjusted models showed that regular brushers were more likely to return diet-diaries (Table 7-5).

Table 7-4: Differences in the return rate of diet diaries according to sociodemographic and oral health characteristics of the study sample (n =174)

Variable		Returned N=60	Not returned N=114	p value
		N (%)	N (%)	
Gender	Male	29(47.5)	53 (46.9)	0.936
	Female	31 (52.5)	61 (53.1)	
IMD [¥]	Quintile 1	39 (65.0)	82 (35.0)	0.345
	Quintiles 2-5	21 (71.9)	32 (28.1)	
Perceived high sugar intake		41 (71.8)	79 (79.8)	0.265
Regular dental attendance		44 (73.3)	84 (74.6)	0.860
Regular tooth brushing		52 (86.7)	80 (70.2)	0.016*
Parents in household [¶]	Single parent	24 (58.5)	42 (41.5)	0.144
	Both parents	17 (46.7)	48 (53.3)	
		Mean (SD)	Mean (SD)	
Family size [¶]		3.0 (1.1)	3.37 (1.1)	0.035*
Age		7.1 (1.7)	7.03 (1.6)	0.873
DMFT- dmft		5.7 (2.7)	6.36 (2.8)	0.109

Chi-squared test and Mann-Whitney U test were used to compare study sub-groups.

* $P \leq 0.05$, statistically significant, ¶ N=131, ¥ IMD denotes Index of Multiple Deprivation Quintiles, DMFT- dmft means decayed, missing and filled permanent and primary teeth

Table 7-5: Multiple regression analyses of sociodemographic and oral health predictors of diet diaries return rate (n =174)

Variables		Unadjusted models	Adjusted models	Adjusted model after imputations (Pooled)
		OR (95% CI)	OR (95% CI)	OR (95% CI)
Gender	Male	Reference	--	--
	Female	1.0 (0.6, 1.9)	--	--
IMD [¥]	Quintile 1	Reference	--	--
	Quintiles 2-5	1.4 (0.7, 2.7)	--	--
Perceived sugar consumption	Low	Reference	--	--
	High	0.6 (0.3,1.4)	--	--
Dental attendance	Irregular	Reference	--	--
	Regular	1.01 (0.5, 2.2)	--	--
Teeth brushing	Irregular	Reference	Reference	Reference
	Regular	2.4 (1.1, 5.4) * [†]	1.9 (0.7, 4.9)	2.7 (1.1, 6.3) *
Parents in household [¶]	Single parent	Reference	Reference	Reference
	Both parents	0.6 (0.3,1. 2) [†]	0.9(0.4, 2.2)	1.0 (0.8, 1.1)
Teeth brushing Irregular		Reference	Reference	Reference
Family size [¶]		0.7 (0.5, 1.0) * [†]	0.7 (0.5, 1.1)	0.8 (0.5, 1.1)
Age		1.0 (0.8,1.2)	--	--
DMFT- dmft		0.9 (0.8, 1.0) [†]	0.98 (0.85, 1.1)	0.9 (0.8, 1.1)

* $p \leq 0.05$, Statistically significant [†] $P \leq 0.2$, eligible for inclusion in adjusted models

-- Not included in the adjusted models, [¥]IMD means Index of Multiple Deprivation quintiles

DMFT- dmft means decayed, missing and filled permanent and primary teeth

7.5.3 Diet diaries yielded types of information

Table 7-6 displays the findings of the content analysis of the sixty returned diet diaries. It was possible to identify consumption of ‘harmful items’ in all diaries, and also the frequency and between-meals consumption of sugars, as well as general aspects of the diet, from more than 90% of diaries. However, information on the

sequence of food/drink consumption could not be elicited at all, and information on sugar amount and prolonged contact with teeth could only be identified from just over half of diaries. The least frequently extracted information was the context of the intake (17, 28.0%) and whether the consumption was near bed-time (18, 30.0%).

Table 7-6: Frequency of information extracted from completed diet diaries (n=60)

Information type	N (%)
Harmful items	60 (100.0)
Sugar Frequency	56 (93.0)
Sugar Amount	32 (53.0)
Between meals sugars	56 (93.0)
Prolonged contact	34 (57.0)
Sequence	0 (0.0)
Hidden sugars	50 (83.0)
Combination	48 (80.0)
Context	18 (30.0)
General dietary issues	56 (93.0)
Near bed-time	17 (28.0)

N= Number of diet diaries with this information

7.5.4 Concordance between methods of measuring sugar intake frequency

Data from 39 cases that had information on the self-reported frequency of sugar intake in both prevention pro forma and diet diary, was compared to investigate the concordance between the two methods in measuring the frequency of sugar intake. Displaying this comparison using a Bland–Altman plot (Figure 7-2) shows a relatively small mean bias (-0.5, SD=1.95) and wide limits of agreement (3.2, - 4.3). A sample t test of this mean bias was not statistically significant, p=0.092. The graph indicates that the difference between the two methods increases as perceived frequency of sugar intake increases. The linear regression model of the difference and mean frequency of

sugar intake shows that there is a statistically significant proportional bias ($p \leq 0.001$), with more data points below the mean difference line (solid grey line).

Figure 7-2: A Bland-Altman graph shows an overview of difference between prevention pro forma and diet diaries as a measure of sugar intake frequency, with mean differences (solid lines) and 2 limits of agreement (dashed lines)

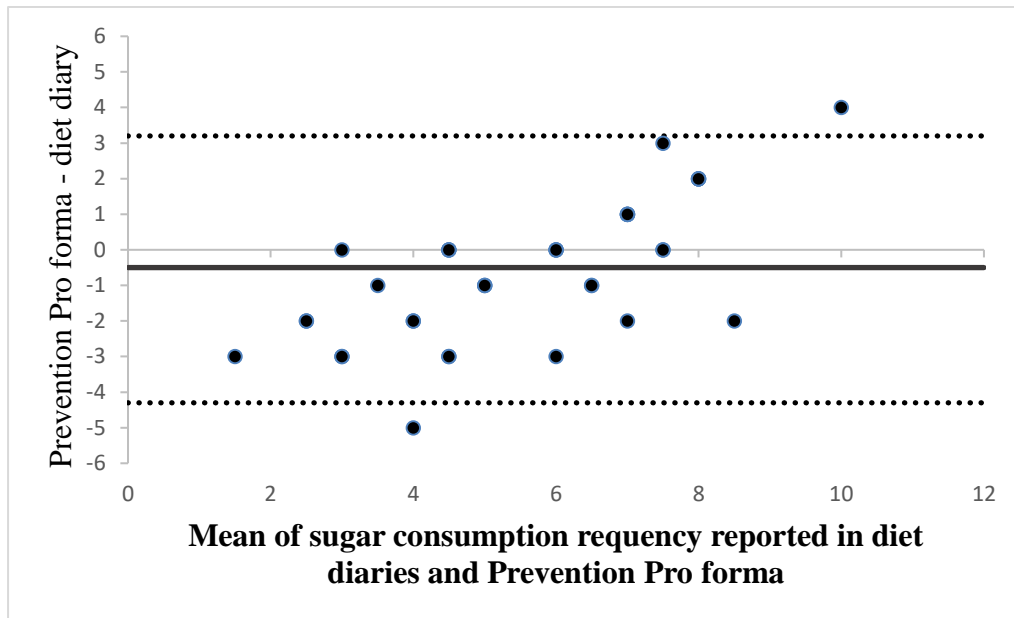


Figure 7-3 shows the distribution of patients categorised as having low, marginal or high frequency of sugar intakes, according to diet diaries and prevention pro formas. The prevention pro forma categorised more patients as having low sugar intake (19) than did the diet diary (9). Just above half of patients (20) were considered as having marginal number of sugar intakes, using the diet diary method, whereas prevention pro forma categorised only 8 patients in this group.

Figure 7-4 shows the distribution of agreement between the two methods in each category of sugar intake. Perfect agreement was observed in a total of 14 patients. The majority of them were in low sugar intake category (8). Agreements on marginal and high sugar consumption were equally observed in 3 patients. Poor concordance of the two methods was indicated by Cohen's kappa of 0,087, $p = 0.234$.

Figure 7-3: Bar chart comparing the distribution of dental patients' sugar intake frequency as low, marginal or high as measured using prevention pro forma and diet diaries (n=39)

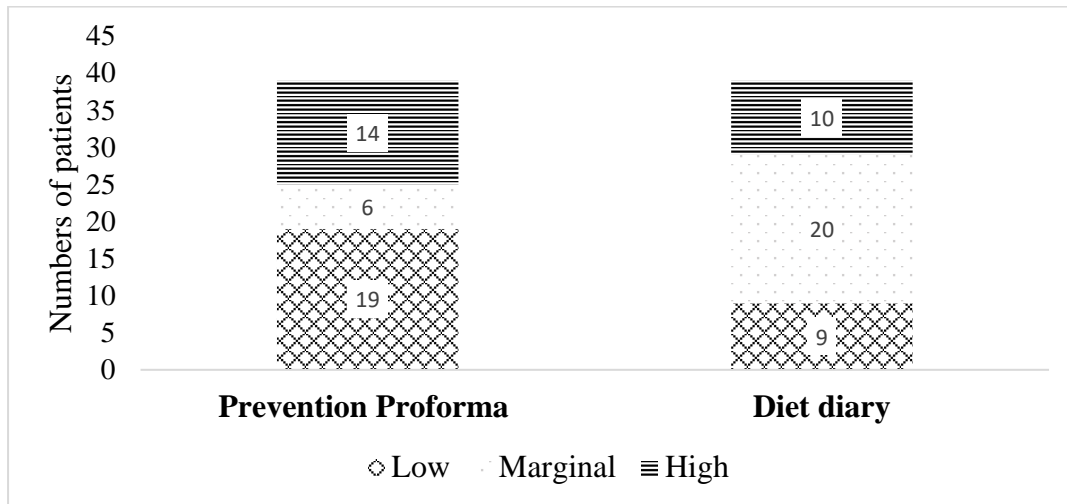
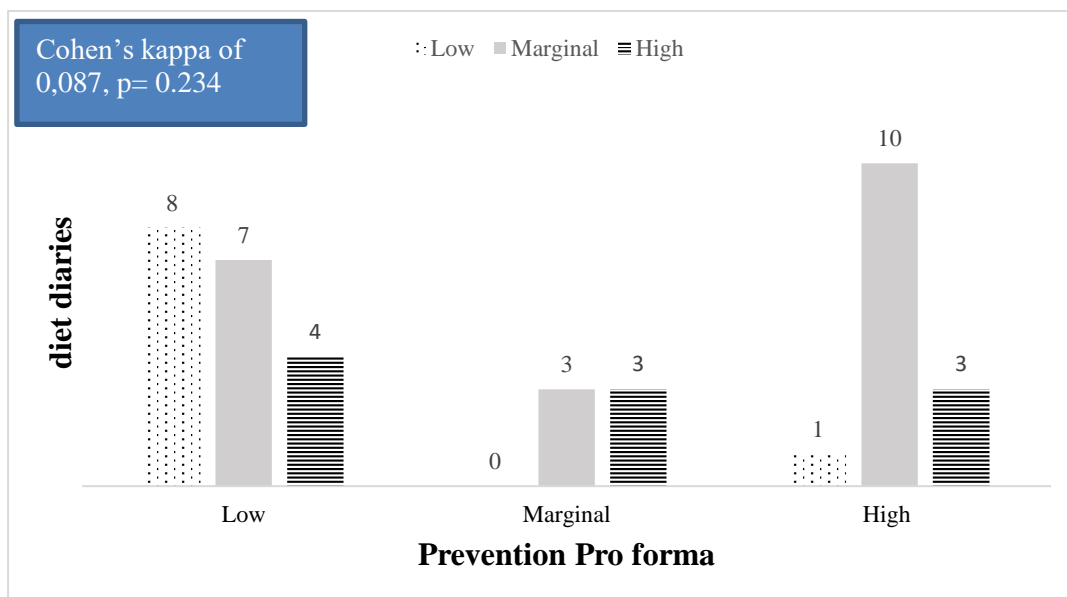


Figure 7-4: Bar chart depicting the concordance between prevention pro forma and diet diaries in categorising patients as low, marginal or high sugar consumers (n=39)



7.6 Discussion

To the author's best of knowledge, this is the first study which reports how often paediatric dental patients return diet diaries with associated analyses. This study

shows that a relatively low proportion of diet diaries were returned (60, 34.5%). This also accords with a previous estimate of 30% arising from clinical audit in the setting and my earlier observations (Chapter 5), which showed that GPs perceived patients' adherence to diet diaries to be poor and hindering their use of diet diaries. Taken together, this research suggests that even in a dental hospital setting where NHS remuneration is not an issue, other factors related to the patients still impeding the use of diet diaries to tailor an effective diet advice.

The low return rate of diet diaries observed in this study, may also have something to do with the fact that the majority of records included in this study belonged to patients from the poorest end of the SES spectrum. Given that diet diaries are found to be the least preferred method of dietary assessment by people from low SES backgrounds when compared with other diet assessment methods; owing to low literacy, numeracy and language skills (Holmes et al., 2008), this comes as no surprise.

However, this study's data indicates that the return rate of diet diaries is also associated with other patient characteristics. Children who reported regular teeth brushing and those from small families, were more likely to return diet diaries. Since regular tooth brushing is a sign of the patient's and parents' motivation and positive attitudes towards oral health; and a smaller family size probably indicates that these families may have more time to complete a diary task; collectively the findings suggest that many of those children/ parents who would benefit from detailed dietary advice for caries prevention, lack the necessary motivation and time to use diet diaries.

A second objective of the study was to examine the quality of information yielded by completed diet-diaries, which are related to dietary behaviours relevant to developing dental caries. In respect to this, the content analysis of returned diet diaries showed that diet diaries did not consistently capture the full range of complexities

relevant to giving dietary advice to dental patients. Information on sugar amount, consumption context, sequence of intake within meals, prolonged contact with teeth and sugars consumed near bedtime - all of which are recognised as being detrimental to developing dental caries (Moynihan, 2002, Touger-Decker and van Loveren, 2003, Watt et al., 2003), was partially or completely missing from the returned diaries.

It could be argued that what would happen in clinical practice in the event of such uncertainties is that the GDP would probe for this missing information during a chairside discussion of the diary with the patient. However, relying on further probing effectively compromises the prospective nature, temporal proximity of recording and accuracy of recording dietary intake, which are all, considered to be the major strengths of diet diaries usage (Thompson and Subar, 2013).

Most striking on the list of missing information, is that *amount* of sugar consumed could not be extracted from many diaries. This comes as a surprise given that the current national guidance of dental prevention ‘Delivering Better Oral Health’ (DBOH) articulates this consideration as one of the main dietary messages which should be covered when giving advice (Public Health England, 2014a). This is of particular concern given very recent evidence which indicates that dietary sugars amount may be more important factor related to caries development, than frequency of sugar intake (Bernabé et al., 2016).

Identifying ‘hidden sugars’ in the diet is another key objective of dietary counselling (Public Health England, 2014a). It is noteworthy that although ‘hidden sugars’ were identifiable in most of the diaries, in this study, extraction of data from diet diaries allowed the use of additional sources such as food tables where hidden sugars/harmful dietary items required clarification. A GDP undertaking a chairside

interpretation of diet diaries would probably not be realistically able to also drawn on these additional resources.

The third objective of this study was to compare the differences in measuring the frequency of sugar intakes between two methods of written assessment- diet diaries and prevention pro forma. Although the difference bias was found to be relatively small and inconsistent, wide limits of agreement and proportional bias were observed. The differences in measurement tend to be higher when the mean number of sugar intakes, obtained from both methods, is high, with the prevention pro forma generally under-reporting the number of sugar intakes obtained compared to diet diaries. In addition, poor concordance between diet diaries and retrospective measurement using the prevention pro forma, in categorising the level of sugar intake was observed in this study.

No previous studies can be found that directly compare diet diaries with retrospective measures of sugar intake in dental clinical settings. However, previous epidemiological studies comparing dietary assessment methods have shown contrary findings and have suggested that retrospective measurement (for example using food frequency questionnaires) resulted in over reporting of sugar consumption when compared with prospective dietary assessment methods (Kiwanuka et al., 2006, Amaral et al., 2014). The findings of this study support the notions that dietary assessment is a challenging task (Burrows et al., 2012), and that any attempt to measure dietary intake in dental practice may result in estimates rather than a true version of dietary intakes (Johansson, 1993). In addition, it is well recognised from dietary assessment research that all self-report methods are prone to bias (Thompson et al., 2010a).

This study therefore suggests that while prevention pro formas represent a time-efficient tool to assess sugar consumption, they do not appear to be a valid substitute for diet diaries. The two methods classify dental patients into different categories of caries risk, which may eventually put patients on different routes of care. On the other hand, there is no guarantee that diet diaries are any more valid. One striking finding in this study was that when using diet diaries, a higher proportion of patients reported low or a marginal-number of sugar intakes than when they were asked to recount their usual intake while completing the prevention pro forma. While acknowledging this observation as an area of future research, it could be the result of a social desirability bias (The prevention Pro forma being not only a semi-structured question format, but essentially delivered in face-to-face interview). The parents might be aware of the maximum allowed number of sugar exposures per day (≥ 4), and hence they tend to provide an ideal account to avoid any negative feedback (Vuckovic et al., 2000). Although this remains an assumption and this finding is based on small amount of data, since patient's honesty is a well-recognised condition for the successful use of diet diaries in the dental care setting, this is a concern.

One of the drawbacks of any retrospective analysis is that these studies are often unable to address why patients choose to act in particular ways (Nicholls, 2006). In this study, it was impossible to figure out why patient didn't complete or return the diet diaries or chose not to do so. Inferences from study findings are also partly limited by missing data which are inevitable in this type of study (Gearing et al., 2006). Some case notes were excluded from the final analysis because they did not contain the prevention pro forma, and this effectively reduced the sample size a little. Yet, a precision rate of $\pm 6\%$ for diet diaries return rate was achieved from this study sample. Additional uncertainty arises from the assumption that have been made that completion

of the prevention pro forma meant that a diet diary had been issued. However, there is no independent verification of this and so this should be borne in mind when interpreting findings.

7.7 Summary and implications

To sum up, the return rate of diet diaries by children and their families in a dental hospital setting is low, and appears to be associated with patients' demographic and oral health maintenance habits. This finding is rather intriguing and draws attention to the probable patient related barriers of diet diaries use given that the study was conducted in a dental setting where NHS remuneration was not an issue. There are still many unanswered questions as to why children and families do not complete and return diet diaries.

Returned diet diaries showed a varied range of frequently missing, important dietary information. This included the amount of sugar consumed which is one of the main aspects of the diet recommended to be covered by dentists, and thus effectively compromises the validity of diet diaries as a diet assessment tool for everyday clinical practice. Also, differences in reporting the frequency of sugar consumption was observed between diet diaries and a prevention pro forma used, with indications of socially desirable responses obtained from diet diaries. All of this then raises questions as to whether diet diaries as a tool is the most appropriate means to support caries prevention for groups most in need of advice.

Chapter 8. Factors affecting adherence to diet diaries issued to paediatric dental patients in a hospital setting (Study IV)

8.1 Introduction

This chapter presents a qualitative study that explores the issue of adherence to diet diaries in a dental setting. The study involves multiple case studies of child/parent dyads received diet diaries as part of preventive dental care provided to children at high risk of dental caries. This chapter starts with a background presenting the rationale of conducting the study. Objectives, methods, and results are described in the sections that follow. Finally, discussion and conclusion are then provided. This study is related to the following research questions posed at the outset of the thesis (Page 43):

- II. What are the strengths and weaknesses in the way diet diaries are currently used in dentistry?
- III. Should the current format and procedure be modified to more effectively provide a monitoring tool?

8.2 Background

It has been demonstrated throughout this thesis that patients' non-adherence hinders the appropriate use of diet diaries in dental practice. In the general literature, non-adherence is identified as taking many forms; from carrying out the task incorrectly (for example; not keeping a contemporaneous diet record), overlooking parts of it (for example: only providing few details), to not doing the task at all (Jin et al., 2008). Earlier in this thesis it was shown that all of these issues are relevant to the completion of diet diaries by dental patients. The retrospective analysis of clinical records, reported in chapter 7 identified that as many as 65% failed to adhere at all when a diet diary was issued, with 35% return rate of diet diaries. I also found that

partial adherence was manifested in a range of missing important information in diet diaries which were returned. Therefore, the issue of poor adherence is an important one to explore in the context, especially since the reasons for poor adherence are not known at present.

Several reasons for non-adherence to diet diaries have been reported in studies assessing the use diet diaries as an assessment and monitoring tool in nutritional and behavioural research settings where diet diaries are commonly used (Glanz et al., 2006, Knudsen et al., 2011, Gondolf et al., 2012, Thompson and Subar, 2013). These include but are not limited to: the patient having a lack of motivation or skills to complete the diary task, the task itself of keeping a diet diary being too labour intensive (leading the respondent to provide incomplete details; to ignore complicated details or to complete the diary retrospectively). However, this knowledge comes from studies carried out in research settings rather than clinical settings. To author's best of knowledge there have been no such studies exploring the use of diet diaries as part of patient care including dentistry. There may be different whys and wherefores distinctive to the clinical setting; the clinician-patient relationship, for example, has previously been shown to be influential on patient's adherence to suggested treatment plans (Kardas et al., 2013).

Chapter 5 identified that dental practitioners use diet diaries most often for children (section 5-5-6). Moreover, in this chapter (table 5-7) it was reported that practitioners' motivation to use diet diaries in part driven by the remuneration system. Therefore, this study aims to address this research gap by closely investigating the complexities of the phenomenon of patients' non-adherence to diet diaries in a dental teaching hospital setting where a remuneration is not an issue and diet diaries are routinely used as part of preventive dental care for children at high risk of developing dental caries.

8.3 Study IV objectives

1. To explore what influences adherence to diet diaries from the user's (parent/child) perspective.
2. To explore dentists' experiences of using diet diaries in the dental setting, and to understand their perspectives of reasons for child/parent adherence/non-adherence.
3. To explore interactions between dentists and patients where diet diaries are used in a dental clinical setting, in order to understand how the context of issuing and analysing diet-diaries may influence adherence.

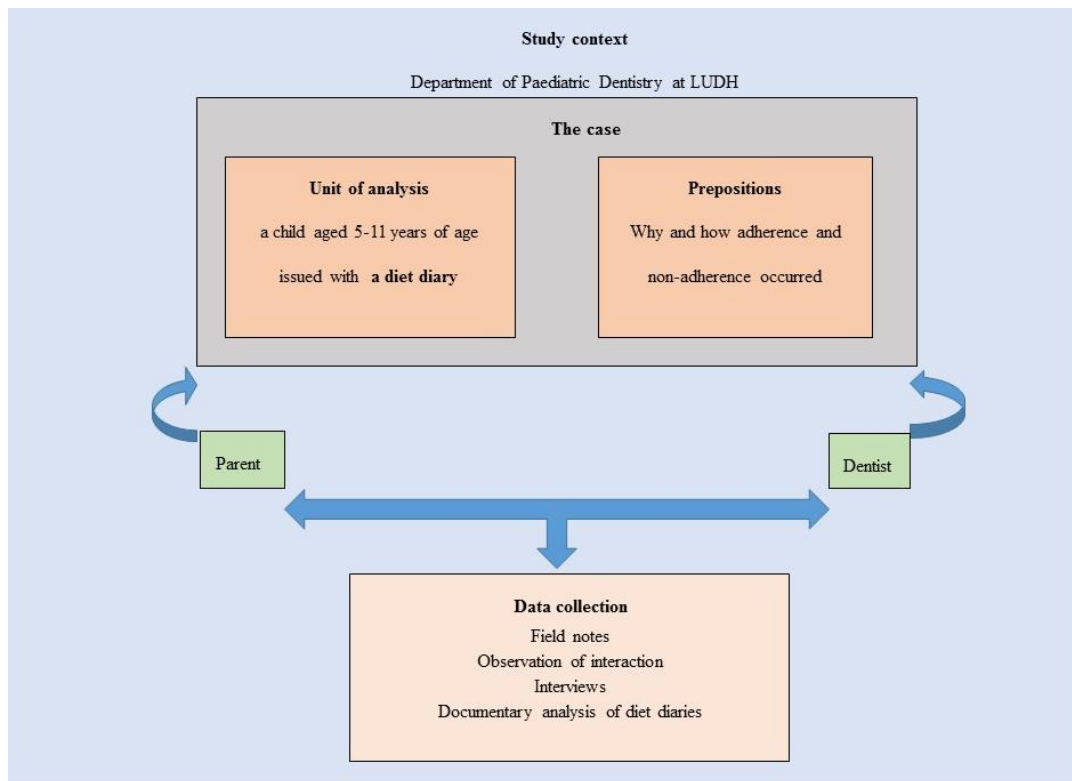
8.4 Methods

8.4.1 An overview of study design

A qualitative rather than quantitative approach was used to fit the exploratory nature of the study. Qualitative case study design (Chapter 4, section 4-4) was used. A case study design was chosen because it enabled an in-depth assessment of a phenomenon in its real life context, using various sources of evidence (Yin, 2014, Merriam and Tisdell, 2015). In case study methodology, the case is defined by the 'unit of analysis' (which can be an individual, group, organisation, or event), and a 'proposition' (which is a description of what the case study is trying to find to answer the research questions). The unit of analysis in this study was the issuing of a diet diary to a child aged 5-11 years of age. Sources to explore this 'case' were therefore: interview data from dentists and from parents/children, observational data from the interaction between the parties at the appointment where the diet diary was given and documentary analysis of the diet diary itself. The propositions were the 'how' and 'why' non-adherence and adherence occurred.

Multiple cases were involved using a collective case study design, wherein several cases are jointly studied in order to form a combined understanding of the phenomenon of interest (Stake, 2000). Therefore, analysis involved integration of the multi-perspective analysis of one diet diary and its set of interactions with others (Figure 8-1).

Figure 8-1: An overview of case study design



8.4.2 Setting

This study was carried out in the Department of Paediatric Dentistry situated in LUDH which provided secondary and tertiary dental care for children referred from dental practices and community dental services. A detailed description of the setting and diet diaries provision process has been given in section 7.4.1(Chapter 7). In summary, diet diaries are administered to children who are identified at high risk of developing dental caries (have active dental caries), as part of preventive protocols at LUDH. The diet diary is handed to the child/parent in their first visit to

complete and bring back on the subsequent appointment where preventive dental care including dietary advice has to be provided by different grade of staff and dental students supervised by clinical instructors.

8.4.3 Preliminary work

Prior to study commencement, permission to access the study site (LUDH) was gained from the appropriate authorities, see section 4-5-1 (Chapter 4). To better understand who, how, when and where diet diaries are issued and analysed, the researcher made a couple of visits to explore the setting and the processes of providing preventive dental care and issuing the diet diaries. The investigator then performed on-site observations and preliminary discussions with the team to inform them about the planning of participants' recruitment and data collection procedures.

8.4.4 Sampling and recruitment

The sample in qualitative studies is determined by the number of cases needed to arrive at a consistent interpretation of the phenomenon of interest, also known as data saturation (Bowen, 2008). In multiple case studies Yin (2014) identifies at least 2 cases are required although cases are recruited until a level of data saturation is reached and this is considerably more. A purposeful sample of child/parent dyads was recruited between February and June 2016, at the unit of paediatric dentistry in LUDH. Only those aged between 5 and 11 years of age, who had active dental caries and had been given appointments with staff members to complete a course of treatment were included in this study. The appointments structure within the hospital is such that all those referred for the management of dental caries attend undergraduate prevention clinics. This was deemed inappropriate for the study, and hence children with dental caries were recruited

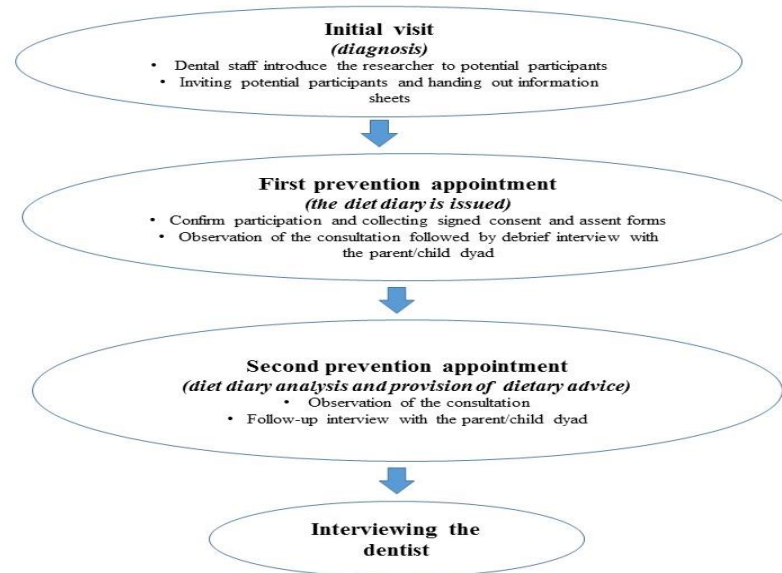
whether or not dental caries was their primary complaint. Exclusion criteria required children to be booked for a prevention appointment for reasons other than dental caries, or assigned to undergraduate dental student's clinics.

Participants were recruited during their initial consultation visit to LUDH (Figure 8-2). Eligible participants were identified by a consultant in Paediatric dentistry (SA) who is a member of the supervisory team. After explaining the aim of the study and taking a permission from the child/parent, the paediatric dentistry consultant introduced me to the potential participants where I further explained the study procedures and handed out study information sheets to the parent/child dyad. No diet diaries were provided at this initial consultation in order to fulfil the ethical requirements of this study which requires that the participants should be given enough time to decide whether or not they will take part. As those patients required a course of treatment this did not affect the overall number of visits to the hospital. The next appointment, I approached the potential participants who were asked to confirm that they were happy to participate in the study. If this was the case, signed consent and assent forms were obtained from parent/guardian and their children, respectively, before commencing data collection. Similarly, permissions and informed consents were obtained from the dentists involved in issuing and analysing the diet diaries.

8.4.5 Data collection

The data was collected and triangulated by using a sequence of non-participant observations supported with field notes, semi-structured interviews, and a document analysis of completed diet diaries (Figure 8-2).

Figure 8-2: Flow chart of participants' recruitment and data collection



8.4.5.1 Observations

Two sets of non-participant observations of dentist-patient encounter were undertaken for each case in order to capture dentist-patient interactions in relation to the use of diet diaries. The first being at the time when diet diary was issued and the second when the dietary advice was given (in the subsequent appointment). The observations were supported by field notes and memos written by the researcher who was physically present at the research site to systematically collect pertinent contextual data. The whole of these two encounters were also audiotaped. Field notes were recorded using semi-structured form which included basic information such as date, time, and the child's name and age. The form also captured the sequence of events and nonverbal data which could not be audiotaped (Appendix G). Shortly after the observation, the researcher also wrote a memo summarising their reflection on the encounter, and which contained other details which might not have been recorded earlier using the field note template. The focus of the observations was

based on the relevant study objectives (Merriam and Tisdell, 2015), and the following lines of enquiry:

- Who is taking part in this interaction (actors)?
- What are the actions these people do and in what context (activity)?
- What is happening in the setting and in what sequence?
- Non-verbal expressions

8.4.5.2 Interviews

Two in-depth semi-structured, face-to-face interviews were carried out with child/parent dyads and dentists. While the intention was to gather patient perspective from both the child and parent, and also together, in practice it was difficult to interview the child because of the tendency for parents to dominate the conversation. The patient's perspective could only be obtained from the parent and therefore the word '*patient*' in this chapter essentially refers to the parent's perspective.

The first interview took place immediately after first observation when patients first received the diet diaries (Figure 8-2). This interview was designed to focus on patient's thoughts and feelings towards diet diaries. It took place away from the clinical environment where the clinicians could not overhear the discussion. A follow-up interview was arranged with the patient for the subsequent appointment where they returned the diet diaries to be discussed. The second interview aimed to explore child and parent's experiences of using diet diaries and the reported reasons for poor adherence, if this was the case. A separate interview was arranged with the dentists who were involved in the study, at some time later after completing the preventive care visits. This interview aimed to reflect on the clinician's experience of using diet diaries. The interview also explored particular issues that emerged from observations and

interviews with child/parent dyads. Although this might be viewed as limited by difficulties in recalling specific events, clinicians appeared to be able to recall details of various consultations relatively easily.

All interviews were audio- recorded and undertaken in a quiet non-clinical setting. Each interview took between 30 to 45 minutes. Topic guides were used for each interview (Appendix F), which were modified iteratively after each interview/observation and throughout the study to accommodate observations from the diaries or in the interviews. No particular order of questions was followed, allowing the participants to freely connect different topic areas.

Since the interviewee responses may be affected by how they perceive the question or interviewer's characteristics such as gender, age, and ethnicity and the sensitivity of the research topic (Denscombe, 2014), after the first interview, a discussion was held with the primary supervisor to reflect on the transcript and how the questions can be better phrased and probing strategies be used. This aided the process of reflexivity which is an important ingredient in high quality qualitative research (Mays and Pope, 2000, Malterud, 2001). Social desirability is another possible downside of interviews. The purpose of the research and confidentiality of information were clearly stated at the beginning of the interview which intended to put the interviewee at ease and to establish good rapport.

8.4.5.3 Documentary analysis

Returned diet diaries were photocopied and transcribed verbatim to be analysed for any issues related to the contextual data collected from interviews and observations of dentist-patient interactions.

8.4.6 Data analysis:

All data sources were uploaded into Nvivo 10 software and organised according to 'case'. This included all interviews, observations, field notes and memos. The audio-records were transcribed verbatim as soon as they were collected, by a specialist audiotaping transcription-company. Thematic analysis (TA) was performed to analyse interviews, observations, field notes and memos (Braun and Clarke, 2006).

Although the aim of the TA, was to provide a detailed and a collective account of the whole dataset rather than focusing on a particular case, the analysis was performed on a case-by-case basis in an iterative inductive-deductive process to develop a preliminary coding framework. As the analysis progressed the preliminary framework was refined and adjusted according to the emerging themes that were then explored in the subsequent interviews and observations and further refined in the analysis. Thus, analysis was undertaken concurrently with data collection. Constant comparison across the cases and across different sources of data was applied so that emerging themes were based on converging the interpretation of all sets of data.

The TA started with 'Familiarisation stage which involved listening to the audiotapes, reading, and re-reading of the manuscripts and field notes, to become immersed in the data and to gain an overview of ranges and diversities of the gathered material. Before coding the themes using the NVIVO system, hand highlighting of key ideas was carried out on hard copy for all the transcripts, field notes and completed diet diaries, so that potential codes and themes could be identified. This paved the way for a second stage of analysis which was the generation of initial codes.

Once a preliminary coding framework had been generated, a textual index of codes and labels was checked for validity by the wider research team. Initial codes were then systematically applied to all transcripts for one case at a time until all data

has been assigned suitable codes. Only data that showed a relevance to research questions were coded.

The analysis progressed in an iterative way as a cross-case comparisons were undertaken, and new data added. New codes were identified and older ones were changed or refined. Validity of analysis was assumed by involving a second experienced qualitative researcher (non-dental) in the analysis who questioned and discussed the interpretation of the developing coding scheme. As the analysis progressed, a discussion was held with the second researcher to remove unsupported themes, create new themes, collapse homogenous themes, and split heterogeneous ones. Analysis and data collection finished when new data did not alter the coding system substantially but confirmed previous analysis. Finally, the themes were organised into overarching fewer themes. Producing the report was the final place of analysis where data extracts were selected to be presented and related back to the research story and supported by evidence from literature.

The analysis was performed at an interpretive level rather than simply describing the surface meanings within data. While the analysis can be classified as thematic analysis, it incorporated some elements of grounded theory approach such as inductive approach, constant comparison, analysing immediately, memo writing and theoretical saturation (Sbaraini et al., 2011).

8.4.7 Rigour and trustworthiness of qualitative analysis

Strategies to ensure the reliability of the findings and to establish criteria for trustworthiness and rigour in qualitative research were applied (Mays and Pope, 2000, Shenton, 2004). Systematic procedures were used and a comprehensive description of data collection and analysis methods was provided to allow transparency in the methodology and reproducibility of the study. Another researcher, with a sociology

background, was involved in discussing the emerging coding system and analysis to guard against the bias from a single researcher. The coding framework with sample sections of data was also discussed with a multidisciplinary team involving 4 people with a range of backgrounds.

8.5 Results

8.5.1 Informants' profile

In this section, the distribution of data sources and the profiles of the study informants (child/parent dyads and dentists) is described. Pseudonyms are given to each informant dentist whereas child/parent dyads were identified using a case number. Six child/parent dyads (cases) and three dentists were involved in this study.

The analysis is based on 11 observations of dentist-patient interactions (6 observations while diet diaries were being issued, and another 5 observations during the follow-up appointments -analysis of diet diary and the delivery of dietary advice), 12 interviews (5 initial interviews, 4 follow-up interviews with the child/parent dyads and 3 interviews with dentists) and document analysis of three completed diet diaries (Table 8-1).

Table 8-1: Summary of data sources collected from the six cases included in the analysis.

Case	Data sources					
	Interview 1	Interview 2	Diet diary	Dentist interview	Observation 1	Observation 2
Case 1	√	X	√	√	√	√
Case 2	√	√	X	√	√	√
Case 3	√	√	√	√	√	√
Case 4	√	X	X	√	√	X
Case 5	X	X	X	√	√	√
Case 6	√	√	√	√	√	√

The next section presents narrative description of cases and dentists:

Case 1: The child was an 11-year-old male. Accompanying him was his mother. The mother was of Middle Eastern origin and worked as an interpreter. The child had two younger sisters and lived with both parents in South Liverpool. Delayed eruption of teeth was the primary cause for referral to the dental hospital, although recently he reported suffering from dental pain that had been diagnosed with dental caries. (*The parent was not able to attend the follow-up interview*).

Case 2: The child was an 11-year-old male who attended the clinic with his father who is originally from South Asia. He worked as a doctor. His mother was also a doctor. The child lived with his parents and two twin younger brothers in an area near Liverpool. The reason for GDP referral was because of crowded teeth and the need for specialist care to place a space maintainer for a primary tooth that required extraction because of dental caries.

Case 3: The child was a 9-year-old female who lived with her older sister and both parents, near Liverpool. The parents were originally from Ireland. At the first appointment, the child came with her father who works for a commercial company whereas in the follow-up appointment her mother, who worked in the education sector, accompanied her. The GDP referred the child to the LUDH because of post-traumatic discoloration of her anterior permanent tooth but she was also diagnosed with dental caries in her primary teeth.

Case 4: The child was an 11-year-old male who came to the Dental Hospital with his mother. He lived with his twin brother, older sister and both parents in an area near Liverpool. The mother is a teacher and the father worked as a director in a commercial company. The child was primarily referred to the LUDH because of delayed eruption of his anterior teeth but on examination found also to have dental

caries in her primary teeth. (*The patient failed to attend the second appointment and hence follow up interview and 2nd observation, were not performed*).

Case 5: A 9-year-old female child who lived in Liverpool with her parents and younger brother. She came to the appointments with her mother who worked in marketing sector. The child was referred to the LUDH because of mal-aligned teeth. The child was also found to have dental caries. (*The parent was not able to attend the interviews because she had no time*).

Case 6: A 9-year-old male who lived with his younger brother and both parents in Liverpool. He was accompanied by his mother who reported working in marketing. The child was originally referred to the LUDH because of a mal-aligned lower anterior tooth. The child was also found to have dental caries.

The following section presents narrative description of dentists (pseudonyms were used for anonymity purposes):

William: Male English dentist who has recently graduated (within the last five years). Since graduating he has completed a foundation year in general dental practice, and worked as a Dental Core Trainee (DCT) at LUDH. He was a speciality trainee in paediatric dentistry.

Karen: A female English dentist who has recently graduated (within the last five years). Since graduation, she has worked as a dentist in a general dental practice, a Dental Core Trainee (DCT) at LUDH. She was a clinical lecturer in paediatric dentistry.

Sarah: A female English dentist who graduated from a UK dental school more than 20 years ago, and has worked in community dentistry, hospitals and in practices, mostly with children. Currently, Sarah is a clinical lecturer in paediatric dentistry.

8.5.2 Themes:

In this section, the themes emerged from data analysis are described, supporting this with appropriate quotes, data extracts and references when appropriate. In the analysis, three themes and 11 subthemes were identified, which are organised as set out in the summary table below:

Table 8-2: Summary of themes, subthemes and supporting quotations

Theme	Subtheme	Supporting quotations (example)
1. The test perception and its outcomes	a) Defending image of ‘a good parent’	<i>“You want to look good in front of the dentist I think that’s very important for us, as human beings” (Case 2, parent, follow up interview)</i>
	b) Giving the ‘right’ answer	<i>“I think two appointments ago Dr (NAME) he mentioned about dietary advice. We also get a lot of advice from our own general dentist” (Case 2, parent, follow up interview)</i>
	c) Clinicians seeding the misperception	<i>“Dentist: Shall we have a little test? Are you ready? ” (Case 1, Dentist, observation1)</i>
2. Dentists’ Cynicism	a) Cynicism about patients’ honesty	<i>“I think it is often quite difficult to motivate patient and parent to fill them in correctly, you know be quite accurate and honest” (Dentist interview, Karen)</i>
	b) Validity concerns	<i>“I think that the issue personally I find is the rate of return is probably about 50%” (Dentist interview, William)</i>
	c) Ticking the box	<i>“It’s not the end of the world because you’ve given good advice, but I think probably that would have been the ideal scenario.” (Dentist interview, William)</i>
	d) Clinical interventions are more reliable	<i>“at least with fluoride you can make some sort of professional intervention. With diet, you can’t go home and make them fill it in properly” (Dentist interview, William)</i>
	e) Dealing with sensitive and contentious matter	<i>“I always try and make it as pleasant, non-threatening environment as possible because some people will come back and say that: well we are not having any sugar and it’s just that they haven’t been informed of the things that have sugar in. But yes, some people can be defensive, but I suppose you have just got to try and persevere and do what you can and be polite and make sure it’s not awkward” (Dentist interview, William)</i>

Theme	Subtheme	Supporting quotations (example)
3. User's values, priorities, and circumstances	a) Position of diet diaries in the hierarchy of priorities	<i>"I forgot the food diary but I haven't got the time to do them...the thing is just with me be at work and everything." (Case 5, parent, observation 2)</i>
	b) Parent-child differences	<i>"so what happens with him and his friends is they save up all the money for the, for the few days and then go buy sweets in the shop when they are walking home and in the past he'd never tell us about it but I have noticed that he has got wrappers in his pockets." (Case 2, parent, Debrief interview)</i>
	c) Paper diet diaries format is outmoded and onerous	<i>"I think what we thought when we discussed is nowadays everybody has phones and everybody has Smartphones. Apps are better I think. Having an app on the phone because people are always on their phone, even when they are talking to people on the phone" (Case 2, parent, Debrief interview)</i>

The following section gives a narrative description of how the themes contributed to an understanding of how the factors influencing patients' adherence to diet diaries.

8.5.2.1 Theme 1: The test perception and its outcomes

There was a general perception amongst the parents that the diet diary was something their parenting style might be judged on. The diet diary was received as a test that would be marked by a person in authority (dental practitioner), that there were right and wrong answers, and that 'failure' in the test could lead to a negative judgment of their parenting style, with potential embarrassment. In the clinical interaction dentists even specifically included referring to a '*test*' during discussions on diet. Aspects of this defensive attitude are outlined in the following sub-themes.

a) Defending image of 'a good parent'

People tend to behave in ways that present them as good and moral, and avoid behaviours that make them feel shamed and disgraced (Lazare, 1987). Therefore, it is no surprising that the best versions of oneself during dental encounters was a common observation during the interviews with the parents and in their reactions at the times of diet diaries issuance. Anticipating the possibility of negative feedback and blame from the dentists was something acknowledged both verbally during the interviews and when observing behaviour.

"You want to look good in front of the dentist I think that's very important for us, as human beings"

(Case 2, parent, follow up interview)

The parents tended to portray themselves as considerate parents who cared about their child's oral health, valued healthy messages and appreciated the value of diet diaries. Some parents observed continuously showing verbal and non-verbal agreement with the dentist's advice, for example, manifested as *nodding of the head*:

The parents also expressed agreement with the importance of diet diaries task verbally during the interviews.

“I think it will be good to know what is wrong with Ala’s diet”

(Case 1, parent, Debrief interview)

“so, a diary will give us an idea as to where we are going... where we are doing things in the wrong way and help us correct it, so that’s very useful that way”

(Case 2, parent, Debrief interview)

While some of these parents adhered to the task, others did not. On the second appointment, the non-adherent parents gave different excuse for not doing the diet diary task. The risk of negative impression or judgment was clearly stated during the follow-up interviews.

“When we faced the dental surgeon, we didn’t want to look careless”

(Case 2, parent, follow up interview)

“This parent did also start the conversation with the dentists by expressing apology for not bringing the diary and tended to assure the dentists that everything is ok with the child’s diet”

(Case 2, observation 2, field notes)

An individual, normally, has a tendency to present and defend the best versions of him or herself during social interactions, such as an encounter with a dentist, and particularly when faced with a challenge such as receiving advice against their behaviours or when they may be deemed responsible for an outcome (Myers, 2003). Although implicit, the parents were very keen on preserving their ‘good parent’ ideal by avoiding the causes of the embarrassment and blame. Defensive behaviours of this kind have been termed ‘hiding manoeuvres’ (Lazare, 1987). Two kinds of hiding manoeuvres were observed in the data: First, the complete avoidance of the diet diary task where the parent completely opted out of the test (diet diary). A variety

of excuses were given in order to allow the parent to ‘Save Face’ while maintaining their good persona. Dentists acknowledged some of these excuses are merely face-saving stories.

“I forgot the food diary but I haven’t got the time to do them...the thing is...just with me being at work and everything”

(Case 5, parent, observation2)

“Normally it’s ‘I’ve lost the diary, can I have another one’, ‘I’ve done it, but I’ve forgotten it’ some people are just generally honest and say we didn’t do it, as well.”

(Dentist interview, William)

Secondly, some parents modified dietary intakes or edit the dietary account in order to present a socially desirable record that allows them to ‘pass the test’ and preserve their ‘good parent’ image. For example, one parent revealed that he avoided giving the child sweets while keeping the diary, and when asked why, he said:

“Because if you write sweets then you automatically think the dental surgeon will think “oh he is eating sweets like this all the time”, so that will be a bad impression”

(Case 2, parent, follow up interview)

This is despite the fact the dentist had emphasised the importance of the keeping an honest record of dietary intakes

“We are not judging you”

(Case 3, Dentist, observation1)

“don’t change anything that you are already doing, just because you are filling this in, just be as sort of normal as you can really”

(Case 2, Dentist, observation 1)

b) Giving the ‘right’ answer

Most parents appeared generally aware of what correct entries should diet diary include in order to ‘*pass the test*’. It was very uncommon that parents came for dental care without previous experiences or knowledge about oral health including dietary behaviours. Universal dietary advice that encourages patients to reduce amount, frequency and near bedtime intake of sugars is recommended as routine to all dental patients. Interviews revealed that some parents had already received dietary advice from previous encounters in dental practice.

“I think two appointments ago Dr (NAME) he mentioned about dietary advice. We also get a lot of advice from our own general dentist”

(Case 2, parent, follow up interview)

Dentist also, perhaps unintentionally, were observed to prime the patients to provide the right answers by providing the dietary advice at the time of issuing the diet diary. For example, in case 1, the dentist provided a comprehensive diet advice before issuing the diet diary. The emphasised the importance of having 4 sugar attacks as the maximum allowed number of sugar per day, on the same visit of issuing the diet diary.

“Dentists: So, what we want to try and do is have no more than four sugar attacks a day. Okay. So, that’s your breakfast, your lunch, your dinner and one other time and anything in between those four always try to be sugar free. So, the key thing is to try and cut out the juices but if you can’t at least have it with your meal and then anything in between the only things you can have really is water. It’s not very nice, it’s boring isn’t it but between meals that’s the idea. Is that alright with you?”

Parent: That’s fine.

Dentists: Another test? How many sugar attacks should you have a day?

Parent: Three.

Dentists: Well that would be perfect but four is okay but three would be even better. Is that okay with you?

Parent: Yes.

Dentists: Are you sure?

Parent: Yes.

Dentists: Good. If you do the diet diary for next time.

Parent: yes”

(Case 1, observation1)

The documentary analysis of returned diet diaries showed evidence of editing the number of sugar attacks. For example, in one record, one sugar attack was crossed out. This can be interpreted as an attempt by the parent to maintain the optimum number of intakes recommended by the dentist during the first visit, and hence ‘pass the test’. However, this is only a hypothesis since the patient did not attend the second interview with the researcher and so further exploration of this issue was not possible.

Figure 8-3: an extract from edited diet diary

Day Three

Time	Food	Quantity
9am	fried Eggs + Toast - cardinal berry no added sugar	1 glass.
12pm	Breakfast bar. Breakfast Cari Sun orange. milky buttons	amp
2pm	Burger + c hips Dates vs. sugar.	
7pm	Chips + cheese. bed frame.	

c) Clinicians seeding the misperception

Data suggested that dentist's communicative behaviours may also be responsible for presenting the diet diary as a test which then lowers adherence. There is an inherent asymmetry in power between the physicians and patients by virtue of professionals' higher knowledge and expertise (Lawlor and Mattingly, 1998). Observations showed that dentists tended to check patient's understanding of correct dietary behaviours by marking the diet diary.

“So what have we got? Let's have a peek through these. So that first day there is only 4 sugar attacks which is kind of what we're aiming for”

(Case 1, Dentist, observation 2)

The nature of this dialogue is very much of a 'parent-child' interaction though the conversation is between two adults. In this case the dentist acted as a teacher: giving advice as a short lecture accompanying by barraging of the patient with a set of DOs and DON'Ts.

“Now obviously, we want a nice balanced diet. We don't want you having bags and bags of unhealthy things. But at the same time, I am not saying cut it all out because that's not possible. Now I am going to be a bit mean now and go on about Ribena. Is that alright with you?”

(Case 1, Dentist, observation 2)

Within such a paternalistic approach, there is little opportunity for patients to participate. With the dentists taking the role of 'parent', this places the child's parent in the submissive role as 'child'. In consultation one clinician actually presented the conversation as a 'test':

“Dentist: Shall we have a little test? Are you ready?”

How many times a day should you brush?”

Parent: Twice.

Dentist: Good. When? I haven't told you that.

Parent: Morning and night.

Dentist: Good, fantastic. When you brush, your teeth do you rinse your mouth out afterward?

Parent: No.

Dentist: How many minutes should you brush for?

Parent: Two."

(Case 1, observation 1)

"The dentist was challenging patient's knowledge when he gave the diet diary)

(Case 1, observation 1, field note)

In the follow-up appointment, the parents seemed to make attempts to avoid the blame expected from the dentist if the parent did not follow the advice and recommended dietary habits. For example, the parent used family demands as an excuse to avoid blame from the dentist and to deter embarrassment.

"Sorry, it was difficult, my Nan was ill"

(Case 1, parent, observation 2)

8.5.2.2 Theme 2: Dentists' Cynicism

The physician-patient encounter is not a one-way street. Instead, it is a two-way process where each contributor can influence the behaviour of the other (Street, 2001; Street & Millay, 2001). The data shows that dentists' perspective on diet diaries tends to influence how diet diaries are administered and analysed. Dentist informants appeared to show some cynicism concerning the reliability and validity of diet diaries in assessing patient's diet during observations suggesting that dentists may not be comfortable using diet diaries. This may have been a challenging issue for the

clinicians since the use of diet diaries is part of the teaching hospital policy. Dentists underlying cynicism may have resulted in only minimal time being allocated for diet diaries discussions. This in turn inevitably negatively impacts how patient perceives and responds to the diet diary task.

a) Cynicism about patients' honesty

The interviewed dentists, regardless of the number of years of experience they had in delivering diet diaries to children and parents, tended to hold very similar views that an inherent limitation of diet diaries use in dental clinical setting patients, is that parents tend to perceive and handle the diet diaries as a test. This was translated in dentist's continuous emphasis of honesty as a must for effective usage of diet diaries.

"I think they are a useful tool if they are done properly. I think it is often quite difficult to motivate patient and parent to fill them in correctly, you know be quite accurate and honest"

(Dentist interview, Karen)

Dentists' views about honesty reinforce what is a moral tone of interactions involving diet diaries, which is received by patients as a moral judgment (blame) about their parenting skills. This was also echoed in dentists' interactions with the parents whilst issuing the diet diary. The observations showed that dentists tend to encourage patients to provide accurate diary records and to not misperceive the diet diary as a test and not to overlook any information:

"So, the important thing is to not miss anything out, so you need to kind of keep this somewhere where you are going to be able to access it so you can fill it in as you go along"

(Case 2, Dentist, observation 2)

b) Validity concerns

The dentists reported concerns that the patient may not return the diet diary or may not do it properly. The dentists explicitly criticised the low return rate of diet diaries. They also expressed suspicion about the validity of a flawless dietary records.

“I think that the issue personally I find is the rate of return is probably about 50%”

(Dentist interview, William)

“Sometimes people do come back and it’s a perfect 3 things a day, meals and nothing else and you think. Is that, right? So, I try and probe a little bit more when it comes back and if I’m getting nowhere then I tend to just give the advice and just explain the points”

(Dentist interview, William)

c) Ticking the box

The use of diet diaries is enacted by the institution policy, which entails a routine administration of diet diaries to all patients categorised as high risk of dental caries. Despite their agreement with the rationale, the dentists did not seem fully convinced of the validity of this tool for the group receiving care in this setting.

“It is difficult really because the children who probably need it the most are probably the ones that are least likely to have it filled in”

(Dentist interview, Sarah)

The dentists considered the provision of universal dietary advice to be their main priority. While supporting this with a diet diary was thought to be helpful but albeit unnecessary or non-essential. But, they still do it even though they were sceptical about the reliability and validity of diet diaries. This indicates that, the dentists give diet diaries merely to ‘tick the box’, in order to comply with the institution’s policy.

“It’s not the end of the world because you’ve given good advice, but I think probably that would have been the ideal scenario.”

(Dentist interview, William)

“Dentist: I always document in the notes, I always say like I’ve given it, tried so many attempts diet diary, not been returned, however diet advice given – or something along those lines”

(Dentist interview, William)

d) Clinical interventions are more reliable

Successful oral health education interventions in dental practice relies on health professional’s beliefs, skills and whether he/she trusts the effectiveness and efficacy of the intervention they are giving (Kay et al., 2016a). The diet diary was seen as an intervention that needs patients’ cooperation and adherence, and therefore their effectiveness lies within the patient's hands. Consequently, the dentists did not appear to invest more time and efforts to encourage patients to complete the diet diary.

Alternately, the dentists appeared to prefer more concrete interventions wherein they can apply their clinical skills and trust the effectiveness of these interventions without relying on the patients. For instance, fluoride application was considered as a controllable and a trustworthy professional intervention.

“You don’t know if people are being honest so... I think... at least with fluoride you can make some sort of professional intervention. With diet, you can’t go home and make them fill it in properly”

(Dentist interview, William)

e) Dealing with a sensitive and contentious matter

The diet diary seemed to evoke tensions in the relationship between the dentist and their patients. The dentists appeared to behave in a cautious way when dealing with diet topic to avoid any conflict and maintain a peaceful relationship with their

patients. This is shown in the use of modifiers ('just', 'so') and qualifiers ('if that's alright') in the following extract:

"Just a few questions if that's okay about your diet now if that's all right. So how often would you have sugary snacks and things now?"

(Dentist interview, Karen)

The data shows that the dentists were not very keen on emphasising the need of the diary or encouraging the patient to do it. For example, one dentist seemed sure that the patient would not do the diet diary and immediately switched to a 24-hours dietary recall when the parent said that she forgot the diet diary.

"I forgot the food diary but I don't have the time to do them

Dentist: Okay well, we will just go through the 24-hour recall"

(Case 5, Parent, observation2)

There was a concern amongst dentists that parents may become defensive and may not accept the diet diary. This makes the provision and analysis of diet diaries both uncomformable and challenging since the dentists are required to find the balance between the institutional policy which requires the use of diet diaries and maintaining a peaceful relationship with their patient. The dentists appear to avoid asking patients why they did not complete the diary or to emphasise the need of completing it. Instead, they appeared to prefer providing universal recommendations, which were less offensive, absolves them the responsibility and evades the possible conflict with the patient.

"I always try and make it as pleasant, non-threatening environment as possible because some people will come back and say that: well we are not having any sugar and it's just that they haven't been informed of the things that have sugar in. But yes, some people can be defensive, but I suppose you have just got to try and persevere and do what you can and be polite and make sure it's not awkward"

(Dentist interview, William)

The same dentist, after analysing the diet diary ignored many issues and gave some general advice.

“Is that alright with you guys? So overall advice, if you can, keep things to no more than 4 sugar attacks a day which is kind of what you are doing, and try have a few more other things, maybe a bit more fruit and veg and other stuff as well”

(Case 1, Dentist, observation 2)

8.5.2.3 Theme 3: User’s values, priorities, and circumstances

Parents and adult caregivers play a pivotal role in the development and adoption of the dietary habits of their children since they act as gatekeepers who control the availability of food and overlook their children’s behaviours (Golan et al., 1998). Throughout this study the parents were the primary keepers of diet diaries issued in the dental setting, which means that this is embedded in the context of their own values, compelling responsibilities, motives and views.

a) Position of diet diaries in the hierarchy of priorities

The extent to which an individual pays attention and participates in issues relevant to their own health is defined by their motivation to be healthy (Moorman and Matulich, 1993). A recurrent observation by the dentists was that children with extensive tooth decay and poor oral hygiene were less likely to return the diet diary. This is probably because of a lower motivation to adopt health-related practices in general.

“I think people who have got wall to wall decayed teeth and they aren’t maybe brushing their teeth properly may be less inclined to do it. If people aren’t willing to go and brush their teeth and do that then are they willing to fill in a diary?”

(Dentist interview, William)

The data showed that one reason for low parental motivation may be a lack of belief in the need for and usefulness of diet diaries.

“ And the second thing is not believing in the system. I think you need to have some belief in it but this is for your good and if you start to believe in it I think that works. If they think this is rubbish, then this is all a wasted exercise then there is no point”

(Case 2, parent, Debrief interview)

The parents may even consider the unhealthy dietary behaviours as norms that do not require intervention or that these behaviours are inevitable for children. One parent, for example, described sugar consumption as an irresistible behaviour, using the language of addiction, to explain why it would be difficult to change these habits.

“He knows the sweets are not good for him but he can't somehow. Why can't he have sweets? Because he likes them too much”

(Case 2, parent follow up interview)

It is noteworthy that the primary cause for referral to the dental hospital, in most of the cases, was not tooth decay, therefore, diet was not a primary concern to many parents. This was evident in many observations. After delivering dietary advice, the dentists asked the parents if they have any questions related to the diet, but the parents kept asking about treatment and sometimes interrupted dentists to ask about it. This suggests that parents involved did not perceive diet diaries as a priority for them.

“Particularly because of the dental hospital, we have appointments specifically for prevention so they have a whole appointment where they are just getting diet advice and tooth brushing and a lot of them think it's a waste of time and you can tell that they just want to, their child needs treatment so they just want to get the treatment done.

(Dentist interview, Karen)

Busy parents appeared struggling to fit the diet diary into their everyday responsibilities that they have to deal with. Working parents described that they found it difficult to keep an eye on the child throughout the day or to do the diary task. The situation was even more complicated where the child is of school-age and both parents worked. There were out of sight time (Baranowski et al., 1991), when parents couldn't observe their children and hence some information is inevitably missed. This was demonstrated in parents' responses to what would prevent them from completing the diary:

“Just life and being busy I suppose. Well just being really honest we both work full time, she has after school activities every day so it's kind of like a full day anyway and then it's just finding time for other things.

(Case 3, parent, Debrief interview)

“I forgot the food diary but I haven't got the time to do them...the thing is...just with me be at work and everything. She has got to go back to school and I have got to go back to work, I just don't have the time to do the thing.”

(Case 5, parent, observation 2)

Such constraints hinder the timely and prospective completion of the diet diary and the parents may complete the diary retrospectively which brings the pitfall of recall bias.

“I was going to work on Friday afternoon and I realised ‘Oh the diary is here’ next to me on my seat, so we took it in and tried to fill it retrospectively”.

(Case 2, parent, follow up interview)

Parents may rely on the child to keep the diary or to memorise their dietary intakes, which in turn has its own shortcomings. Although this may vary from one child to another, it has been suggested that children cannot be a reliable independent

source for dietary information until late childhood (Livingstone and Robson, 2000). The child may also have their own preferences, and so he/she may provide an edited account to avoid advice against their desires.

“She (the child) kept the diary and we just sit with her at the end of the day to check that she did not forget things”

(Case 3, parent, follow up interview)

“I think the reason he would not maintain a food diary is probably because he doesn’t want us to know how much sweets he has had”

(Case 2, parent, follow up interview)

As a family, the child and parents have to be, sometimes, involved in social activities such as visiting friends or special occasions such as religious and seasonal celebrations where the consumption of sweets is a popular tradition. Keeping the diet diary during such events will misrepresent the usual dietary intake.

D: It’s difficult as well because they’ve asked you to do this when it’s like Christmas and like you are having all the Christmas parties.

(Dentist interview, William)

“But on the weekend because we were at a friend’s house on Friday night the timings were quite late we had quite a late dinner”

(Case 2, parent, follow up interview)

b) Parent-child differences

The child’s cooperation is important for a proper keeping of diet diaries. The parent is not always the gatekeeper who has full control over their child’s behaviours nor is the child always passive. There is extensive research with even very young children, showing that children and parents actively negotiate rules around food and eating (Curtis, James & Ellis 2010). Parents emphasised faced difficulties in convincing their child to avoid unfavourable behaviour and to control their desire as well as access to eating sweets.

“So what happens with him and his friends is they save up all the money for the, for the few days and then go buy sweets in the shop when they are walking home and in the past he’d never tell us about it but I have noticed that he has got wrappers in his pockets.”

(Case 2, parent, Debrief interview)

(The child did not seem interested in the topic of diet, unlike the mother who was. Linking this to what mother wants to achieve from the diary may indicate some sort of tension between mother and child regarding the sugary drinks)

(Case 1, observation1, field notes)

“The child looked not interested or uncomfortable with subject. He was crossing legs and resting chin on his hand. The father appeared embarrassed because he was late and also forgot the diet diary”

(Case 2, observation2, field notes)

A common observation, in this study, was that some parents asked the child to focus or to listen carefully when the dentist started giving the advice. This could be the tip of the iceberg of what parents are handling in terms of modulating their child’s behaviours. In fact, some parents admitted that the child would listen to the dentist but not to his/her parents. Credibility of the sources of information, in this case the dentist, is well recognised as a key factor in enhancing attitudes, intentions, and acts (Arora, 2000). Therefore, parent appear to credit dentists with some responsibility in shaping child’s behaviours.

“I think it will help me or help mark more because he needs to know how much sugar is affecting his teeth and I think that is – it’s the – I feel it’s the drinks that are causing the decay but as much as I tell him he doesn’t listen. But he seems to take on advice of other people, like Dentists, Doctors, he probably listens to them more”

(Case 1, parent, Debrief interview)

(The dentist addressed the talk to the father and started taking history and filling the prevention pro forma. When asking about OHI the father pointed to the child to answer)

(Case 2, observation1, field notes)

c) Paper diet diaries format is outmoded and onerous

The parents found the paper diet diary difficult, labour intensive and sometimes inaccessible, which appeared to discourage them from filling them properly. When asked about constraints related to filling in the diet diary, one parent replied:

“Not having access to the diary is one. Of course if you keep it somewhere else and you don’t have it then you have to fill it in retrospectively. Also, if it’s for a few days it’s easy I will be very honest, and if it’s for a longer duration than 3 or 4 days then I think we tend to forget don’t we so”

(Case 2, parent, follow up interview)

Moreover, a recurrent suggestion, from dentists and patients, was to use a structured rather than free-text diet diary with time slots, which would make it easier to fill out and would reduce the risk of missing information, with respect to timing.

“I think what we found is if you had time slots, you know morning, lunch time, break time, afternoon, bedtime. That would be a quite useful one to have – what did you have at bedtime to prompt them”

(Dentist interview, Karen)

The paper-based diaries were labelled as ‘old-fashioned’, in the now digital age that colours every aspect of our lives. Mobile apps were suggested as a practical alternative. One parent, for example, highlighted that diet diaries are impractical in comparison to a mobile app that can be accessed anywhere and at any time.

“I think what we thought when we discussed is nowadays everybody has phones and everybody has Smartphones. Apps are better I think. Having an app on the phone because people are always on their phone, even when they are talking to people on the phone”

(Case 2, parent, Debrief interview)

Another parent pointed to the merit of using mobile phone to record the dietary intake when they were out of home. She wrote a note which was then used to complete the diary.

“We were out on the Sunday; we did have an ice cream. So, I just kept a note on my phone if he had anything whilst we were out.”

(Case 5, parent, follow up interview)

8.6 Discussion:

To the author’s best knowledge, there are no previous studies that have investigated patient’s adherence to diet diaries issued in a dental clinical setting. This study shows that adherence to diet diaries is a multi-contextual phenomenon associated with interacting factors which are generally related to the patient (parent/child), the dentist and the diet diary itself. These factors are in essence similar to those recognised in the wider medical literature which influence the adherence to professional recommendations or medications (Garrity, 1981, Donovan and Blake, 1992, Kardas et al., 2013), and adherence to diet diaries in nutritional research and dietary monitoring (Thompson and Subar, 2013). However, the nature of diet diary usage in the dental clinical setting as a tool to inform the dietary advice appeared to provoke distinctive influences such as dentist-patient relationship and patient’ perceptions of diet diaries.

A key finding in this study was that the adherence to diet diaries is influenced by how the parent perceives it. A perception of the diet diary as a test appeared to be

a powerful deterrent of parents' adherence since it has shown to elicit fears from embarrassment and criticism. This later appears to activate what is so called 'hiding manoeuvres' (Lazare, 1987), in order to protect the good parent ideal and to evade such embarrassing situation. The parents do this presenting a socially desirable account or completely avoiding the task. Similar findings have been observed in a previous qualitative study exploring the experiences of the users of diet diaries in nutritional research, where the participants indicated that they may modify their dietary intakes or to alter the recording itself in order to avoid negative feedback (Vuckovic et al., 2000).

Furthermore, this study's findings suggest that parents who view diet diaries as unimportant or irrelevant may show poor adherence. Beliefs and attitudes are well-recognised predictors of human behaviours (Bandura, 1991). In addition, psychosocial constructs such as motivation and attitude have listed among factors that may explain patient's non-adherence (Freeman, 1999a). It was clear that parents' lack of motivation to maintain good oral health is considered by dentists as an indicator of poor-adherence to diet diaries.

To add to the complexity of the issue, dentists themselves may also contribute to how patients perceive diet diaries through their communication with patients. Dentists who adopt a paternalistic and controlling communication style wherein diet diaries are used and presented as an audit to approve/disapprove patient behaviours may put patients at unease and drive them to see the diet diary as a source of discomfort rather than a tool of support. It is well recognised that adopting controlling and dominant behaviour by physicians tends to lead to lower satisfaction which elicits lower adherence to physician's recommendations (Street et al., 2007). However, this does not mean that a collaborative and assuring communication style will by default

enhance adherence. The data shows that telling the patient that the diet diary is not a tool for judgment or criticism may be insufficient to relieve patient's concerns. Although it was not explored in this study, other factors in dentist-patient relationship such as patient-physician trust may offer a possible explanation for this phenomenon. Such trust is a well-documented covariate of many health outcomes including patient's satisfaction and adherence (Pearson and Raeke, 2000). To put it simply, the patients may not trust the dentist or dentist's intentions of using the diet diary. This seems logical given that dentist-patient trust needs time to develop which is not the case in this study with all the participants meeting the dentists for first time. However, further assessment of the role of dentist-patient trust in adherence to diet diaries is required.

Another important assumption raised by this study was that the diet diary might be avoided or at least given less attention if it is considered a source of tension in the relations and interactions between dentist and patient on one side, and between the parent and child on the other side. Dentists endeavour to keep the peace in their relationship with the patient has been observed when they were asked to address sensitive issues such as smoking cessation counselling (Chestnutt and Binnie, 1994). Current data further supports this idea and suggest that dentists avoid emphasising the need of diet diaries among those who did not return them back and instead provide universal dietary advice which absolve them the moral and the professional responsibility and evades them from any tension in the dentist-patient relationship. On the other hand, diet diaries may expose parent-child conflicts as well as difficulties in controlling child behaviour. This study found that parents may either admit this and seek the dentist's help or deny the conflict, with the ultimate result being inaccurate diet diaries due to lack of child cooperation. All these complex relationships and

interactions made the diet diary a difficult and uncomfortable task for both dentist and the parent. These findings suggest that the dynamics of dentist-parent relationship is an important influence on diet diaries adherence.

This study shows that diet diaries may also have to compete with other duties in the demanding and busy lifestyle of modern societies. It has been suggested that the patients weigh up the costs and benefits of recommended courses of action as they perceive them within the circumstances and constraints of their everyday lives and needs (Donovan and Blake, 1992). Therefore, it could be the case that adherence to diet diaries is contingent upon how highly the patient rates the diet diary among other competing priorities of everyday life. In other words, an individual may not do a trivial task such as the diet diary, even if it is considered useful, at the expense of more essential duties and responsibilities. Alternately, the patients may choose to keep the diary to the extent that fits their priorities and does not affect their daily routines. This study shows that busy parents may tend to fill in the diary retrospectively or rely on children to keep the diary, which undermines the quality of collected data by recall bias or child's incapability to provide an accurate record (Livingstone et al., 2004).

The effect of the diet diary form and nature of use is another aspect affecting the adherence to its protocol. This study's findings are consistent with that of other studies in the field of dietary assessment and self-monitoring research, which suggested that the use of paper diaries for several consecutive days is an exhaustive and burdensome activity for many patients and may result in underreporting, altering the record and retrospective filling (Burke et al., 2005, Burke et al., 2009, Thompson and Subar, 2013). What is more, using paper form was viewed as impractical and outmoded in the current age of modern technology, which is believed to hamper the accessibility and the proper recording of the dietary intake.

Mobile phones which are widely available and accessible regardless of the time and the place and easy to handle (Lacson and Long, 2006), may represent an effective alternative that, in fact, has been suggested as a possible alternative by this study's participants. Technology such cell phones which come with camera capability could enable an easier and more timely recording technique such audio recording of the dietary intakes, and taking and storing pictures of foods before and/or after eating which could also reduce self-report error (Thompson et al., 2010a). The reliance on electronic diaries for dietary assessment and monitoring in health care generally, is now preferred over paper diaries which are currently being progressively replaced with camera phones (Burke et al., 2005, Thompson and Subar, 2013). The use of mobile devices for dietary assessment and monitoring has shown superior acceptability, user satisfaction, and adherence to dietary self-monitoring when compared to paper based diaries (Burke et al., 2005, Yon et al., 2007, Carter et al., 2013). However, while such advancements in technology are yet subjective to self-report bias and technical problems such as data transfer, storage and battery life (Sun et al., 2010), they have the potential to provide high quality and real time dietary information (Lieffers and Hanning, 2012).

This study has some strengths, limitations and methodological choices which are worth discussing here. The use of a case study design has enabled the collection of data from multiple sources and the use of different collection strategies. Central to this is the use of observation, which allowed studying the phenomenon in its natural setting (Mills et al., 2009). This was further informed by interviews and documentary analysis. Yet, using observations endures an inherent risk of observer effect bias, which is also called the 'Hawthorne effect' and it means the participant might change their response because of their awareness of being observed (Napolitano, 2009). To

minimise the observer effect, the researcher spent some time in the study setting (Department of paediatric dentistry) before commencing data collection to allow dentists to begin to be desensitised to the presence of the researcher. Similarly, the researcher was introduced early to parents and children in their first visit before carrying out the observation (Polit-O'Hara and Beck, 2006). In addition, the participants were assured about their confidentiality and the aim of the study was explained to them.

The choices of data collection methods and study setting were influenced by issues related to recruitment and research site access. For example, direct observation was preferred over videoing to avoid potential recruitment and ethical difficulties that might be caused by videoing (Napolitano, 2009). Also, a non-participant mode of observation was adopted because the investigator did not have a licence to work as dentist in the UK. In addition, a semi-structured form of observation was used in this study to focus the scope of the observation on the research objective and to avoid the complexity and diversion of analysis which might be caused by adopting unstructured approach. Moreover, the paucity of literature on diet diaries usage in dentistry made it impossible to use completely structured form.

The study was conducted in a hospital dental setting, which was deemed to have two advantages. First, the site was accessible since it was included in the ethics approval for the whole project. Secondly, diet diaries are used on a routine basis as part of the preventive care of children with dental caries. A general dental practice that was identified from practices indicating the use of diet diaries in the earlier questionnaire study (chapter 5) were contacted and invited to take part in the study by allowing recruitment of the participants from their patients. However, although they

initially showed interest they failed to respond to correspondence after getting the required permissions and adding them as another research site to ethics approval.

The interviews were conducted immediately after the observations which gave the investigator no time to review the transcript of the observed encounter. This was not a problem for the first interview because the investigator always had the opportunity to ask questions in the follow up interview but it limited the ability to cover things emerging in the second observation.

Because of the appointments structure within the LUDH, dental caries was not the primary concern for the study participants. This may have affected the participants' interest in caries prevention and the topic of sugar consumption, and hence how they value and use the diet diaries. Acknowledging this as a potential limitation, future research should include children with caries as their primary concern.

8.7 Summary and implications

This study, while small scale and exploratory in nature, sheds the light on several key factors associated with adherence with diet diaries issued in a dental hospital setting. The findings of this study highlight the fact that patient's adherence to diet diaries is influenced by a complex range of factors related to the diet diary, the child, the parent, the dentist and the interactions between them within the clinical environment. Important issues such as dentist's communication style and parents' perception of the diet diary as a test of their parenthood and attitudes to diet in general, were found to have an influential effect on adherence to diet diaries in the dental clinical setting. This study suggests that the idea of keeping paper diet diary in current modern, technology driven society is outmoded.

Chapter 9. Concluding Discussion

9.1 Introduction

In this final chapter of the thesis, a general discussion is presented bringing together the findings of studies carried out to answer the general research questions posed at the outset of this thesis (Page 43):

- I. How diet diaries are currently used in dental practice for children and what do dentists/ families hope to achieve by their use?
- II. What are the strengths and weaknesses in the way the diet diaries are currently used?
- III. Should the current format and procedure be modified to more effectively provide a monitoring tool?

Guided by these questions, this chapter discusses the implications of the findings in relation to dental practice and future directions for research on dietary assessment and interventions in the dental care setting. A summary of conclusions is then provided.

9.2 How diet diaries are currently used in dental practice for children and what do dentists/ families hope to achieve by their use?

As previously mentioned, as far as the author is aware no attempts have been made to investigate the use of diet diaries in dental practice in the UK. This work, therefore, provides the first glimpse into this area and provides timely data because of the renewed interest in sugar consumption as a common risk factor of dental caries, obesity and non-communicable diseases such as diabetes and heart diseases.

This work shows that in England diet diaries are mainly used for children considered to be at high risk of developing dental caries, but are neither a popular nor the primary tool for collecting dietary information in the dental practice. Instead,

simply asking patients to recount their usual dietary habits is the prevailing means of dietary assessment. In all, only half of the GDPs reported doing any form of diet assessment although most of those that do indicated giving diet advice to almost all dental patients (Chapter 5).

While a comparable pattern of dietary assessment has been observed in the medical clinical setting where quick assessment methods such as 24-hour diet recall and diet histories are more desirable (Welch, 2014), this was surprising given that the individualisation of chair-side dietary advice, based on objective information, has been widely advocated in dentistry for some time (Rugg-Gunn and Nunn, 1999, Watt et al., 2003, Marshall, 2009, Mobley and Dounis, 2010). There is a growing current emphasis on the use of risk assessment tools to highlight patients' responsibility to maintain their own health (Bratthall and Hansel Petersson, 2005, Featherstone et al., 2007, Crall et al., 2015) (Literature review, section 2-11). In all these approaches, discussions regarding health behaviours are detailed, complex, and necessary. However, the thesis suggests that diet diary tools to support dietary advice in dental practice are currently underused.

One reason for this, is attributed to patients' low return rate of diet diaries (34%) which was observed on assessing clinical records of paediatric dental patients issued with diet diaries in a dental teaching hospital (Chapter 7). A higher return rate of diet diaries was observed in smaller families and those motivated to maintain good oral health, as indicated by regular brushing. This finding is in agreement with those observed in nutrition assessment research literature where user's motivation has been shown to be a prerequisite for the successful use of diet diaries (Thompson and Subar, 2013).

The use of diet diaries is traditionally recommended to support patients at high risk of dental disease by providing dietary advice tailored to their needs and circumstances (Rugg-Gunn and Nunn, 1999, Watt et al., 2003, Kidd, 2005, Zero et al., 2008). This may partly explain why the diet diaries were not used for a large number of patient assuming that a few patients were at high risk of dental caries. There are, however, other possible explanations. It has been demonstrated throughout the thesis (Chapters 5, 7 & 8) that many factors related to the dentist, patient, dentist-patient relationship, and the diet diary itself complicate the use of diet diaries in dental practice. These include, for example, financial and time constraints, dentists' lack of confidence in diet diaries and the skills to use them, patients' perceptions, circumstances and motivation and the effect of diet diaries on the dentist- patient relationship. Collectively, these findings suggest that the use of diet diaries in dental practice is a complex issue which relies upon multi-contextual factors related to the patient, dentists and the health care system.

Moving on now to consider what do dentists/ families hope to achieve by their use of diet diaries, in chapter 5, the findings of the postal survey of English GDPs showed that the main purposes for using diet diaries were to motivate behaviour change, and to assess caries risk. In doing so, GDPs rely, mainly, upon a strategy of intelligent selection of a subset of information to filter complex information gathered via diet diaries in order to provide simple dietary advice (Chapter 6). This is probably either the most useful or the easiest information to understand and implement. However, this may not be always the case. The findings of study IV (Chapter 8, page 160) suggested that the dentists may provide simpler advice to improve patients' adherence, in response to pressures on their time or because they wish to preserve good relationships with patients by avoiding being overly critical of them. However,

the reasons why dentists do so need to be explored using further qualitative research techniques and is recommended as an area of future research.

One of the most interesting findings throughout this thesis was that dentists, contrary to the current focus in the dental literature, pay relatively little attention to the '*amount*' of sugar in the diet, compared with other aspects of sugar consumption, such as '*frequency*' and '*hidden sugars*' (Chapter 6). *Amount* was also the most frequently missing information in diet diaries returned by paediatric patients at LUDH (Chapter 7). It could be surmised that there are two possibilities why information on sugar '*amount*' is not given by patients completing diet diaries – either patients see this as unimportant, or bothersome to report (Knudsen et al., 2011, Gondolf et al., 2012); or that dentists, when issuing the diet diaries, place more emphasis on recording behaviours that they personally perceive as particularly important and effectively prime their patient. Observations from the qualitative work (Chapter 8) confirm the second explanation may be the most likely. Dentists seem to consider reducing the frequency of sugar consumption as more practical than reducing the amount, perhaps, because they are aware that patients find it easier to visualise frequency than the amount (Moynihan, 2002).

Current dental public health messages advocate reducing the amount of dietary sugar because it is a common risk factor for dental caries and other conditions such as diabetes and obesity (Public Health England, 2014b). Therefore, it is important to encourage the dentists to advise patients to reduce both amount and frequency to achieve both clinical and public health aims of reducing the consumption of sugar.

A recent systematic review evidence suggests that parents' attributes such as their beliefs and attitudes and parenting style and skills are crucial factors influencing the dietary habits as well as the oral health of their children (Hooley et al., 2012).

Consistent with this, a notable observation in the qualitative case study (Chapter 8) was that parents tend to be the primary keepers of diet diaries and that their values and perceptions regarding diet diaries can inform how they approach completing the task. This thesis (Chapter 8) shows that, on one hand, the parents may misperceive the diary as a test of their parenting style fearing that the dentist may judge them. Hence parents may associate ‘failure’ in the test with negative judgment, and potential embarrassment and shame. For such parents, ‘passing the test’ and ‘face saving’ is their main objective in completing the diary (if they do it at all), which therefore compromises the validity of their record keeping. On the other hand, parents showed a tendency to provide an accurate diet record where there was sufficient motivation and time to complete the diary.

Furthermore, parent-child relationships are a two-way street. The child can also influence parents’ behaviours in terms of food choices and dietary habits (Hooley et al., 2012). For example, parents may struggle to control the dietary habits of children with difficult temperament. A previous study found that parents who tend to be more permissive towards their child's wishes when they request sweets is highly correlated with child’s dental caries level (Skeie et al., 2006). One interesting observation in the qualitative case study (Chapter 8) the diet diary task appeared to some parents as a way to offload the sugar sanctioning role onto the dentist. In summary therefore diet diary completion in the clinical setting is influenced by parents’ attributes and the dynamics of relationship between the parents and dentists on one side and between the parents and child on the other.

9.3 Strengths and weaknesses in the way diet diaries are currently used in dentistry to record sugar intakes

This research work has allowed some valuable insights about the relative strengths of using diet diaries in the dental practice. The key advantage of using diet diaries was found to be their potential to raise patients' awareness about issues which they would not usually consider as harmful. For instance, some GDPs were able to provide advice concerning hidden sugars in foods and drinks which can result in a considerable number of sugar exposures (Malhotra, 2013), and also praise patients for products having anti-cariogenic properties such as milk, cheese and other dairy products (Kashket and DePaola, 2002). This facilitates discussions with the patient, enabling tailoring of diet advice and accounting for the complex nature of sugar-caries relationship. In this way, the diet diaries enable the dentist to provide effective advice relevant to patient's individual circumstances.

However, the advantages of using diaries must be weighed against certain weaknesses. Being a complex and contentious matter, influenced by a myriad of multi-contextual (e.g. dentist, patient, and health care system) and sometimes unpredictable factors is, perhaps, the all-encompassing weakness of diet diaries. This results in varied and unpredictable disinterest in using the diet diaries by dentists and/or patients. For example, even the financial and time constraints appear to be the most prominent barriers in general dental practice, a low return rate of diet diaries was observed in a dental teaching hospital where remuneration was not an issue. The qualitative case study (chapter 8) explored these interacting complexities of diet diaries use in dental practice.

Diet diaries appear to be undervalued by dentists who consider diet diaries less effective than clinical interventions. A common theme in the qualitative interviews

with the dentists was that they seemed to prefer tangible interventions such as fluorides and sealants, placing a lower value on comparing diet diaries on account of doubts that patients would complete them honestly (Study IV, Chapter 8). Although it must be noted because the qualitative nature of the study with a limited sample size, the influence needs to be further tested in a larger sample and different clinical setting (General Dental Practice). By holding such stance towards diet diaries, the dentists may then invest limited efforts in the diet diary task, doing it as ‘tick the box’ in a mediocre way to evade the responsibility associated with not doing it. This finding is in line with a previous qualitative study which suggested that GDPs devote less time to preventive advice if they believed parents are not motivated (Threlfall et al., 2007), and also with wider literature which shows that clinician-related factors such knowledge, values and beliefs influence dentist’s chairside behaviours and choices (McGlone et al., 2001).

The thesis indicates that a paper based diet diary is a time-consuming tool that does not fit well within the busy nature of NHS general dental practice where lengthy assessments are not practical. The analysis of diet diaries takes 10 minutes on average (Study I, Chapter 5) which is relatively long time for a busy dentist that he/she is not directly remunerated for. This is meant to be absorbed into the cost of check-up (Chapter 2, section 2-11). Similar views on the insufficient support to preventive care in the current NHS remuneration system were captured among UK GDPs in a recent qualitative study aimed to investigate the GDPs views on promoting oral health in high caries risk children (Aljafari et al., 2015). These observations while highlight the need to consider preventive dental care and patients’ assessment in the payment system if the health advice to be tailored to patient’s needs and circumstances, as recommended by NICE (National Institute for Health and Care Excellence, 2015),

they may explain why GDPs appear to prefer more time-efficient tools such as diet histories (Study I, Chapter 5).

Reliance on patient cooperation and honesty is another downside of diet diaries. Poor adherence was considered by GDPs as a barrier to their use of diet diaries (Study I, Chapter 5). There is no guarantee that patients will return diet diaries issued by dentists or adhere to their protocol of use. As demonstrated throughout the thesis and in general medical literature, non-adherence can come in many forms: ranging from carrying out the task incorrectly, overlooking parts of it to completely ignoring it (Jin et al., 2008). Diet diaries return rate was as low as 34% among paediatric patients in LUDH, and even returned diaries were not comprehensive enough (a considerable amount of dietary information was missing) (Study III, Chapter 7). The qualitative case study (Study IV, Chapter 8) suggested that social desirability bias and recall bias can deprive diaries of their real-time and accuracy superiority, and thus effectively compromises the validity of diet diaries as a diet assessment tool for everyday clinical practice.

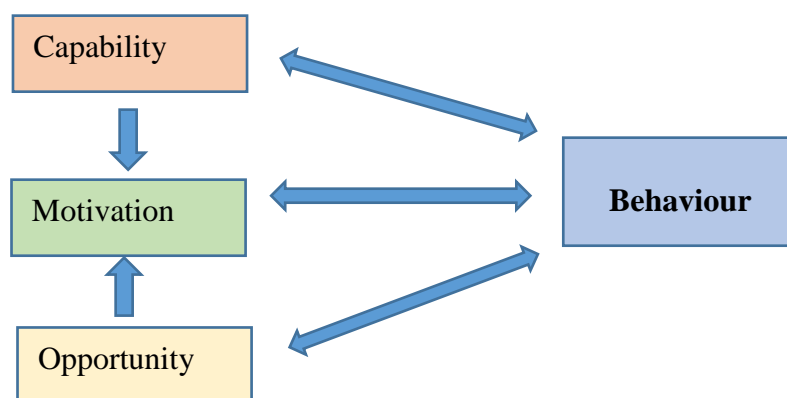
The successful use of diet diaries in dental settings requires a highly-motivated patient. The retrospective analysis of dental patients' records (Study III, Chapter 7) suggested that diet diaries were more likely to be completed and returned by patients who are highly motivated towards oral health. On the other hand, a common observation among interviewed dentists was that patients' who exhibited extensive decay were the least likely to comply with diet diaries (Study IV, Chapter 8). Bearing in mind that severe dental caries and poor oral health are more common among children lower SES groups (Steele et al , 2015), collectively, these findings further support the notion that diet diaries are unsuitable for lower SES groups (Holmes et al., 2008). Therefore, the current research raises the possibility that diet diaries may

be a wrong choice for those who are in most need of additional professional support in the form of dietary advice tailored to their needs.

9.4 Should the current format and procedure be modified to more effectively provide a monitoring tool?

The research work presented in this thesis was designed to explore the under-researched topic of diet diaries use in dental practice primarily as a tool for dietary assessment. Because of this exploratory and descriptive nature of the study, no attempts have been made, the beginning of the study, to adopt any theoretical position to predict behaviours of dentists and patients in relation to diet diaries use. However, behaviour models have long been used to inform behaviour prediction and interventions. Recently, behavioural scientists suggested COM-B system of behaviour change to provide guidance on what is the minimal set of behavioural constructs which required for any behaviour to occur. According to COM-B system, for any behaviour to take place the individual should have: 1) Capability (C) that is the skills to execute the targeted behaviour; 2) Opportunity (O), that is the physical and social environment that enable the person to undertake the targeted behaviour; 3) Motivation (M) refers to the person's conscious and automatic processes said to underline the emission of any behaviour (Michie et al., 2011).

Figure 9-1: COM-B model of behaviour change



(Adopted from: Michie et al., 2011)

This thesis has identified many aspects of diet diaries use and administration which might be modified in order to improve their effectiveness in dietary assessment and monitoring. With this regard, applying the COM-B model of behaviour to the findings of the thesis suggests some areas of future research and actions to improve the use of and adherence to diet diaries which are discussed in detail in the sections that follow. In summary, a key finding in the thesis was that patient's 'motivation' is crucial for the successful use of diet diaries for both patients and dentists. In terms of 'opportunity', many patients appeared to lack the opportunity to complete the diet diaries because of their lifestyle and the low priority of diet diaries in the hierarchy of their priorities. Likewise, the dentists appear to lack the time and sufficient compensation for using diet diaries. The third component is 'Capability'. The lack of knowledge and skills to use the diet diaries was one of the prominent barriers perceived by the dentists. However, it was not clear if the patients lack the capability to use diet diaries.

Perhaps the most important aspect of diet diaries practice to be modified is the paper based form which is both time consuming and old-fashioned. As stated previously in the literature review section (Page 42), advancements in digital technology provide new, more modern and promising alternatives to replace paper records, which also have the potential to enhance the dietary assessment through less burdensome and more acceptable tools of data collection (Ngo et al., 2009, Thompson et al., 2010a, Illner et al., 2012, Bonilla et al., 2015). Evidence from RCTs shows that the electronic devices have superior acceptability, user satisfaction, and adherence over conventional paper diaries (Yon et al., 2007, Carter et al., 2013). For example, a previous study among adolescents showed that assessing diet through innovative technology (a Personal Digital Assistant with or without a camera or a disposable

camera) was well accepted and less laborious than traditional diet assessment using paper food record and suggested enhanced adherence and accuracy (Boushey et al., 2009). In addition, using mobile apps in dietary assessment may benefit behaviour change in some ways (Edwards et al., 2016). A systematic review evidence has demonstrated that health behaviour interventions using smartphone apps to collect health-related information are well accepted by participants and may enhance the adoption of healthier behaviours such as increasing physical activity, decreasing sugar-sweetened beverage intake, and encouraging healthier eating patterns (Stephens and Allen, 2013).

In line with the aforementioned explosion of innovation in this area Public Health England has recently launched the "sugar smart app" which helps users to recognise total sugar in different dietary products, as part of Change4Life advertising campaign (Public Health England, 2016). However, whilst the "sugar smart app" appear to be helpful in identifying sugar in diet, it fails to account for the complex nature of the association between sugar consumption behaviours and dental caries. Recently, young dentists have launched the "FoodForTeeth" app which is specifically designed to be used by dental patients. The app incorporated a digital diet diary allowing both text and photo entries and a traffic light system to educate patients on their diet and oral health (BDJ Product news, 2017). However, little is known about the effectiveness of apps like this, and whether these mitigate the caveats of paper diaries. Furthermore, bearing in mind the social gradient of dental caries distribution, with higher prevalence in children from socially deprived groups (Steele et al., 2015), such technology-based interventions need to be evaluated for their affordability and accessibility for these high need groups and also for different child ages. Therefore, in the view of the promising results of these apps in the general dietary assessment

and monitoring, this appears to be a possible fruitful area for future research which may enhance dietary assessment in dental care setting. However, until this happens, adopting more upstream approaches to tackle sugar consumption related to dental caries prevalence in these groups could be a better option.

The thesis has also pointed to the importance of dentists' communication style and their ways of presenting the diet diary on patients' perceptions of diet diaries and their adherence to the diary task. A recent systematic review of strategies for oral health promotion in dental practices undertaken to inform recent NICE guidance in this area concludes that "There is moderate evidence that patient motivation and satisfaction are dependent on the oral health professionals' communication skills and ability to build therapeutic alliances with their patients." (Kay et al., 2016a). Generally speaking, effective dentist-patient communication is required to build trust, exchange information and to enable shared treatment decisions, which all enhance patient's satisfaction and adherence (Shigli and Awinashe, 2010, DiMatteo et al., 2012b). In line with this, the findings of the thesis support this view and suggest that approaching dental patients in a supportive and assuring manner, rather than a dominant way, can be successful in eliciting positive perception of the diet diary and improve adherence. The thesis showed that dentists could be successful in reducing the complex set of information collected via diet diaries into simple diet advice (Chapter 6).

Another area to consider is dentists' skills and attitude towards diet diaries use. It is well-recognised that dentists' attitude is an important determinant of their delivery of dental care, which needs to be modified if their behaviours are to be enhanced (Dyer and Robinson, 2006). In a recent survey of a group of NHS dentists in England, attitude, and to lesser extent perceived self-efficacy, were important predictors to asking about dietary habits and providing diet advice (Yusuf et al., 2016).

The authors concluded that changing dentists' attitudes is necessary to change their preventive behaviours though it is not the only the determinant (Yusuf et al., 2016). Thus, in order to improve the use of diet diaries, it would be recommended that dentists be equipped with appropriate attitudes and skills needed to use diet diaries comfortably and confidently. This may have some implications for dental education and training where more emphasis should be placed on dietary assessment and analysis to tailor an effective diet advice and to provide a basis for discussions around diet in dental settings. Dental training should also emphasise the importance of providing the dental practitioners with effective communication skills enabling them to work in partnership with their patients to establish therapeutic alliance necessary for effective successful care.

This thesis shows that one of the obvious disincentives for diet diaries use in the general dental practice, as perceived by the dentists, is the lack of support in the current NHS remuneration system (Chapter 5). Therefore, any effort to enhance the use of diet diaries may be meaningless if perceived constraints associated with the remuneration system remain unchanged. The limited support for preventive dentistry in the current NHS contracts based on UDAs has already been recognised (Steele, 2009). A new contract system is being tested, with the payment system in England moving towards focusing on quality measures, and preventive care pathways that tailor treatment according to patient's needs (Harris and Bridgman, 2010). This is intended to give dentists more room to apply strategies that optimise preventive advice such as diet diaries.

To summarise, in order to improve the current format and procedure of using diet diaries, multifaceted interventions at the levels of dentists, patients, the healthcare system and the diet diary itself are required. The successful use of diet diaries requires

a motivated patient. The diet diary format should be socially acceptable and time-efficient. Dentists, on the other hand, need a simple tool that is easy to use, patient centred, quick and supported by the health care system. Educational interventions to improve attitude, competency, and communication skills of the dental practitioners regarding the use of diet diaries and to motivate their patients to use them are also required. However, developing effective interventions to eliminate these barriers can be complicated by the fact that these barriers are multiple, interacting and unpredictable.

9.5 Diet diaries as a tool to support behaviour change

Although the research work presented in this thesis was designed to explore the use of diet diaries primarily as a tool for dietary assessment in dental practice, the use of diet diaries has some implications as a tool for assisting in individualising diet advice and self-monitoring and, hence, facilitate behaviour change. In this regard, the thesis suggests that the successful use of diet diaries, to a large extent, relies upon patient's motivation to complete the diet diary. Therefore, any efforts to use the diet diaries as a tool to facilitate patients' behaviour change without considering psychosocial determinants (patients' motivation, attitude, trust) of its use seems to jump the gun. In other words, using diet diaries for a patient who is not ready to share his/her information with dentist generates misleading information (for example: because of the potential social desirability bias) (Ardito and Rabellino, 2011).

It has been suggested that the role of the health care professional is to identify those patients who are ready to change their behaviours and to provide them with the appropriate support (Freeman, 1999c). Therefore, diet diaries, in concept, could be used for patients who are motivated to honestly complete the diary and trust the tool and where the provider is aiming to work for his/her best interest. In other words, diet

diaries should be used as an adjunct tool to support behaviour change interventions at the point that the patient acknowledges their readiness to change. In addition, behaviour change interventions should combine education with behavioural counselling to help patients acquire the skills, motivation, and support needed to modify their usual dietary habits (US Preventive Services Task Force, 2003, Abraham et al., 2009). Although there are many models for behaviour change intervention (e.g. theory of planned behaviour), there is a lack of consensus on one universal model of behaviour change that is effective in tackling any one given health behaviour (Michie et al., 2011).

Recently, Motivational Interviewing (MI) has been used to facilitate the provision of behavioural counselling in dental practice with some success (Harrison et al., 2007, Gao et al., 2014, Kay et al., 2016b). MI is a patient-centred counselling approach to enhance readiness for change by helping patients identify and resolve ambivalence about behaviour change (Hettema et al., 2005). It is used in conjunction with Trans-theoretical Model of behaviour change to facilitate behaviour change (DiClemente and Velasquez, 2002). According to Trans-theoretical Model of behaviour change there are five stages of behaviour change: 1) Precontemplation (the individual is not aware of the problematic behaviour); 2) Contemplation (admitting that there is a problematic behaviour but the individual is not ready to make a change); 3) Preparation (ready to change); 4) Action (taking actions to change the problematic behaviour); 5) Maintenance (continuing the behaviour change) (Prochaska, 2013).

The use of diet diaries could be incorporated in the MI at different stages and with different uses. First, as a dietary assessment tool, the use of diet diaries should ideally take place after the contemplation phase when the individual became aware of their problem and developed the intention to change their behaviour. At this stage the

patients may be well motivated to complete the diary accurately and timely. Second, as a self-monitoring tool, the diet diary is likely to be useful at the maintenance phase where it can help the patient in maintaining the healthy behaviour. Diet diaries are proven effective in prompting self-monitoring of behaviours (Burke et al., 2005). However, this remains a hypothesis and further research is needed to assess the effectiveness of diet diaries as an adjunct to MI. In addition, the effectiveness of MI in dental practice is quite controversial and further investigations are required in this area (Gao et al., 2014).

Above all, the thesis suggests that any efforts to use diet diaries to facilitate behaviour change would be meaningless if the aforementioned factors impeding the use of diet diaries in the dental care settings are not eliminated. Doing so will enhance the effectiveness and acceptability of diet diaries as a diet assessment tool in dental care settings. This will facilitate therapeutic alliance necessary for optimising oral health advice, and support dentists' contribution to addressing the issue of high sugar consumption as a common risk factor dental caries and obesity.

9.6 Summary of conclusions:

- Diet-related discussions appear to be appropriately held in dental practice setting, but the tools to support this, appear underused and probably underdeveloped.
- Diet diaries were neither frequently used by the GDPs nor often returned nor adequately completed by patients and their families. The GDPs appear to prefer dietary assessment tools that are more time efficient than diet diaries.
- The use of diet diaries in clinical dentistry is a complex issue that intertwines various factors related to patients/ families, dentists, the healthcare system, and

oral health researchers. Therefore, improving their use in dental care settings will require a multi-level effort.

- GDPs tend to filter complex diet diary information to provide their patients with simple and easy to implement diet advice. They mainly do this by selecting from a range of information available to them although a summative strategy where an overarching advice is given has been observed.
- Diet diaries showed a capacity to capture important dietary information which would optimise the preventive advice. However, the reliability of diet diaries is questionable since there is no guarantee that social desirability or retrospective completion does not bias the information collected.
- A highly-motivated patient is an essential prerequisite for a successful use of diet diaries. This undermines the validity of diet diaries for those at high risk of dental caries usually have poor oral health and motivation and are in most of the need of additional support in the form of tailored health messages.
- Paper diaries are of low acceptability and may not be the ideal approach for dietary assessment in the view of current NHS dental remuneration system, and the best available scientific evidence. Therefore, a time efficient and socially acceptable means of conducting dietary assessment for children in the dental setting needs to be sought.
- Diet diaries in current paper form are outmoded and appear to have low social acceptability in the current age of technological advances. The need of modern, technology-based dietary assessment tools was notable and an interesting area for future research in terms of adherence and outcomes.
- Diet diaries might better be used as an adjunct tool to support behaviour change interventions when the patient is motivated and ready to make the change.

9.7 Implications for practice

- With attention now shifting in recent years towards more fully rewarding prevention practices within the NHS dental remuneration system (Department of Health, 2015), what represents ‘best practice’ in terms of dental practice dietary advice needs to be clarified; with discussions around how remuneration and rewards might be set to fully recognise the time required. The time dentists spend on diet advice should be considered in the payment system. Until this happens, diet histories and 24-hour diet recall can be time-efficient tools to form a basis for discussions around diet in dental care settings.
- There is a need for better training and support for GPs and dental care professionals on how to assess diet, in order to apply the evidence-based preventive advice in the dental practice. Professional training of dental health professionals should also support the development of communication skills that enable them to work in partnership with their patients to establish therapeutic alliance necessary for effective behaviour change.
- Bearing in mind the various barriers to the provision of effective dietary advice tailored to patients’ needs and circumstances, adopting more upstream approaches to tackle sugar consumption as a common risk factor for dental caries and obesity may be a better option until effective dietary behaviour interventions become available.
- The new version of DBOH should pay more attention to the use of diet diaries and dietary assessment in general. This is because it allows for tailoring of an individualised diet advice which is compatible with the available evidence about preventive advice. It might be useful if the exemplar of diet diary given

in the current version DBOH be updated to one that includes a slot for amount rather than time and type of food only.

9.8 Recommendations for future research:

- The findings of the thesis provide some direction for the development of more socially acceptable diet assessment tool. Further investigations are needed to develop and assess a dentistry oriented mobile app as an alternative to paper diaries to support preventive advice in dental practice. Adaptations of technology in nutrition research resulted in more accurate and quick and less costly and inconvenient assessment of diet (Thompson et al., 2010). This can be simply a modification of an existing app or completely a new one. However, in either case, it should also be assessed for the feasibility, affordability, and effectiveness.
- In future research the use of diet diaries as a supportive tool of other behaviour change interventions that consider individual's readiness to change, such as motivational interviewing, should be investigated.
- Further research is needed to better understand why the dentists would choose a summative or selective approach when analysing diet diaries.

References

- ABRAHAM, C., KELLY, M. P., WEST, R. & MICHIE, S. 2009. The UK National Institute for Health and Clinical Excellence public health guidance on behaviour change: a brief introduction. *Psychol Health Med*, 14, 1-8.
- ADAIR, S. M., WRAY, I. A., HANES, C. M., SAMS, D. R., YASREBI, S. & RUSSELL, C. M. 1997. Perceptions associated with dentists' decisions to report hypothetical cases of child maltreatment. *Pediatr Dent*, 19, 461-5.
- ADAMS, R., JONES, A., LEFMANN, S. & SHEPPARD, L. 2014. Utilising a collective case study system theory mixed methods approach: a rural health example. *BMC Med Res Methodol*, 14, 94.
- AGGARWAL, V. R., JOUGHIN, A., ZAKRZEWSKA, J., APPELBE, P. & TICKLE, M. 2012. Dentists' preferences for diagnosis, management and referral of chronic oro-facial pain: Results from a national survey. *Health Educ. J.*, 71, 662-669.
- ALJAFARI, A. K., GALLAGHER, J. E. & HOSEY, M. T. 2015. Failure on all fronts: general dental practitioners' views on promoting oral health in high caries risk children-a qualitative study. *BMC oral health*, 15, 45.
- ALLISON, P. D. 2000. Multiple imputation for missing data - A cautionary tale. *Sociol Method Res*, 28, 301-309.
- ALTRICHTER, H. & HOLLY, M. L. 2005. Research diaries. In: ALASZEWSKI, A. (ed.) *Research methods in the social sciences*. SAGE Publications Ltd.24-33.
- AMARAL, R. C., SCABAR, L. F., SLATER, B. & FRAZÃO, P. 2014. Estimates of self-reported dietary behavior related to oral health among adolescents according to the type of food. *J Appl Oral Sci*, 22, 416-425.
- AMERICAN ACADEMY OF PAEDIATRIC DENTISTRY, A. 2013. *Guideline on Periodicity of Examination, Preventive Dental Services, Anticipatory Guidance/Counseling, and Oral Treatment for Infants, Children, and Adolescents*.
http://www.aapd.org/media/policies_guidelines/g_periodicity.pdf.
- AMERICAN ACADEMY OF PEDIATRIC DENTISTRY. 2002. *Guideline on Caries-risk Assessment and Management for Infants, Children, and Adolescents*.http://www.aapd.org/media/policies_guidelines/g_cariesriskassessment.pdf.
- ANDERSON, C. A., CURZON, M. E., VAN LOVEREN, C., TATSI, C. & DUGGAL, M. S. 2009. Sucrose and dental caries: a review of the evidence. *Obes Rev*, 10 Suppl 1, 41-54.
- ARDITO, R. B. & RABELLINO, D. 2011. Therapeutic alliance and outcome of psychotherapy: historical excursus, measurements, and prospects for research. *Front Psychol*, 2, 270.
- ARENS, U. 1999. *Oral health-diet and other factors : the report of the British Nutrition Foundation's Task Force*, Amsterdam, Elsevier.44-75.
- AYTON, J. & HANSEN, E. 2016. Complex young lives: a collective qualitative case study analysis of young fatherhood and breastfeeding. *Int Breastfeed J*, 11, 6.
- BANDURA, A. 1991. Social Cognitive Theory of Self-Regulation. *Organ Behav Hum Decis Process*, 50, 248-287.
- BARTER, C. & RENOLD, E. 1999. The use of vignettes in qualitative research. *Social research update*, 25, 1-6.

- BARTER, C. & RENOLD, E. 2000. 'I wanna tell you a story': Exploring the application of vignettes in qualitative research with children and young people. *Int J Soc Res Meth*, 3, 307-323.
- BARTLEY, E. J., BOISSONEAULT, J., VARGOVICH, A. M., WANDNER, L. D., HIRSH, A. T., LOK, B. C., HEFT, M. W. & ROBINSON, M. E. 2015. The influence of health care professional characteristics on pain management decisions. *Pain Med*, 16, 99-111.
- BARTON, K. L., ANDERSON, A. S., PINE, C. M., PATERSON, M. G., & BURNSIDE, G. 2001. Dietary interventions in general dental practice: an unexplored opportunity for promoting dietary change in low income communities? *Proc Nutr Soc*, 60, 5A.
- BATCHELOR, P. & SHEIHAM, A. 2002. The limitations of a 'high-risk' approach for the prevention of dental caries. *Community Dent Oral Epidemiol*, 30, 302-312.
- BATES, B., LENNOX, A., PRENTICE, A., BATES, C., P., P., NICHOLSON, S. & SWAN, G. 2014. *National Diet and Nutrition Survey: Headline results from Years 1 to 4 (combined) of the rolling programme from 2008 and 2009 to 2011 and 2012*. <https://www.gov.uk/government/publications/national-diet-and-nutrition-survey-results-from-years-1-to-4-combined-of-the-rolling-programme-for-2008-and-2009-to-2011-and-2012>.
- BAXTER, P. & JACK, S. 2008. Qualitative case study methodology: Study design and implementation for novice researchers. *Qual Rep*, 13, 544-559.
- BDJ PRODUCT NEWS 2017. New app looks at diet and the teeth. *Br Dent J*, 222, 60.
- BEATTY, P. C. & WILLIS, G. B. 2007. Research synthesis: The practice of cognitive interviewing. *Public Opini*, 71, 287-311.
- BEDI, R. & BROWN, C. P. 1983. Behavioural principles underlying effective dietary instruction. *J Dent*, 11, 35-40.
- BELL, J. A., HYLAND, S., DEPELLEGRIN, T., UPSHUR, R. E., BERNSTEIN, M. & MARTIN, D. K. 2004. SARS and hospital priority setting: a qualitative case study and evaluation. *BMC Health Serv Res*, 4, 36.
- BERNABÉ, E., VEKALAHTI, M., SHEIHAM, A., LUNDQVIST, A. & SUOMINEN, A. 2016. The Shape of the Dose-Response Relationship between Sugars and Caries in Adults. *J Dent Res*, 95, 167-172.
- BERNABE, E., VEKALAHTI, M. M., SHEIHAM, A., AROMAA, A. & SUOMINEN, A. L. 2014. Sugar-sweetened beverages and dental caries in adults: a 4-year prospective study. *J Dent*, 42, 952-8.
- BLOCH, A. S. 2007. *Issues and choices in clinical nutrition practice*, Lippincott Williams & Wilkins. 163-177.
- BOGDAN, R. & BIKLEN, S. 2007. *Qualitative research for education: An introduction to theory and practice*. Boston: Allyn and Bacon. 13-25.
- BONILLA, C., BRAUER, P., ROYALL, D., KELLER, H., HANNING, R. M. & DICENSO, A. 2015. Use of electronic dietary assessment tools in primary care: an interdisciplinary perspective. *BMC Med Inform Decis Mak.*, 15, 14.
- BOUSHEY, C. J., KERR, D. A., WRIGHT, J., LUTES, K. D., EBERT, D. S. & DELP, E. J. 2009. Use of technology in children's dietary assessment. *Eur J Clin Nutr*, 63 Suppl 1, S50-7.
- BOWEN, G. A. 2008. Naturalistic inquiry and the saturation concept: a research note. *Qual Res*, 8, 137-152.
- BOWEN, G. A. 2009. Document Analysis as a Qualitative Research Method. *Qual. Res J*, 9, 27-40.

- BOWEN, W. H., AMSBAUGH, S. M., MONELL-TORRENS, S., BRUNELLE, J., KUZMIAK-JONES, H. & COLE, M. F. 1980. A method to assess cariogenic potential of foodstuffs. *J Am Dent Assoc*, 100, 677-81.
- BOWER, E., GULLIFORD, M., STEELE, J. & NEWTON, T. 2007. Area deprivation and oral health in Scottish adults: a multilevel study. *Community Dent Oral Epidemiol*, 35, 118-29.
- BOYATZIS, R. E. 1998. *Transforming qualitative information: Thematic analysis and code development*, Sage.
- BOYD, L. & DWYER, J. 1997. Guidelines for nutrition screening, assessment, and intervention in the dental office. *J Dent Hyg*, 72, 31-43.
- BRADSHAW, D. J. & LYNCH, R. J. 2013. Diet and the microbial aetiology of dental caries: new paradigms. *Int Dent J*, 63 Suppl 2, 64-72.
- BRATTHALL, D. & HANSEL PETERSSON, G. 2005. Cariogram--a multifactorial risk assessment model for a multifactorial disease. *Community Dent Oral Epidemiol*, 33, 256-64.
- BRAUN, V. & CLARKE, V. 2006. Using thematic analysis in psychology. *Qual Res Psychol*, 3, 77-101.
- BRITISH DENTAL ASSOCIATION. 2016. *New figures reveal extent of rotten teeth removed in primary care*. [Online]. <https://www.bda.org/news-centre/press-releases/new-figures-reveal-extent-of-rotten-teeth-removed-in-primary-care> [Accessed 23/1/2017 2017].
- BRITTEN, N. 2008. Qualitative interviews. In: MAYS, N. & POPE, C. (eds.) *Qualitative Research in Health Care*. 3rd ed. London,: John Wiley & Sons, Incorporated. 11–19.
- BURKE, L. E., SWIGART, V., WARZISKI TURK, M., DERRO, N. & EWING, L. J. 2009. Experiences of self-monitoring: successes and struggles during treatment for weight loss. *Qual Health Res*, 19, 815-28.
- BURKE, L. E., WARZISKI, M., STARRETT, T., CHOO, J., MUSIC, E., SEREIKA, S., STARK, S. & SEVICK, M. A. 2005. Self-monitoring dietary intake: current and future practices. *J Ren Nutr*, 15, 281-90.
- BURROWS, T., GOLLEY, R. K., KHAMBALIA, A., MCNAUGHTON, S. A., MAGAREY, A., ROSENKRANZ, R. R., ALLLMAN-FARINELLI, M., RANGAN, A. M., TRUBY, H. & COLLINS, C. 2012. The quality of dietary intake methodology and reporting in child and adolescent obesity intervention trials: a systematic review. *Obes Rev*, 13, 1125-38.
- BURROWS, T. L., MARTIN, R. J. & COLLINS, C. E. 2010. A Systematic Review of the Validity of Dietary Assessment Methods in Children when Compared with the Method of Doubly Labeled Water. *J Am Diet Assoc*, 110, 1501-1510.
- BURT, B. A. & EKLUND, S. A. 2005. *Dentistry, dental practice, and the community*, Missouri, Elsevier Health Sciences. 233-259.
- BURT, B. A., EKLUND, S. A., MORGAN, K. J., LARKIN, F. E., GUIRE, K. E., BROWN, L. O. & WEINTRAUB, J. A. 1988. The effects of sugars intake and frequency of ingestion on dental caries increment in a three-year longitudinal study. *J Dent Res*, 67, 1422-9.
- BURT, B. A. & ISMAIL, A. I. 1986. Diet, Nutrition, and Food Cariogenicity. *J Dent Res*, 65, 1475-1484.
- BURT, B. A. & PAI, S. 2001. Sugar consumption and caries risk: a systematic review. *J Dent Educ*, 65, 1017-23.
- CALDWELL, R. C. 1968. The retention and clearance of food from the mouth. *Ann. N. Y. Acad. Sci.*, 153, 64-70.

- CALDWELL, R. C. 1970. Physical properties of foods and their caries-producing potential. *J Dent Res*, 49, 1293-8.
- CALFAS, K. J., ZABINSKI, M. F. & RUPP, J. 2000. Practical nutrition assessment in primary care settings: a review. *Am J Prev Med*, 18, 289-99.
- CAMPAIN, A. C., MORGAN, M. V., EVANS, R. W., UGONI, A., ADAMS, G. G., CONN, J. A. & WATSON, M. J. 2003. Sugar-starch combinations in food and the relationship to dental caries in low-risk adolescents. *Eur J Oral Sci*, 111, 316-25.
- CARTER, M. C., BURLEY, V. J., NYKJAER, C. & CADE, J. E. 2013. Adherence to a smartphone application for weight loss compared to website and paper diary: pilot randomized controlled trial. *J Med Internet Res*, 15, e32.
- CARTER, S. M. & LITTLE, M. 2007. Justifying knowledge, justifying method, taking action: epistemologies, methodologies, and methods in qualitative research. *Qual Health Res*, 17, 1316-28.
- CARVALHO, J. C., EKSTRAND, K. R. & THYLSTRUP, A. 1989. Dental plaque and caries on occlusal surfaces of first permanent molars in relation to stage of eruption. *J Dent Res*, 68, 773-9.
- CASHDAN, E. 1994. A sensitive period for learning about food. *Hum Nat*, 5, 279-91.
- CHAMBERS, D. W., MIRCHEL, R. & LUNDERGAN, W. 2010. An investigation of dentists' and dental students' estimates of diagnostic probabilities. *J Am Dent Assoc*, 141, 656-66.
- CHAMBLISS, H. O. 2004. Behavioral approaches to obesity treatment. *Quest*, 56, 142-149.
- CHESTNUTT, I. & BINNIE, V. 1994. Smoking cessation counselling--a role for the dental profession? *Br Dent J*, 179, 411-415.
- COOK, J. V., DICKINSON, H. O. & ECCLES, M. P. 2009. Response rates in postal surveys of healthcare professionals between 1996 and 2005: An observational study. *BMC Health Serv Res*, 9, 160.
- CRALL, J. J., QUINONEZ, R. B. & ZANDONÁ, A. F. 2015. Caries risk assessment. In: JOEL, H. B. & REBECCA, L. S. (eds.) *Early Childhood Oral Health*. John Wiley & Sons, Inc. 193-220.
- Craven, R&, Kay, E. 2008, Promoting oral health in populations. In: FEJERSKOV, O. & KIDD, E. A. M. (eds.) *Dental caries : The disease and its clinical management*. 2nd ed. Oxford :Wiley-Blackwell, 330-354.
- CROWE, S., CRESSWELL, K., ROBERTSON, A., HUBY, G., AVERY, A. & SHEIKH, A. 2011. The case study approach. *BMC Med Res Methodol*, 11, 100.
- CUMMINGS, S. M., SAVITZ, L. A. & KONRAD, T. R. 2001. Reported response rates to mailed physician questionnaires. *Health Serv Res*, 35, 1347-55.
- CURTIS, E. A. & REDMOND, R. A. 2009. Survey postal questionnaire: optimising response and dealing with non-response. *Nurse Res*, 16, 76-88.
- CURY, J. A., REBELLO, M. A. B. & DELBELCURY, A. A. 1997. In situ relationship between sucrose exposure and the composition of dental plaque. *Caries Res*, 31, 356-360.
- DAVIES, R. M., DAVIES, G. M., ELLWOOD, R. P. & KAY, E. J. 2003. Prevention. Part 4: Toothbrushing: What advice should be given to patients? *Br Dent J*, 195, 135-141.
- DAWES, C. 2008. Salivary flow patterns and the health of hard and soft oral tissues. *J Am Dent Assoc*, 139 Suppl, 18S-24S.
- DENSCOMBE, M. 2014. *The good research guide: for small-scale social research projects*, Maidenhead, Berkshire Open University Press.

- DEPARTMENT OF HEALTH 1991. *Dietary reference values for food energy and nutrients for the United Kingdom*, London: H.M.S.O, 1991.
- DEPARTMENT OF HEALTH 2015. Dental contract reform: Prototypes, Overview document. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/395384/Reform_Document.pdf.
- DICLEMENTE, C. C. & VELASQUEZ, M. M. 2002. Motivational interviewing and the stages of change. *Motivational interviewing: Preparing people for change*, 2, 201-216.
- DILLMAN, D. A. 1991. The Design and Administration of Mail Surveys. *Annu. Rev. Sociol.*, 17, 225-249.
- DILLMAN, D. A., SMYTH, J. D. & CHRISTIAN, L. M. 2014. *Internet, Phone, Mail, and Mixed-Mode Surveys. [electronic book] : The Tailored Design Method*, Somerset : Wiley, 2014.4th ed. 1-19.
- DIMATTEO, M. R., HASKARD-ZOLNIEREK, K. B. & MARTIN, L. R. 2012a. Improving patient adherence: a three-factor model to guide practice. *Health Psychol Rev.*, 6, 74-91.
- DIMATTEO, M. R., HASKARD-ZOLNIEREK, K. B. & MARTIN, L. R. 2012b. Improving patient adherence: a three-factor model to guide practice. *Health Psychology Review*, 6, 74-91.
- DOLAN, T. A., MCNAUGHTON, C. A., DAVIDSON, S. N. & MITCHELL, G. S. 1992. Patient age and general dentists' treatment decisions. *Spec Care Dentist*, 12, 15-20.
- DONG, Y. & PENG, C. Y. 2013. Principled missing data methods for researchers. *Springerplus*, 2, 222.
- DONOVAN, J. L. & BLAKE, D. R. 1992. Patient non-compliance: deviance or reasoned decision-making? *Soc Sci Med*, 34, 507-13.
- DUGGAL, M. S., TOUMBA, K. J., AMAECHI, B. T., KOWASH, M. B. & HIGHAM, S. M. 2001. Enamel demineralization in situ with various frequencies of carbohydrate consumption with and without fluoride toothpaste. *J Dent Res*, 80, 1721-4.
- DYER, T. A. & ROBINSON, P. G. 2006. General health promotion in general dental practice--the involvement of the dental team Part 2: A qualitative and quantitative investigation of the views of practice principals in South Yorkshire. *Br Dent J*, 201, 45-51;.
- EDWARDS, P., ROBERTS, I., CLARKE, M., DIGUISEPPI, C., PRATAP, S., WENTZ, R., KWAN, I. & COOPER, R. 2007. Methods to increase response rates to postal questionnaires. *Cochrane Database Syst Rev*, 2, MR000008.
- Edwards EA, Lumsden J, Rivas C, Steed L, Edwards LA, Thiyagarajan A, Sohanpal R, Caton H, Griffiths J, Munafò MR, Taylor S, Walton RT. (2016) Gamification for health promotion: systematic review of behaviour change techniques in smartphone apps. *BMJ Open*, 6: e012447
- ELO, S. & KYNGAS, H. 2008. The qualitative content analysis process. *J Adv Nurs*, 62, 107-15.
- ELOUAFKAOUI, P., BONETTI, D., CLARKSON, J., STIRLING, D., YOUNG, L. & CASSIE, H. 2015. Is further intervention required to translate caries prevention and management recommendations into practice? *Br Dent J*, 218, E1.
- EPSTEIN, L. H., VALOSKI, A. M., KALARCHIAN, M. A. & MCCURLEY, J. 1995. Do Children Lose and Maintain Weight Easier Than Adults: A Comparison of

- Child and Parent Weight Changes From Six Months to Ten Years. *Obes Res*, 3, 411-417.
- EUROPEAN ACADEMY OF PAEDIATRIC DENTISTRY, E. 2008. Guidelines on Prevention of Early Childhood Caries: An EAPD Policy Document. <http://www.eapd.eu/dat/1722F50D/file.pdf>.
- EVANS, S. C., ROBERTS, M. C., KEELEY, J. W., BLOSSOM, J. B., AMARO, C. M., GARCIA, A. M., STOUGH, C. O., CANTER, K. S., ROBLES, R. & REED, G. M. 2015. Vignette methodologies for studying clinicians' decision-making: Validity, utility, and application in ICD-11 field studies. *Int J Clin Hlth Psyc*, 15, 160-170.
- FEATHERSTONE, J. 2004. The continuum of dental caries—evidence for a dynamic disease process. *J Dent Res*, 83, C39-C42.
- FEATHERSTONE, J. D. 2000. The science and practice of caries prevention. *J Am Dent Assoc*, 131, 887-99.
- FEATHERSTONE, J. D. 2008. Dental caries: a dynamic disease process. *Aust Dent J*, 53, 286-91.
- FEATHERSTONE, J. D., DOMEJEAN-ORLIAGUET, S., JENSON, L., WOLFF, M. & YOUNG, D. 2007. Caries risk assessment in practice for age 6 through adult. *CDA*, 35, 703.
- FEJERSKOV, O. 1995. Strategies in the design of preventive programs. *Adv Dent Res*, 9, 82-8.
- FEREDAY, J. & MUIR-C.E 2006. Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *Int J Qual Meth*, 5, 80-92.
- FINCH, J. 1987. The Vignette Technique in Survey-Research. *Sociology*, 21, 105-114.
- FIRESTONE, A. R., SCHMID, R. & MUHLEMANN, H. R. 1982. Cariogenic effects of cooked wheat starch alone or with sucrose and frequency-controlled feedings in rats. *Arch Oral Biol*, 27, 759-63.
- FISHER-OWENS, S. A., GANSKY, S. A., PLATT, L. J., WEINTRAUB, J. A., SOOBADER, M.-J., BRAMLETT, M. D. & NEWACHECK, P. W. 2007. Influences on Children's Oral Health: A Conceptual Model. *Pediatrics*, 120, e510-e520.
- FONTANA, M. & ZERO, D. T. 2006. Assessing patients' caries risk. *J Am Dent Assoc*, 137, 1231-9.
- FOX, C. 2010. Evidence summary: what do dentists mean by 'prevention' when applied to what they do in their practices? *Br Dent J*, 208, 359-363.
- FRANK, J., HAYES, M. & TAYLOR, J. 2014. The provision of dietary advice by dental practitioners: A review of the literature. *Community Dent Health*, 31, 9-14.
- FREEMAN, R. 1999a. Barriers to accessing and accepting dental care. *Br Dent J*, 187, 81-4.
- FREEMAN, R. 1999b. The psychology of dental patient care: Communicating effectively: some practical suggestions. *Br Dent J*, 187, 240-244.
- FREEMAN, R. 1999c. the psychology of dental patient care: Strategies for motivating the non-compliant patient. *Br Dent J*, 187, 307-312.
- GAFNI, A., CHARLES, C. & WHELAN, T. 1998. The physician-patient encounter: The physician as a perfect agent for the patient versus the informed treatment decision-making model. *Soc Sci Med*, 47, 347-354.

- GAO, X., LO, E. C., KOT, S. C. & CHAN, K. C. 2014. Motivational interviewing in improving oral health: a systematic review of randomized controlled trials. *J Periodontol*, 85, 426-37.
- GARRITY, T. F. 1981. Medical compliance and the clinician-patient relationship: a review. *Soc Sci Med* 15, 215-22.
- GEARING, R. E., MIAN, I. A., BARBER, J. & ICKOWICZ, A. 2006. A methodology for conducting retrospective chart review research in child and adolescent psychiatry. *J Can Acad Child Adolesc Psychiatry*, 15, 126-34.
- GEDDES, D. A. 1994. Diet patterns and caries. *Adv Dent Res*, 8, 221-4.
- GHAURI, P. 2004. Designing and conducting case studies in international business research. *Handbook of qualitative research methods for international business*, Blackwell's.109-124.
- GILL, P., STEWART, K., TREASURE, E. & CHADWICK, B. 2008. Methods of data collection in qualitative research: interviews and focus groups. *Br Dent J*, 204, 291-5.
- GILMORE, D., STURMEY, P. & NEWTON, J. T. 2006. A comparison of the impact of information from a clinician and research-based information on patient treatment choice in dentistry. *J Public Health Dent*, 66, 242-7.
- GLANZ, K., MURPHY, S., MOYLAN, J., EVENSEN, D. & CURB, J. D. 2006. Improving dietary self-monitoring and adherence with hand-held computers: a pilot study. *Am J Health Promot*, 20, 165-70.
- GONDOLF, U. H., TETENS, I., HILLS, A. P., MICHAELSEN, K. F. & TROLLE, E. 2012. Validation of a pre-coded food record for infants and young children. *Eur J Clin Nutr*, 66, 91-6.
- GOODWIN, M., SANDERS, C., DAVIES, G., WALSH, T. & PRETTY, I. A. 2015. Issues arising following a referral and subsequent wait for extraction under general anaesthetic: impact on children. *BMC Oral Health*, 15, 1-7.
- GOULD, D. 1996. Using vignettes to collect data for nursing research studies: how valid are the findings? *J Clin Nurs*, 5, 207-212.
- GRANEHEIM, U. H. & LUNDMAN, B. 2004. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Educ Today*, 24, 105-12.
- GREEN, A. S., RAFAELI, E., BOLGER, N., SHROUT, P. E. & REIS, H. T. 2006. Paper or plastic? Data equivalence in paper and electronic diaries. *Psychol Methods*, 11, 87-105.
- GRENBY, T. H. & PATERSON, F. M. 1972. Effect of sweet biscuits on the incidence of dental caries in rats. *Br J Nutr*, 27, 195-9.
- GROL, R. & WENSING, M. 2004. What drives change? Barriers to and incentives for achieving evidence-based practice. *Med J Aust*, 180, S57.
- GROVES, R. M. & PEYTCHEVA, E. 2008. The impact of nonresponse rates on nonresponse bias - A meta-analysis. *Public Opin*, 72, 167-189.
- GUSTAFSSON, B. E., QUENSEL, C. E., LANKE, L. S., LUNDQVIST, C., GRAHNEN, H., BONOW, B. E. & KRASSE, B. 1954. The Vipeholm dental caries study; the effect of different levels of carbohydrate intake on caries activity in 436 individuals observed for five years. *Acta Odontol Scand*, 11, 232-64.
- HAN, J. C., LAWLOR, D. A. & KIMM, S. Y. 2010. Childhood obesity. *Lancet*, 375, 1737-48.
- HARRIS, R. & BRIDGMAN, C. 2010. Introducing care pathway commissioning to primary dental care: the concept. *Br Dent J*, 209, 233-9.

- HARRIS, R., BROWN, S., HOLT, R. & PERKINS, E. 2014. Do institutional logics predict interpretation of contract rules at the dental chair-side? *Soc Sci Med*, 122, 81-89.
- HARRIS, R., GAMBOA, A., DAILEY, Y. & ASHCROFT, A. 2012. One-to-one dietary interventions undertaken in a dental setting to change dietary behaviour. *Cochrane Database Syst Rev*, 3.
- HARRIS, R. & HOLT, R. 2013. Interacting institutional logics in general dental practice. *Soc Sci Med*, 94, 63-70.
- HARRIS, R., NICOLL, A. D., ADAIR, P. M. & PINE, C. M. 2004. Risk factors for dental caries in young children: a systematic review of the literature. *Community Dent Health*, 21, 71-85.
- HARRIS, R., PERKINS, E., HOLT, R. D., BROWN, S., GARNER, J., MOSEDALE, S., MOSS, P. & FARRIER, A. 2015. Contracting with General Dental Services: a mixed-methods study on factors influencing responses to contracts in English general dental practice. *Health Serv Deliv Res*, 3, 1-222.
- HARRISON, R., BENTON, T., EVERSON-STEWART, S. & WEINSTEIN, P. 2007. Effect of motivational interviewing on rates of early childhood caries: a randomized trial. *Pediatr Dent*, 29, 16-22.
- HAYATI REZVAN, P., LEE, K. J. & SIMPSON, J. A. 2015. The rise of multiple imputation: a review of the reporting and implementation of the method in medical research. *BMC Med Res Methodol*, 15, 30.
- HAYDEN, C., BOWLER, J. O., CHAMBERS, S., FREEMAN, R., HUMPHRIS, G., RICHARDS, D. & CECIL, J. E. 2013. Obesity and dental caries in children: a systematic review and meta-analysis. *Community Dent Oral Epidemiol*, 41, 289-308.
- HEALTH RESEARCH AUTHORITY. 2016. *Consent and participant information* [Online]. <http://www.hra.nhs.uk/> [Accessed 1.1 2016].
- HETTEMA, J., STEELE, J. & MILLER, W. R. 2005. Motivational interviewing. *Annu. Rev. Clin. Psychol.*, 1, 91-111.
- HILL, A. B. 1965. The Environment and Disease: Association or Causation? President's Address. *Proc R Soc Med*, 58, 295-300.
- HOLBROOK, W. P., ARNADOTTIR, I. B., TAKAZOE, I., BIRKHED, D. & FROSTELL, G. 1995. Longitudinal-Study of Caries, Cariogenic Bacteria and Diet in Children Just before and after Starting School. *Eur J Oral Sci*, 103, 42-45.
- HOLBROOK, W. P., KRISTINSSON, M. J., GUNNARSDOTTIR, S. & BRIEM, B. 1989. Caries Prevalence, Streptococcus-Mutans and Sugar Intake among 4-Year-Old Urban Children in Iceland. *Community Dent Oral Epidemiol*, 17, 292-295.
- HOLMES, B., DICK, K. & NELSON, M. 2008. A comparison of four dietary assessment methods in materially deprived households in England. *Public Health Nutr*, 11, 444-56.
- HOLT, R. D. 1991. Foods and Drinks at 4 Daily Time Intervals in a Group of Young-Children. *Br Dent J*, 170, 137-143.
- HOOLEY, M., SKOUTERIS, H., BOGANIN, C., SATUR, J. & KILPATRICK, N. 2012. Parental influence and the development of dental caries in children aged 0-6 years: a systematic review of the literature. *J Dent*, 40, 873-85.
- HOWITT, D. & CRAMER, D. 2007. *Introduction to research methods in psychology*, Harlow : Pearson/Prentice Hall.164-186.

- HSIEH, H. F. & SHANNON, S. E. 2005. Three approaches to qualitative content analysis. *Qual Health Res*, 15, 1277-88.
- HUGHES, R. 1998. Considering the vignette technique and its application to a study of drug injecting and HIV risk and safer behaviour. *Sociol. Health Illn*, 20, 381-400.
- HUGHES, R. & HUBY, M. 2002. The application of vignettes in social and nursing research. *J Adv Nurs*, 37, 382-6.
- HUMPHREY, S. P. & WILLIAMSON, R. T. 2001. A review of saliva: normal composition, flow, and function. *J Prosthet Dent*, 85, 162-9.
- HUUMONEN, S., TJADERHANE, L. & LARMAS, M. 1997. Greater concentration of dietary sucrose decreases dentin formation and increases the area of dentinal caries in growing rats. *J Nutr*, 127, 2226-30.
- ILLINGWORTH, R. S. & LISTER, J. 1964. The Critical or Sensitive Period, with Special Reference to Certain Feeding Problems in Infants and Children. *J Pediatr*, 65, 839-48.
- ILLNER, A. K., FREISLING, H., BOEING, H., HUYBRECHTS, I., CRISPIM, S. P. & SLIMANI, N. 2012. Review and evaluation of innovative technologies for measuring diet in nutritional epidemiology. *Int J Epidemiol*, 41, 1187-203.
- INKSTER, M. E., DONNAN, P. T., MACDONALD, T. M., SULLIVAN, F. M. & FAHEY, T. 2006. Adherence to antihypertensive medication and association with patient and practice factors. *J Hum Hypertens*, 20, 295-297.
- JACKSON, S. L., VANN JR, W. F., KOTCH, J. B., PAHEL, B. T. & LEE, J. Y. 2011. Impact of poor oral health on children's school attendance and performance. *American Journal of Public Health*, 101, 1900-1906.
- JIN, J., SKLAR, G. E., MIN SEN OH, V. & CHUEN LI, S. 2008. Factors affecting therapeutic compliance: A review from the patient's perspective. *Ther Clin Risk Manag*, 4, 269-86.
- JOHANSSON, I. 1993. Diet counselling and behaviour change. *Caries Res*, 27 Suppl 1, 47-9.
- KALSBECK, H. & VERRIPS, G. H. 1994. Consumption of sweet snacks and caries experience of primary school children. *Caries Res*, 28, 477-83.
- KANER, E., HAIGHTON, C. A. & MCAVOY, B. R. 1998. 'So much post, so busy with practice--so, no time!': a telephone survey of general practitioners' reasons for not participating in postal questionnaire surveys. *Brit J Gen Pract*, 48, 1067-1069.
- KARDAS, P., LEWEK, P. & MATYJASZCZYK, M. 2013. Determinants of patient adherence: a review of systematic reviews. *Front Pharmacol*, 4, 91.
- KASHKET, S. & DEPAOLA, D. P. 2002. Cheese consumption and the development and progression of dental caries. *Nutr Rev*, 60, 97-103.
- KASHKET, S., VANHOUTE, J., LOPEZ, L. R. & STOCKS, S. 1991. Lack of Correlation between Food Retention on the Human Dentition and Consumer Perception of Food Stickiness. *J Dent Res*, 70, 1314-1319.
- KASHKET, S., ZHANG, J. & VANHOUTE, J. 1996. Accumulation of fermentable sugars and metabolic acids in food particles that become entrapped on the dentition. *J Dent Res*, 75, 1885-1891.
- KASSEBAUM, N. J., BERNABE, E., DAHIYA, M., BHANDARI, B., MURRAY, C. J. & MARCENES, W. 2015. Global burden of untreated caries: a systematic review and metaregression. *J Dent Res*, 94, 650-8.
- KASTE, L. M., SELWITZ, R. H., OLDAKOWSKI, R. J., BRUNELLE, J. A., WINN, D. M. & BROWN, L. J. 1996. Coronal caries in the primary and permanent

- dentition of children and adolescents 1-17 years of age: United States, 1988-1991. *J Dent Res*, 75 Spec No, 631-41.
- KAY, E., VASCOTT, D., HOCKING, A., NIELD, H., DORR, C. & BARRETT, H. 2016a. A review of approaches for dental practice teams for promoting oral health. *Community Dent Oral Epidemiol*, 44, 313-30.
- KAY, E. J., VASCOTT, D., HOCKING, A. & NIELD, H. 2016b. Motivational interviewing in general dental practice: A review of the evidence. *Br Dent J*, 221, 785-791.
- KELLY, S. A. & MOYNIHAN, P. J. 2008. Attitudes and practices of dentists with respect to nutrition and periodontal health. *Br Dent J*, 205, E9; discussion 196-7.
- KHATAMI, S. & MACENTEE, M. I. 2011. Evolution of clinical reasoning in dental education. *J Dent Educ*, 75, 321-8.
- KIDD, E. 2005. *Essentials of Dental Caries: The Disease and Its Management: The disease and its management*, Oxford University Press.88-107.
- KIWANUKA, S. N., ASTROM, A. N. & TROVIK, T. A. 2006. Sugar snack consumption in Ugandan schoolchildren: Validity and reliability of a food frequency questionnaire. *Community Dent Oral Epidemiol*, 34, 372-80.
- KNUDSEN, V. K., GILLE, M. B., NIELSEN, T. H., CHRISTENSEN, T., FAGT, S. & BILTOFT-JENSEN, A. 2011. Relative validity of the pre-coded food diary used in the Danish National Survey of Diet and Physical Activity. *Public Health Nutr*, 14, 2110-2116.
- KONDRACKI, N. L., WELLMAN, N. S. & AMUNDSON, D. R. 2002. Content analysis: Review of methods and their applications in nutrition education. *J Nutr Educ Behav*, 34, 224-230.
- KÖNIG, K., SCHMID, P. & SCHMID, R. 1968. An apparatus for frequency-controlled feeding of small rodents and its use in dental caries experiments. *Arch Oral Biol*, 13, 13-IN7.
- KRAVIT, A. S. & TREASURE, E. T. 2009. Manual of dental practice version 4.1. Cardiff: The Council of European Dentists
- KRIPPENDORFF, K. 2012. *Content analysis: An introduction to its methodology*, Sage.
- KVALE, S. 2007. Epistemological issues of interviewing. In: KVALE, S. (ed.) *Doing Interviews*. London, England: SAGE Publications, Ltd. 1116-1138.
- LACSON, R. & LONG, W. 2006. Natural language processing of spoken diet records (SDRs). *AMIA Annu Symp Proc*, 2006, 454-8.
- LANIGAN, J. A., WELLS, J. C. K., LAWSON, M. S., COLE, T. J. & LUCAS, A. 2004. Number of days needed to assess energy and nutrient intake in infants and young children between 6 months and 2 years of age. *Eur J Clin Nutr*, 58, 745-750.
- LAZARE, A. 1987. Shame and humiliation in the medical encounter. *Arch Intern Med*, 147, 1653-8.
- LEE, J. G. & BREARLEY MESSER, L. J. 2011. Contemporary fluid intake and dental caries in Australian children. *Aust Dent J*, 56, 122-31.
- LEME, P., DALCICO, R., TABCHOURY, M., CURY, D., ROSALEN, L. & CURY, A. 2004. In situ effect of frequent sucrose exposure on enamel demineralization and on plaque composition after APF application and F dentifrice use. *J Dent Res*, 83, 71-75.

- LEME, A. F. P., KOO, H., BELLATO, C. M., BEDI, G. & CURY, J. A. 2006. The role of sucrose in cariogenic dental biofilm formation - New insight. *J Dent Res*, 85, 878-887.
- LENANDER-LUMIKARI, M. & LOIMARANTA, V. 2000. Saliva and dental caries. *Adv Dent Res*, 14, 40-7.
- LEVIN, K. A. 2006. Study design III: Cross-sectional studies. *Evid Based Dent*, 7, 24-5.
- LEVINE, R. S. 2001. Caries experience and bedtime consumption of sugar-sweetened food and drinks--a survey of 600 children. *Community Dent Health*, 18, 228-231.
- LEVINE, R. S., NUGENT, Z. J., RUDOLF, M. C. & SAHOTA, P. 2007. Dietary patterns, toothbrushing habits and caries experience of schoolchildren in West Yorkshire, England. *Community Dent Health*, 24, 82-7.
- LEVY, T. A. & RAAB, C. A. 1993. A study of the dietary counseling practices among Oregon dental hygienists. *J Dent Hyg*, 67, 93-100.
- LEWIS-BECK, M., BRYMAN, A. E. & LIAO, T. F. 2003. *The Sage encyclopedia of social science research methods*, Sage Publications.
- LIEFFERS, J. R. & HANNING, R. M. 2012. Dietary assessment and self-monitoring with nutrition applications for mobile devices. *Can J Diet Pract Res*, 73, e253-60.
- LINDNER, J. R., MURPHY, T. H. & BRIERS, G. E. 2001. Handling nonresponse in social science research. *J Agric Educ*, 42, 43-53.
- LINGSTROM, P., VAN HOUTE, J. & KASHKET, S. 2000. Food starches and dental caries. *Crit Rev Oral Biol Med*, 11, 366-80.
- LIVINGSTONE, M. B., ROBSON, P. J. & WALLACE, J. M. 2004. Issues in dietary intake assessment of children and adolescents. *Br J Nutr*, 92 Suppl 2, S213-22.
- LLENA, C. & FORNER, L. 2008. Dietary habits in a child population in relation to caries experience. *Caries Res*, 42, 387-93.
- LOCKER, D. 2000. Response and nonresponse bias in oral health surveys. *J Public Health Dent*, 60, 72-81.
- LOESCHE, W. J. 1986. Role of Streptococcus mutans in human dental decay. *Microbiol Rev*, 50, 353-80.
- LUDWIG, D. S., PETERSON, K. E. & GORTMAKER, S. L. 2001. Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet*, 357, 505-508.
- LUKE, G. A., GOUGH, H., BEELEY, J. A. & GEDDES, D. A. 1999. Human salivary sugar clearance after sugar rinses and intake of foodstuffs. *Caries Res*, 33, 123-9.
- LYNCH, R. J. 2013. The primary and mixed dentition, post-eruptive enamel maturation and dental caries: a review. *Int Dent J*, 63 Suppl 2, 3-13.
- MACDONALD, S. E., NEWBURN-COOK, C. V., SCHOPFLOCHER, D. & RICHTER, S. 2009. Addressing nonresponse bias in postal surveys. *Public Health Nurs*, 26, 95-105.
- MACHIN, D., CAMPBELL, M. J., TAN, S.-B. & TAN, S.-H. 2011. *Sample size tables for clinical studies*, John Wiley & Sons. 1-315.
- MALHOTRA, A. 2013. The dietary advice on added sugar needs emergency surgery. *BMJ*, 346, f3199.
- MALIK, V. S., POPKIN, B. M., BRAY, G. A., DESPRES, J. P., WILLETT, W. C. & HU, F. B. 2010. Sugar-sweetened beverages and risk of metabolic syndrome and type 2 diabetes: a meta-analysis. *Diabetes Care*, 33, 2477-83.

- MALTERUD, K. 2001. Qualitative research: standards, challenges, and guidelines. *The lancet*, 358, 483-488.
- MANDAL, A., EADEN, J., MAYBERRY, M. K. & MAYBERRY, J. F. 2000. Questionnaire surveys in medical research. *J Eval Clin Pract*, 6, 395-403.
- MANJI, F. & FEJERSKOV, O. 1994. An epidemiological approach to dental caries. *In: THYLSTRUP, A. & FEJERSKOV, O. (eds.) Textbook of clinical cariology. Copenhagen: Munksgaard.* 2nd ed. 159-191.
- MARCENES, W., KASSEBAUM, N. J., BERNABE, E., FLAXMAN, A., NAGHAVI, M., LOPEZ, A. & MURRAY, C. J. 2013. Global burden of oral conditions in 1990-2010: a systematic analysis. *J Dent Res*, 92, 592-7.
- MARSH, P. 1990. Sugar, fluoride, pH and microbial homeostasis in dental plaque. *Proceedings of the Finnish Dental Society. Suomen Hammaslaakariseuran toimituksia*, 87, 515-525.
- MARSH, P. & MARTIN, M. V. 2009. Plaque-mediated diseases – dental caries and periodontal diseases. *In: MARSH, P. & MARTIN, M. V. (eds.) Oral microbiology. [electronic book]. Edinburgh : Churchill Livingstone, 2009.* 5th ed. 104-144.
- MARSH, P. D. 1994. Microbial ecology of dental plaque and its significance in health and disease. *Adv Dent Res*, 8, 263-71.
- MARSHALL, T. A. 2003. Diet and nutrition in pediatric dentistry. *Dent Clin North Am*, 47, 279-303.
- MARSHALL, T. A. 2004. Caries prevention in pediatrics: dietary guidelines. *Quintessence Int*, 35, 332-5.
- MARSHALL, T. A. 2009. Chairside diet assessment of caries risk. *J Am Dent Assoc*, 140, 670-4.
- MARSHALL, T. A., EICHENBERGER-GILMORE, J. M., BROFFITT, B. A., WARREN, J. J. & LEVY, S. M. 2007. Dental caries and childhood obesity: roles of diet and socioeconomic status. *Community Dent Oral Epidemiol*, 35, 449-58.
- MARSHALL, T. A., LEVY, S. M., BROFFITT, B., WARREN, J. J., EICHENBERGER-GILMORE, J. M., BURNS, T. L. & STUMBO, P. J. 2003. Dental caries and beverage consumption in young children. *Pediatrics*, 112, e184-91.
- MARTHALER, T. M. 1990. Changes in the Prevalence of Dental Caries: How Much Can Be Attributed to Changes in Diet? *Caries Res*, 24(suppl 1), 3-15.
- MARTIN, B. J. & ALTMAN, D. G. 1986. Statistical Methods for Assessing Agreement between Two Methods of Clinical Measurement. *Lancet*, 327, 307-310.
- MAUPOME, G., SCHRADER, S., MANNAN, S., GARETTO, L. & EGGERTSSON, H. 2010. Diagnostic thinking and information used in clinical decision-making: a qualitative study of expert and student dental clinicians. *BMC Oral Health*, 10, 11.
- MAUPOMÉ, G. & SHEIHAM, A. 2000. Clinical decision-making in restorative dentistry. Content-analysis of diagnostic thinking processes and concurrent concepts used in an educational environment. *Eur J Dent Educ.*, 4, 143-152.
- MAYS, N. & POPE, C. 2000. Qualitative research in health care. Assessing quality in qualitative research. *BMJ*, 320, 50-2.
- MCCOLL, E., JACOBY, A., THOMAS, L., SOUTTER, J., BAMFORD, C., STEEN, N., THOMAS, R., HARVEY, E., GARRATT, A. & BOND, J. 2001. Design

- and use of questionnaires: a review of best practice applicable to surveys of health service staff and patients. *Health Technol Assess*, 5, 1-256.
- MCGLONE, P., WATT, R. & SHEIHAM, A. 2001. Evidence-based dentistry: an overview of the challenges in changing professional practice. *Br Dent J*, 190, 636-9.
- MCHUGH, M. L. 2012. Interrater reliability: the kappa statistic. *Biochemia Medica*, 22, 276-282.
- MCLENNAN, D., BARNES, H., NOBLE, M., DAVIES, J. & GARRATT, E. 2011. The English Indices of Deprivation 2010. *Crown*.
- MEJARE, I., AXELSSON, S., DAHLEN, G., ESPELID, I., NORLUND, A., TRANAEUS, S. & TWETMAN, S. 2014. Caries risk assessment. A systematic review. *Acta Odontol Scand*, 72, 81-91.
- MEJARE, I., KÄLLESTÅL, C., STENLUND, H. & JOHANSSON, H. 1997. Caries Development from 11 to 22 Years of Age: A Prospective Radiographic Study Prevalence and Distribution. *Caries Res*, 32, 10-16.
- MERRIAM, S. B. & TISDELL, E. J. 2015. *Qualitative research: A guide to design and implementation*, John Wiley & Sons.
- MICHIE, S., ABRAHAM, C., WHITTINGTON, C., MCATEER, J. & GUPTA, S. 2009. Effective techniques in healthy eating and physical activity interventions: a meta-regression. *Health Psychol*, 28, 690-701.
- MICHIE, S., ASHFORD, S., SNIEHOTTA, F. F., DOMBROWSKI, S. U., BISHOP, A. & FRENCH, D. P. 2011. A refined taxonomy of behaviour change techniques to help people change their physical activity and healthy eating behaviours: The CALO-RE taxonomy. *Psychol Health*, 26, 1479-1498.
- MICHIE, S. & JOHNSTON, M. 2012. Theories and techniques of behaviour change: Developing a cumulative science of behaviour change. *Health Psychol Rev*, 6, 1-6.
- MILLS, A. J., DUREPOS, G. & WIEBE, E. 2009. *Encyclopedia of case study research*, Sage Publications.
- MOBLEY, C. & DOUNIS, G. 2010. Evaluating dietary intake in dental practices: doing it right. *J Am Dent Assoc*, 141, 1236-41.
- MORGAN, M., FAIRCHILD, R., PHILLIPS, A., STEWART, K. & HUNTER, L. 2009. A content analysis of children's television advertising: focus on food and oral health. *Public Health Nutr*, 12, 748-55.
- MOYNIHAN, P. 2016. Sugars and Dental Caries: Evidence for Setting a Recommended Threshold for Intake. *Adv Nutr*, 7, 149-56.
- MOYNIHAN, P., LINGSTRÖM, P., RUGG-GUNN, A. & BIRKHED, D. 2003. The role of dietary control. *Dental caries: the disease and its clinical management*, 223-42.
- MOYNIHAN, P. & PETERSEN, P. E. 2004. Diet, nutrition and the prevention of dental diseases. *Public Health Nutr*, 7, 201-26.
- MOYNIHAN, P. J. 1995. The relationship between diet, nutrition and dental health: An overview and update for the 90s. *Nutrition research reviews*, 8, 193-224.
- MOYNIHAN, P. J. 1998. Update on the nomenclature of carbohydrates and their dental effects. *J Dent*, 26, 209-218.
- MOYNIHAN, P. J. 2002. Dietary advice in dental practice. *Br Dent J*, 193, 563-8.
- MOYNIHAN, P. J. & KELLY, S. A. 2014. Effect on caries of restricting sugars intake: systematic review to inform WHO guidelines. *J Dent Res*, 93, 8-18.
- MOYNIHAN, P. J. & LINGSTRÖM, P. 2005. Oral Consequences of Compromised Nutritional Well-Being. In: TOUGER-DECKER, R., SIROIS, D. A. &

- MOBLEY, C. C. (eds.) *Nutrition and Oral Medicine*. Totowa, NJ: Humana Press.107-127.
- MULHALL, A. 2003. In the field: notes on observation in qualitative research. *J Adv Nurs*, 41, 306-13.
- MURRAY, J. J., VERNAZZA, C. R. & HOLMES, R. D. 2015. Forty years of national surveys: An overview of children's dental health from 1973-2013. *Br Dent J*, 219, 281-285.
- NAPOLITANO, D. 2009. Getting the message. *Occup Health Saf*, 78, 28-9.
- NATIONAL INSTITUTE FOR HEALTH AND CARE EXCELLENCE 2015. Oral health promotion: general dental practice NICE guidelines [NG30].
- NATIONAL INSTITUTES OF HEALTH 2001. Diagnosis and management of dental caries throughout life. *NIH consensus statement*, 18, 1.
- NEUENDORF, K. A. 2002. *The content analysis guidebook*, Sage.
- NEUMARK-SZTAINER, D., STORY, M., HANNAN, P. J. & CROLL, J. 2002. Overweight status and eating patterns among adolescents: where do youths stand in comparison with the healthy people 2010 objectives? *Am J Public Health*, 92, 844-851.
- NEWBRUN, E. 1982. Sugar and dental caries: a review of human studies. *Science*, 217, 418-23.
- NEWTON, J. T. & ASIMAKOPOULOU, K. 2015. Managing oral hygiene as a risk factor for periodontal disease: a systematic review of psychological approaches to behaviour change for improved plaque control in periodontal management. *J Clin Periodontol*, 42 Suppl 16, S36-46.
- NGO, J., ENGELEN, A., MOLAG, M., ROESLE, J., GARCIA-SEGOVIA, P. & SERRA-MAJEM, L. 2009. A review of the use of information and communication technologies for dietary assessment. *Brit J Nutr*, 101, S102-S112.
- NHS CHOICES. 2016. *NHS dental services* [Online]. <http://www.nhs.uk/NHSEngland/AboutNHSservices/dentists/Pages/find-an-NHS-dentist.aspx> [Accessed 19/7/2016 2016].
- NHS FUTURE FORUM 2012 NHS Future Forum – Summary Report Second Phase. . In: HEALTH, D. O. (ed.). London: : NHS Future Forum.
- NHS England. 2014. *NHS five year forward view*. <https://www.england.nhs.uk/wp-content/uploads/2014/10/5yfv-web.pdf>
- NICHOLLS, C. 2006. A retrospective study of compliance (adherence) with a care pathway in periodontal therapy in a primary care setting. *Br Dent J*, 201, 709-712.
- NISBET, J. & WATT, J. 1984. Case Study. In: BELL, J. & GOULDING, S. (eds.) *Conducting Small-Scale Investigations in Educational Management*. London Harper & Row. 79-92.
- NIZEL, A. E. & PAPAS, A. S. 1989. *Nutrition in clinical dentistry*, Philadelphia: Saunders, 1989.3rd ed. 417-450.
- NOAR, S. M., BENAC, C. N. & HARRIS, M. S. 2007. Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. *Psychological bulletin*, 133, 673.
- O'DONNELL, J. A., MODESTO, A., OAKLEY, M., POLK, D. E., VALAPPIL, B. & SPALLEK, H. 2013. Sealants and dental caries: insight into dentists' behaviors regarding implementation of clinical practice recommendations. *J Am Dent Assoc*, 144, e24-30.

- O'NEILL, H. W. 1984. Opinion study comparing attitudes about dental health. *J Am Dent Assoc*, 109, 910-915.
- OLIVEBY, A., WEETMAN, D. A., GEDDES, D. A. & LAGERLOF, F. 1990. The effect of salivary clearance of sucrose and fluoride on human dental plaque acidogenicity. *Arch Oral Biol*, 35, 907-11.
- Onwuegbuzie, A.J., Bustamante, R.M. and Nelson, J.A., 2010. Mixed research as a tool for developing quantitative instruments. *J Mix Methods Res*, 4, 56-78.
- PALMER, C. A. 2005. Dental caries and obesity in children: different problems, related causes. *Quintessence Int*, 36, 457-61.
- PATERSON, B. L., BOTTORFF, J. L. & HEWAT, R. 2003. Blending Observational Methods: Possibilities, Strategies, and Challenges. *Int J Qual Meth*, 2, 29-38.
- PATRICK, H. & NICKLAS, T. A. 2005. A review of family and social determinants of children's eating patterns and diet quality. *J Am Coll Nutr*, 24, 83-92.
- PEARCE, E. 1998. Plaque minerals and dental caries. *N Z Dent J*, 94, 12-5.
- PEARSON, S. D. & RAEKE, L. H. 2000. Patients' trust in physicians: many theories, few measures, and little data. *J Gen Intern Med*, 15, 509-13.
- PERES, M. A., SHEIHAM, A., LIU, P., DEMARCO, F. F., SILVA, A. E., ASSUNCAO, M. C., MENEZES, A. M., BARROS, F. C. & PERES, K. G. 2016. Sugar Consumption and Changes in Dental Caries from Childhood to Adolescence. *J Dent Res*, 95, 388-94.
- PETERSEN, P. E., BOURGEOIS, D., OGAWA, H., ESTUPINAN-DAY, S. & NDIAYE, C. 2005. The global burden of oral diseases and risks to oral health. *Bulletin of the World Health Organization*, 83, 661-669.
- PICKETT, K. E. & PEARL, M. 2001. Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. *J Epidemiol Community Health*, 55, 111-22.
- PIGNONE, M. P., AMMERMAN, A., FERNANDEZ, L., ORLEANS, C. T., PENDER, N., WOOLF, S., LOHR, K. N. & SUTTON, S. 2003. Counseling to promote a healthy diet in adults: a summary of the evidence for the U.S. Preventive Services Task Force. *Am J Prev Med*, 24, 75-92.
- PINE, C., HARRIS, R., BURNSIDE, G. & MERRETT, M. 2006. An investigation of the relationship between untreated decayed teeth and dental sepsis in 5-year-old children. *Br Dent J*, 200, 45-47.
- PITTS, N. B., CHESTNUTT, I. G., EVANS, D., WHITE, D., CHADWICK, B. & STEELE, J. G. 2006. 1 Verifiable CPD Paper: The dental caries experience of children in the United Kingdom, 2003. *Br Dent J*, 200, 313-320.
- POLIT-O'HARA, D. & BECK, C. T. 2006. *Essentials of nursing research: Methods, appraisal, and utilization*, Lippincott Williams & Wilkins.5.
- POTTER, W. J. & LEVINE-DONNERSTEIN, D. 1999. Rethinking validity and reliability in content analysis. *J Appl Commun Res*, 27, 258-284.
- PRESTWICH, A., KELLAR, I., PARKER, R., MACRAE, S., LEARMONTH, M., SYKES, B., TAYLOR, N. & CASTLE, H. 2013. How can self-efficacy be increased? Meta-analysis of dietary interventions. *Health Psychol Rev.*, 1-16.
- PRETZLIK, U. 1994. Observational methods and strategies. *Nurse Researcher*, 2, 13-21.
- PROCHASKA, J. O. 2013. Transtheoretical model of behavior change. *Encyclopedia of behavioral medicine*. Springer. 1997-2000.
- PUBLIC HEALTH ENGLAND 2012. National Dental Epidemiology Programme for England: oral health survey of five-year-old children 2012. A report on the prevalence and severity of dental decay.

- <http://www.nwph.net/dentalhealth/Oral%20Health%205yr%20old%20children%202012%20final%20report%20gateway%20approved.pdf>.
- PUBLIC HEALTH ENGLAND 2014a. Delivering better oral health: an evidence-based toolkit for prevention , Third Edition https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/605266/Delivering_better_oral_health.pdf.
- PUBLIC HEALTH ENGLAND 2017. Delivering better oral health: an evidence-based toolkit for prevention , Third Edition, Last updated: 22 March 2017. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/605266/Delivering_better_oral_health.pdf.
- PUBLIC HEALTH ENGLAND 2014b. Sugar reduction: Responding to the challenge. <https://www.gov.uk/government/publications/sugar-reduction-responding-to-the-challenge>.
- PUBLIC HEALTH ENGLAND 2015. Scientific Advisory Committee on Nutrition (SACN):Carbohydrates and Health report. London: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/445503/SACN_Carbohydrates_and_Health.pdf.
- PUBLIC HEALTH ENGLAND. 2016. *The Change4Life campaign* [Online]. <https://www.gov.uk/government/news/5-year-olds-eat-and-drink-their-body-weight-in-sugar-every-year> [Accessed 1/2/2017 2017].
- RAMSEIER, C. A. & SUVAN, J. E. 2015. Behaviour change counselling for tobacco use cessation and promotion of healthy lifestyles: a systematic review. *J Clin Periodontol*, 42, S47-S58.
- REISINE, S. T. & PSOTER, W. 2001. Socioeconomic status and selected behavioral determinants as risk factors for dental caries. *J Dent Educ*, 65, 1009-1016.
- RESNIK, D. B. 2007. Responsibility for health: personal, social, and environmental. *J Med Ethics*, 33, 444-5.
- REYNA, V. F. 2008. A theory of medical decision making and health: fuzzy trace theory. *Med Decis Making*, 28, 850-65.
- RIBEIRO, C. C., TABCHOURY, C. P., DEL BEL CURY, A. A., TENUTA, L. M., ROSALEN, P. L. & CURY, J. A. 2005. Effect of starch on the cariogenic potential of sucrose. *Br J Nutr*, 94, 44-50.
- RICHARDS, W. 2013. Does the general dental practitioner have a role in tackling oral health inequalities? *Prim. Dent. J.*, 2, 58-63.
- RITCHIE, J., LEWIS, J., MCNAUGHTON NICHOLLS, C. & ORMSTON, R. 2013. *Qualitative research practice : a guide for social science students and researchers*, London : SAGE, 138-169.
- ROBERTS, B. L., ANTHONY, M. K., MADIGAN, E. A. & CHEN, Y. 1997. Data management: cleaning and checking. *Nurs Res*, 46, 350-2.
- ROBSON, C. & MCCARTAN, K. 2016. *Real world research: A Resource for Social Scientists and Practitioner-Researchers*. Wiley. 227-268
- ROCKETT, H. R. & COLDITZ, G. A. 1997. Assessing diets of children and adolescents. *Am J Clin Nutr*, 65, 1116S-1122S.
- RODRIGUES, C. & SHEIHAM, A. 2000. The relationships between dietary guidelines, sugar intake and caries in primary teeth in low income Brazilian 3-year-olds: a longitudinal study. *Int J Paediatr Dent*, 10, 47-55.
- ROLLO, M. E., ASH, S., LYONS-WALL, P. & RUSSELL, A. 2011. Trial of a mobile phone method for recording dietary intake in adults with type 2 diabetes: evaluation and implications for future applications. *J Telemed Telecare*, 17, 318-23.

- ROSAL, M. C., EBBELING, C. B., LOFGREN, I., OCKENE, J. K., OCKENE, I. S. & HEBERT, J. R. 2001. Facilitating dietary change: the patient-centered counseling model. *J Am Diet Assoc*, 101, 332-41.
- ROSE, G. 1992. *The strategy of preventive medicine*. Oxford: Oxford University Press, 1-138.
- ROYAL COLLEGE OF SURGEONS. 2015. The state of children's oral health in England. London: Royal College of Surgeons. Faculty of Dental Surgery. <https://www.rcseng.ac.uk/library-and-publications/college-publications/docs/report-childrens-oral-health/>
- RUGG-GUNN, A., EDGAR, W. & JENKINS, G. 1981. Clinical Science The Effect of Altering the Position of a Sugary Food in a Meal Upon Plaque pH in Human Subjects. *J Dent Res*, 60, 867-872.
- RUGG-GUNN, A., HACKETT, A., APPLETON, D., JENKINS, G. & EASTOE, J. 1984. Relationship between dietary habits and caries increment assessed over two years in 405 English adolescent school children. *Arch Oral Biol*, 29, 983-992.
- RUGG-GUNN, A. J., FLETCHER, E. S., MATTHEWS, J. N., HACKETT, A. F., MOYNIHAN, P. J., KELLY, S., ADAMS, J., MATHERS, J. C. & ADAMSON, A. 2007. Changes in consumption of sugars by English adolescents over 20 years. *Public Health Nutr*, 10, 354-63.
- RUGG-GUNN, A. J. & NUNN, J. H. 1999. *Nutrition, diet and oral health*, Oxford University Press. 169-194
- RUGGGUNN, A. J., HACKETT, A. F. & APPLETON, D. R. 1987. Relative Cariogenicity of Starch and Sugars in a 2-Year Longitudinal-Study of 405 English Schoolchildren. *Caries Res*, 21, 464-473.
- RUOTTINEN, S., KARJALAINEN, S., PIENIHAKKINEN, K., LAGSTROM, H., NIINIKOSKI, H., SALMINEN, M., RONNEMAA, T. & SIMELL, O. 2004. Sucrose intake since infancy and dental health in 10-year-old children. *Caries Res*, 38, 142-148.
- RUSSELL, B. H. 1988. *Research methods in cultural anthropology*. SAGE Publications, Inc. 210-251.
- SALE, J. E., LOHFELD, L. H. & BRAZIL, K. 2002. Revisiting the Quantitative-Qualitative Debate: Implications for Mixed-Methods Research. *Qual Quant*, 36, 43-53.
- SANDELOWSKI, M. 1995. Focus on Qualitative Methods - Qualitative-Analysis - What It Is and How to Begin. *Res Nurs Health*, 18, 371-375.
- SANDERS, T. A. 2004. Diet and general health: dietary counselling. *Caries Res*, 38 Suppl 1, 3-8.
- SBARAINI, A., CARTER, S. M., EVANS, R. W. & BLINKHORN, A. 2011. How to do a grounded theory study: a worked example of a study of dental practices. *BMC Med Res Methodol*, 11, 128.
- SCHAMBER, L. 2000. Time-line interviews and inductive content analysis: their effectiveness for exploring cognitive behaviors. *Assoc Inf Sci*, 51, 734-744.
- SCHUZ, N. & FERGUSON, S. G. 2015. Australian Smokers' and Nonsmokers' Exposure to Antismoking Warnings in Day-to-Day Life: A Pilot Study. *Nicotine Tob Res*, 17, 876-81.
- SCOTTISH DENTAL CLINICAL EFFECTIVENESS PROGRAMME 2010. Prevention and Management of Dental Caries in Children. http://www.sdcep.org.uk/wp-content/uploads/2013/03/SDCEP_PM_Dental_Caries_Full_Guidance1.pdf

- SECHREST, L. & SIDANI, S. 1995. Quantitative and qualitative methods:: Is There an Alternative? *Eval Program Plann*, 18, 77-87.
- SELWITZ, R. H., ISMAIL, A. I. & PITTS, N. B. 2007. Dental caries. *Lancet*, 369, 51-9.
- SHEEHY, C., MCNEILL, G., MASSON, L., CRAIG, L., MACDIARMID, J., HOLMES, B. & NELSON, M. 2008. Survey of sugar intake among children in Scotland. Aberdeen, UK: Food Standards Agency (Scotland)
- SHEIHAM, A. 1992. The role of the dental team in promoting dental health and general health through oral health. *Int Dent J*, 42, 223-8.
- SHEIHAM, A. 2001. Dietary effects on dental diseases. *Public Health Nutr*, 4, 569-91.
- SHEIHAM, A. & JAMES, W. P. 2015. Diet and Dental Caries: The Pivotal Role of Free Sugars Reemphasized. *J Dent Res*, 94, 1341-7.
- SHEIHAM, A. & WATT, R. G. 2000. The common risk factor approach: a rational basis for promoting oral health. *Community Dent Oral Epidemiol*, 28, 399-406.
- SHELLEY, A. M., BRUNTON, P. & HORNER, K. 2012. Questionnaire surveys of dentists on radiology. *Dentomaxillofac Radiol*, 41, 267-75.
- SHENTON, A. K. 2004. Strategies for ensuring trustworthiness in qualitative research projects. *Educ Inform* 22, 63-75.
- SHERWOOD, N. E. 2009. Diet assessment in children and adolescents. *Handbook of Childhood and Adolescent Obesity*. Springer. 73-89.
- SHIGLI, K. & AWINASHE, V. 2010. Patient-dentist communication: an adjunct to successful complete denture treatment. *J Prosthodont*, 19, 491-3.
- SIMONS, H. 2009. *Case study research in practice*, SAGE publications.
- SKEIE, M. S., RIORDAN, P. J., KLOCK, K. S. & ESPELID, I. 2006. Parental risk attitudes and caries-related behaviours among immigrant and western native children in Oslo. *Community Dent Oral Epidemiol*, 34, 103-13.
- SMITH, T. 2015. *Qualitative psychology: A practical guide to research methods*. Sage. 1-11.
- SPEIRS, R. L. & DEAN, P. M. 1989. Toffee clearance and lingual sensory and motor activities in normal children and in children with articulation problems of speech. *Arch Oral Biol*, 34, 637-44.
- SREEBNY, L. M. 1981. Sugar and human dental caries. *World Rev Nutr Diet*, 40, 19-65.
- STAKE, R. E. 2000. Case Studies. In: DENZIN, N. K. & LINCOLN, Y. S. (eds.) *The Sage handbook of qualitative research*. Sage. 143-164.
- STECKSENBLICKS, C. 1987. Lactobacilli and Streptococcus Mutans in Saliva, Diet and Caries Increment in 8-Year-Old and 13-Year-Old Children. *Scand J Dent Res*, 95, 18-26.
- STEELE, J. 2009. NHS dental services in England. *London: Department of Health*, 1-86.
- STEELE, J., WHITE, D., ROLLAND, S. & AND FULLER, E. 2015. Child Dental Health Survey 2013. Report 4: The Burden of Dental Disease in Children England, Wales and Northern Ireland.
- STEMLER, S. 2001. An overview of content analysis. *Practical assessment, research & evaluation*, 7, 137-146.
- STEPHENS, J. & ALLEN, J. 2013. Mobile phone interventions to increase physical activity and reduce weight: a systematic review. *J Cardiovasc Nurs*, 28, 320-9.

- STERNE, J. A. C., WHITE, I. R., CARLIN, J. B., SPRATT, M., ROYSTON, P., KENWARD, M. G., WOOD, A. M. & CARPENTER, J. R. 2009. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. *BMJ*, 338.
- STILLMAN-LOWE, C. 2008. Oral health education: what lessons have we learned. *Br Dent J*, 9-13.
- STONE, A. A., SHIFFMAN, S., SCHWARTZ, J. E., BRODERICK, J. E. & HUFFORD, M. R. 2003. Patient compliance with paper and electronic diaries. *Control Clin Trials*, 24, 182-99.
- STOOKEY, G. K. 2008. The effect of saliva on dental caries. *J Am Dent Assoc*, 139 Suppl, 11S-17S.
- STREET, R. L., JR., GORDON, H. & HAIDET, P. 2007. Physicians' communication and perceptions of patients: is it how they look, how they talk, or is it just the doctor? *Soc Sci Med*, 65, 586-98.
- SUN, M., FERNSTROM, J. D., JIA, W., HACKWORTH, S. A., YAO, N., LI, Y., LI, C., FERNSTROM, M. H. & SCLABASSI, R. J. 2010. A wearable electronic system for objective dietary assessment. *J Am Diet Assoc*, 110, 45-7.
- SZPUNAR, S. M., EKLUND, S. A. & BURT, B. A. 1995. Sugar consumption and caries risk in schoolchildren with low caries experience. *Community Dent Oral Epidemiol*, 23, 142-6.
- TAHMASSEBI, J. F., DUGGAL, M. S., MALIK-KOTRU, G. & CURZON, M. E. 2006. Soft drinks and dental health: a review of the current literature. *J Dent*, 34, 2-11.
- TAN, R. T. & BURKE, F. J. T. 1997. Response rates to questionnaires mailed to dentists. A review of 77 publications. *Int Dent J*, 47, 349.
- TAVARES, M., DEWUNDARA, A. & GOODSON, J. M. 2012. Obesity prevention and intervention in dental practice. *Dent Clin North Am*, 56, 831-46.
- TE MORENGA, L., MALLARD, S. & MANN, J. 2013. Dietary sugars and body weight: systematic review and meta-analyses of randomised controlled trials and cohort studies. *BMJ*, 346.
- THE BRITISH SOCIETY OF PAEDIATRIC DENTISTRY, B. 1999. Paediatric Dentistry UK: National Clinical Guidelines and Policy Documents, available at: <http://bspd.co.uk/Resources/BSPD-Guidelines>
- THOMPSON, F. E. & SUBAR, A. F. 2008. Dietary assessment methodology. *Nutrition in the Prevention and Treatment of Disease*, 2, 3-39.
- THOMPSON, F. E. & SUBAR, A. F. 2013. Dietary Assessment Methodology. In: BOUSHEY, C. J. & FERRUZZI, M. G. (eds.) *Nutrition in the Prevention and Treatment of Disease* Academic Press.5-46.
- THOMPSON, F. E., SUBAR, A. F., LORIA, C. M., REEDY, J. L. & BARANOWSKI, T. 2010. Need for technological innovation in dietary assessment. *J Am Diet Assoc*, 110, 48-51.
- THRELFALL, A. G., MILSOM, K. M., HUNT, C. M., TICKLE, M. & BLINKHORN, A. S. 2007. Exploring the content of the advice provided by general dental practitioners to help prevent caries in young children. *Br Dent J*, 202, E9-E9.
- TICKLE, M., BLINKHORN, A. S. & MILSOM, K. M. 2008. The occurrence of dental pain and extractions over a 3-year period in a cohort of children aged 3-6 years. *J Public Health Dent*, 68, 63-9.
- TINANOFF, N., KANELIS, M. J. & VARGAS, C. M. 2002. Current understanding of the epidemiology mechanisms, and prevention of dental caries in preschool children. *Pediatr Dent*, 24, 543-51.

- TINANOFF, N. & PALMER, C. A. 2000. Dietary determinants of dental caries and dietary recommendations for preschool children. *J Public Health Dent*, 60, 197-206; discussion 207-9.
- TJADERHANE, L., BACKMAN, T. & LARMAS, M. 1995. Effect of sucrose and xylitol diets on dentin formation and caries in rat molars. *Eur J Oral Sci*, 103, 166-71.
- TOMLINSON, P. & TREASURE, E. 2006. Provision of prevention to adults in NHS dental practices and attitudes to prevention. *Br Dent J*, 200, 393-7, discussion 387.
- TOUGER-DECKER, R. & VAN LOVEREN, C. 2003. Sugars and dental caries. *Am J Clin Nutr*, 78, 881S-892S.
- US PREVENTIVE SERVICES TASK FORCE 2003. Behavioral counseling in primary care to promote a healthy diet: recommendations and rationale. *Am J Nurs*, 103, 81-92.
- VADIAKAS, G. 2008. Case definition, aetiology and risk assessment of early childhood caries (ECC): a revisited review. *Eur Arch Paediatr Dent*, 9, 114-25.
- VAISMORADI, M., TURUNEN, H. & BONDAS, T. 2013. Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nurs Health Sci*, 15, 398-405.
- VAN DE MORTEL, T. F. 2008. Faking it: social desirability response bias in self-report research. *Aust J Adv Nurs*, 25, 40-48.
- VANOBERGEN, J., MARTENS, L., LESAFFRE, E., BOGAERTS, K. & DECLERCK, D. 2001. The value of a baseline caries risk assessment model in the primary dentition for the prediction of caries incidence in the permanent dentition. *Caries Res*, 35, 442-50.
- VELOSKI, J., TAI, S., EVANS, A. S. & NASH, D. B. 2005. Clinical vignette-based surveys: a tool for assessing physician practice variation. *Am J Med Qual*, 20, 151-7.
- VUCKOVIC, N., RITENBAUGH, C., TAREN, D. L. & TOBAR, M. 2000. A qualitative study of participants' experiences with dietary assessment. *J Am Diet Assoc*, 100, 1023-8.
- WANG, D. H., KOGASHIWA, M. & KIRA, S. 2006. Development of a new instrument for evaluating individuals' dietary intakes. *J Am Diet Assoc*, 106, 1588-93.
- WANYONYI, K. L., THEMESSEL-HUBER, M., HUMPHRIS, G. & FREEMAN, R. 2011. A systematic review and meta-analysis of face-to-face communication of tailored health messages: implications for practice. *Patient Educ Couns*, 85, 348-55.
- WATT, R. G. 2003. New WHO diet and nutrition review: implications for dental disease prevention. *Nutrition*, 19, 1028-9.
- WATT, R. G. 2005. Strategies and approaches in oral disease prevention and health promotion. *Bull World Health Organ*, 83, 711-8.
- WATT, R. G. 2007. From victim blaming to upstream action: tackling the social determinants of oral health inequalities. *Community Dent Oral Epidemiol*, 35, 1-11.
- WATT, R. G. & MARINHO, V. C. 2005. Does oral health promotion improve oral hygiene and gingival health? *Periodontol 2000*, 37, 35-47.
- WATT, R. G., MCGLONE, P. & KAY, E. J. 2003. Prevention. Part 2: Dietary advice in the dental surgery. *Br Dent J*, 195, 27-31.

- WEBER, R. P. 1990. *Basic content analysis*. [electronic book], available at: <https://us.sagepub.com/en-us/nam/basic-content-analysis/book3202>, Newbury Park, [Calif.] ; SAGE, 1-96.
- WELCH, A. 2014. Dietary assessment In: CANDY, J. (ed.) *Manual of Dietetic Practice*. 5th ed.: Wiley-Blackwell.61-71.
- WHITE, B. A. & MAUPOME, G. 2001. Clinical decision-making for dental caries management. *J Dent Educ*, 65, 1121-5.
- WHITE, M. D. & MARSH, E. E. 2006. Content analysis: A flexible methodology. *Libr Trends*, 55, 22-45.
- WHITLOCK, E. P., ORLEANS, C. T., PENDER, N. & ALLAN, J. 2002. Evaluating primary care behavioral counseling interventions: an evidence-based approach. *Am J Prev Med*, 22, 267-84.
- WILFLEY, D. E., KOLKO, R. P. & KASS, A. E. 2011. Cognitive-behavioral therapy for weight management and eating disorders in children and adolescents. *Child Adolesc Psychiatr Clin N Am*, 20, 271-85.
- WILKINS, E. M. & WYCHE, C. J. 2013. *Clinical practice of the dental hygienist*, Philadelphia, Pa. ; Lippincott Williams & Wilkins, 496-516.
- WILLIS, G. B. 2004. *Cognitive interviewing: A tool for improving questionnaire design*, Sage Publications.2-11.
- WITTON R, MOLES D.R . Barriers and facilitators that influence the delivery of prevention guidance in health service dental practice: A questionnaire study of practising dentists in Southwest England. *Community Dent Health* 2013; 30: 71-76.
- WOODWARD, M. & WALKER, A. R. 1994. Sugar consumption and dental caries: evidence from 90 countries. *Br Dent J*, 176, 297-302.
- WORLD HEALTH ORGANISATION 2003. Diet, nutrition and the prevention of chronic diseases: report of a joint WHO/FAO expert consultation. http://apps.who.int/iris/bitstream/10665/42665/1/WHO_TRS_916.pdf.
- WORLD HEALTH ORGANSATION 2015. Guideline:Sugars intake for adults and children. Geneva, Switzerland http://apps.who.int/iris/bitstream/10665/149782/1/9789241549028_eng.pdf.
- YIN, R. K. 2014. *Case study research : design and methods*, 5th ed. Thousand Oaks, California : SAGE Publications, 2-312.
- YIP, J., RADFORD, D. R. & BROWN, D. 2013. How do UK dentists deal with adverse drug reaction reporting? *Br Dent J*, 214.
- YUSUF, H., KOLLIAKOU, A., NTOUVA, A., MURPHY, M., NEWTON, T., TSAKOS, G. & WATT, R. G. 2016. Predictors of dentists' behaviours in delivering prevention in primary dental care in England: using the theory of planned behaviour. *BMC Health Serv Res*, 16, 1.
- ZERO, D. T., MOYNIHAN, P., LAGSTRÖM, P. & BIRKHED, D. 2008. The role of dietary control. In: FEJERSKOV, O. & KIDD, E. A. M. (eds.) *Dental caries : The disease and its clinical management*. 2nd ed. Oxford :Wiley-Blackwell, 330-354.
- ZHANG, Y. & WILDEMUTH, B. M. 2009. Qualitative analysis of content. In: WILDEMUTH, B. M. (ed.) *Applications of social research methods to questions in information and library science*. 2nd ed. Westport, CT: Libraries Unlimited. 3280–3289.

Appendices

Appendix A. Diet diary example extracted from Delivering Better Oral Health Guidelines

Appendix 4.1 Example of a diet diary

Instructions on completing a diet diary

Please write down everything you (or your child if completing on their behalf) eats or drinks and the time during the day when consumed – this will help us to advise you on how best to improve your diet. Choose one weekend day and two others.

Please bring the diet diary with you to the next appointment.

Here is an example to show you how the diary should be filled in:

Record of food and drinks eaten and drink by	
TIME	DAY 1 – Friday
7.30	1 cup of Tropicana orange juice Breakfast - Weetabix + sugar + milk 2 rounds of toast with butter and Marmite
8.30, on the way to school	2 Hobnobs
10.30, school break time	Can of Sprite Muesli health bar
12.45 pm	Ham sandwich, cheese and onion crisps, diet coke
3.30 pm	Banana
6 pm	Roast chicken, potatoes peas, gravy. Rhubarb crumble and custard
7 pm	Packet of Maltesers
8 pm bedtime	Hot chocolate drink and Hobnob

Appendix B.

Appendix C. A systematic search of literature on diet diaries use in dental practice

Database: Ovid MEDLINE(R) and Ovid OLDMEDLINE(R) <1946 to Present with Daily Update>

Search Strategy:

-
- 1 exp dental auxiliaries/ or exp dental assistants/ or exp dental hygienists/ or dental technicians/ or denturists/ (12350)
 - 2 Students, Dental/ (5127)
 - 3 education, dental/ or education, dental, graduate/ (14811)
 - 4 dental.ti,ab. (162380)
 - 5 dentist*.ti,ab. (54779)
 - 6 Oral Health/ (11458)
 - 7 Schools, Dental/ (5784)
 - 8 General Practice, Dental/ (4455)
 - 9 (oral adj3 health).ti,ab. (15535)
 - 10 (dental adj3 pract*).ti,ab. (12005)
 - 11 Preventive Dentistry/ (3098)
 - 12 exp Dental Care/ (26682)
 - 13 dental care setting*.ti,ab. (48)
 - 14 (clinic* adj3 dental).ti,ab. (6164)
 - 15 (clinic* adj3 dental).ti,ab. (6164)
 - 16 (dental adj3 auxiliar*).ti,ab. (633)
 - 17 dental care professional*.ti,ab. (88)
 - 18 general dental practi*.ti,ab. (2426)
 - 19 (clinic* adj3 dentist*).ti,ab. (1796)
 - 20 dental staff/ or dental staff, hospital/ or dentists/ or dentists, women/ or faculty, dental/ (19889)
 - 21 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 (228466)
 - 22 diet record*.ti,ab. (725)
 - 23 (diet adj3 sheet*).ti,ab. (35)
 - 24 (diet adj3 record*).ti,ab. (989)
 - 25 (diet adj3 histor*).ti,ab. (1168)
 - 26 (food adj3 record*).ti,ab. (3115)
 - 27 (food adj3 sheet*).ti,ab. (123)
 - 28 (food adj3 histor*).ti,ab. (681)

- 29 (food adj3 (diary or diaries)).ti,ab. (1019)
- 30 (diet adj3 (diary or diaries)).ti,ab. (288)
- 31 diet diar*.ti,ab. (266)
- 32 food diar*.ti,ab. (889)
- 33 diet* advice.ti,ab. (1528)
- 34 diet* counselling.ti,ab. (349)
- 35 nutrition* counselling.ti,ab. (240)
- 36 (diet* adj3 record*).ti,ab. (2821)
- 37 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 (10523)
- 38 21 and 37 (214)
- 39 limit 38 to (english language and yr="1980 -Current") (199)
- 40 exp dental auxiliaries/ or exp dental assistants/ or exp dental hygienists/ or dental technicians/ or denturists/ (12350)
- 41 Students, Dental/ (5127)
- 42 education, dental/ or education, dental, graduate/ (14811)
- 43 dental.ti,ab. (162380)
- 44 dentist*.ti,ab. (54779)
- 45 Oral Health/ (11458)
- 46 Schools, Dental/ (5784)
- 47 General Practice, Dental/ (4455)
- 48 (oral adj3 health).ti,ab. (15535)
- 49 (dental adj3 pract*).ti,ab. (12005)
- 50 Preventive Dentistry/ (3098)
- 51 exp Dental Care/ (26682)
- 52 dental care setting*.ti,ab. (48)
- 53 (clinic* adj3 dental).ti,ab. (6164)
- 54 (clinic* adj3 dental).ti,ab. (6164)
- 55 (dental adj3 auxiliar*).ti,ab. (633)
- 56 dental care professional*.ti,ab. (88)
- 57 general dental practi*.ti,ab. (2426)
- 58 (clinic* adj3 dentist*).ti,ab. (1796)
- 59 dental staff/ or dental staff, hospital/ or dentists/ or dentists, women/ or faculty, dental/ (19889)
- 60 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 (228466)
- 61 diet record*.ti,ab. (725)
- 62 (diet adj3 sheet*).ti,ab. (35)

- 63 (diet adj3 record*).ti,ab. (989)
- 64 (diet adj3 histor*).ti,ab. (1168)
- 65 (food adj3 record*).ti,ab. (3115)
- 66 (food adj3 sheet*).ti,ab. (123)
- 67 (food adj3 histor*).ti,ab. (681)
- 68 (food adj3 (diary or diaries)).ti,ab. (1019)
- 69 (diet adj3 (diary or diaries)).ti,ab. (288)
- 70 diet diar*.ti,ab. (266)
- 71 food diar*.ti,ab. (889)
- 72 diet* advice.ti,ab. (1528)
- 73 diet* counselling.ti,ab. (349)
- 74 nutrition* counselling.ti,ab. (240)
- 75 (diet* adj3 record*).ti,ab. (2821)
- 76 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75 (10523)
- 77 60 and 76 (214)
- 78 limit 77 to (english language and yr="1980 -Current") (199)

Appendix D. Ethics approval, permissions and forms

NRES Committee London - Camberwell St Giles

Level 3, Block B
Whitefriars
Lewins Mead
Bristol
BS1 2NT

Telephone: 0117 3421381

Fax:

28 July 2014

Prof Rebecca Harris
Professor of Oral Health Services Research University of Liverpool, Hon. Consultant in Dental Public
Health Royal Liverpool and Broadgreen Hospitals Trust
Institute of Psychology, Society and Health, University of Liverpool
Department of Health Services Research
Room 113, 1st Floor, B Block, Waterhouse Building
1-5 Brownlow Street, Liverpool, UK
L69 3GL

Dear Prof Harris

Study title:	Developing diet diaries used in clinical dentistry as a tool for behaviour change
REC reference:	14/LO/1204
Protocol number:	UoL001054
IRAS project ID:	152074

Thank you for your letter of 15th July 2014, responding to the Proportionate Review Sub-Committee's request for changes to the documentation for the above study.

The revised documentation has been reviewed and approved by the sub-committee.

We plan to publish your research summary wording for the above study on the NRES website, together with your contact details, unless you expressly withhold permission to do so. Publication will be no earlier than three months from the date of this favourable opinion letter. Should you wish to provide a substitute contact point, require further information, or wish to withhold permission to publish, please contact the REC Manager Miss Elizabeth Hearn, nrescommittee.london-camberwellstgiles@nhs.net.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised.

Considering the study is working with children, the committee has additionally suggested that it would be a sign of respect to give them the option of signing an assent form and thereby giving them the sense that their voice is heard. If you choose to do this, these forms could be submitted as a substantial amendment.

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission ("R&D approval") should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements.

Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at <http://www.rdforum.nhs.uk>.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of approvals from host organisations.

Registration of Clinical Trials

All clinical trials (defined as the first four categories on the IRAS filter page) must be registered on a publically accessible database within 6 weeks of recruitment of the first participant (for medical device studies, within the timeline determined by the current registration and publication trees).

There is no requirement to separately notify the REC but you should do so at the earliest opportunity e.g. when submitting an amendment. We will audit the registration details as part of the annual progress reporting process.

To ensure transparency in research, we strongly recommend that all research is registered but for non-clinical trials this is not currently mandatory.

If a sponsor wishes to contest the need for registration they should contact Catherine Blewett (catherineblewett@nhs.net), the HRA does not, however, expect exceptions to be made. Guidance on where to register is provided within IRAS.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Ethical review of research sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" above).

Approved documents

The documents reviewed and approved by the Committee are:

Document	Version	Date
IRAS Checklist XML [Checklist_15072014]		15 July 2014
Letter from sponsor [Sponsorship Approval]	No version	28 April 2014
Letters of invitation to participant [Cover letter]	No version	09 June 2014
Other [Response document from the research team]		14 July 2014
Participant consent form [Parent consent form, study 3]	Version 5	09 June 2014
Participant consent form [Child consent form, study 2]	Version 5	09 June 2014
Participant consent form [Parent consent form, study 2]	Version 5	09 June 2014
Participant consent form [Dentist Consent Form]	Version 5	09 June 2014
Participant information sheet (PIS) [Dentist Information Sheet, study 2]	Version 5	09 June 2014
Participant information sheet (PIS) [Parent Information Sheet, study 3]	Version 5	09 June 2014
Participant information sheet (PIS) [Child Information Sheet, study 2]	version 6	09 July 2014
Participant information sheet (PIS) [Child Information Sheet, study 3]	version 6	09 July 2014
Participant information sheet (PIS) [Parent Information Sheet, study 2]	version 6	14 July 2014
REC Application Form [REC_Form_26062014]		26 June 2014
Referee's report or other scientific critique report [Peer review]	No version	07 April 2014
Research protocol or project proposal [Project Proposal]	version 6	14 July 2014
Summary CV for Chief Investigator (CI) [CV Harris]	No version	28 April 2014
Summary CV for student [CV]	No version	02 May 2014

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document "After ethical review – guidance for researchers" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The HRA website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

Feedback

You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the HRA website:
<http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance>

We are pleased to welcome researchers and R & D staff at our NRES committee members' training days – see details at <http://www.hra.nhs.uk/hra-training/>

14/LO/1204

Please quote this number on all correspondence

With the Committee's best wishes for the success of this project.

Yours sincerely

pp *R. Hearn*

Chair

Email: nrescommittee.london-camberwellstgiles@nhs.net

Enclosures: *"After ethical review – guidance for researchers"*

Copy to: *Mr Alex Astor*

Heather Rogers, Royal Liverpool & Broadgreen University Hospitals Trust

TRUST APPROVAL LETTER FOR NON-CTIMP STUDIES

RR: 0151 706 2000
Fax: 0151 706 5806

Prof Rebecca Harris
University of Liverpool
Institute of Psychology, Society and Health
Room 113, 1st Floor, B Block, Waterhouse Building
Brownlow Street, Liverpool
L69 3GL

REC: 14/LO/1204
Date: 30/07/2014

Dear Professor Harris

RD&I No: 4787

Developing diet diaries used in clinical dentistry as a tool for behaviour change

The above study is a Non-Commercial, Questionnaire / Quantitative study, sponsored by University of Liverpool and funded by Libyan Government. The Trust is now happy for you to commence work on this study, using the following ethically approved documents.

Document	Version	Dated
Letters of invitation to participant	No version	09 June 2014
Participant consent form [Parent consent form, study 3]	5	09 June 2014
Participant consent form [Child consent form, study 2]	5	09 June 2014
Participant consent form [Parent consent form, study 2]	5	09 June 2014
Participant consent form [Dentist Consent Form]	5	09 June 2014
Participant information sheet (PIS) [Dentist Information Sheet, study 2]	5	09 June 2014
Participant information sheet (PIS) [Parent Information Sheet, study 3]	5	09 June 2014
Participant information sheet (PIS) [Child Information Sheet, study 2]	6	09 July 2014
Participant information sheet (PIS) [Child Information Sheet, study 3]	6	09 July 2014
Participant information sheet (PIS) [Parent Information Sheet, study 2]	6	14 July 2014
Research protocol or project proposal [Project Proposal]	6	14 July 2014

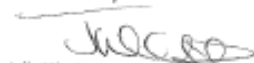
May I to take this opportunity to remind you of your responsibilities as PI for this study to:-

- Report SAE's as per protocol and Trust policy and record total number on OSIRIS
- Ensure that all screening and recruitment activity is updated on OSIRIS every Friday (training can be obtained if required by phoning Ext 3782)
 - Department of Health target for this study is first patient recruited by **08 September 2014**
 - Please provide a timely response to requests for information regarding achievement of this target
- For Trust sponsored studies, provide RD&I with copies of regulatory annual progress and safety reports to Ethics
- Complete and return the RD&I annual report form in a timely manner
- Comply with the Research Governance Framework 2nd Ed 2005 including but not limited to the Medicines for Human use (Clinical Trials) 2004 act plus it's appendices and the Data Protection Act 1998
- Read, disseminate to research team and acknowledge to RD&I, Trust research SOP announcements (details of relevant SOP's can be found at http://staffintranet/departments_and_services/corporate_services/research_and_development/documents/documents.aspx)
- Inform RD&I of any amendments to, or changes of status in, the study.
- Ensure any conditions to approval stipulated by the MHRA/ REC have been addressed prior to implementation of approved changes
- Maintain the study site file (if not provided by the sponsor a template is available on the Trust intranet)
- Provide copies of publications

Investigators who do not comply with the above will be dealt with in accordance with the Trust Disciplinary policy and/or will have their research stopped.

I wish you every success with your research. Please contact the RD&I Department if you require any advice on the above points.

Yours sincerely



Julia West
Operational Director RD&I

cc: Head of Directorate
University of Liverpool

Child Information Sheet**Title of Project: Accuracy of diet diaries****What is the project about?**

Dentists often ask children and their parents to keep a record of their food and drinks intake to help explain what might be causing holes in their teeth. This record is called a diet diary. We would like to know more about how accurate are the diet diaries. This will help us improve the way we collect information like this.

Why have I been chosen?

You have been invited to take part in this study because you and your parents are involved in filling in a diet diary. Completing a diet diary is part of routine dental treatment for many children.

What do you need to do?

You and your parents will be asked to complete two tasks. One task is to fill in a 3-day diet diary. The other task is to tell us about what you eat and drink over a 24-hour period. We will contact your parents by phone to ask about your food and drinks intake during the previous day. We would do this three times. We will need to discuss a suitable time and days for your parents to receive the phone calls. The length of each phone call can last as long as you and your parents wish. But on average it should last 20 minutes. Please note that the phone calls will be audio-recorded, so that do not miss important information.

Do I have to take part?

No. It is up to you if you take part. You can still withdraw at any time without it affecting your dental care, and you don't have to explain why.

Will joining the study help me?

No, there is immediate benefit for you. But it may help dentists looking after children's teeth in the future.

Will anyone else know I'm doing this?

The people that will know about the project will be your parents and your dentist and nurse as well as the interviewer who will ask you the questions.

What happens if I don't want to do it anymore?

You can stop at any time and without saying why.

Thank you for reading this leaflet

I am happy to answer any other questions that you may have

Name of supervisor: Professor Rebecca Harris

Name of researcher: Arheiam Arheiam

Participant information sheet (Dentist)**Project title: Qualitative study of the use of diet diaries in clinical dentistry**

You are being invited to take part in a research project. This research is undertaken by researchers at the University of Liverpool. Before you decide whether you want to take part it is important to understand why the research is being done and what it will involve.

What is the purpose of this research study?

We would like to know more about dentists' and people's experience of using diet diaries to collect dietary information. This will help us improve the way we collect information like this.

Why have I been chosen?

You have been invited to participate because you are a member of staff of the dental practices selected for the study.

What will happen to you if you do take part?

If you do choose to take part in the study, a researcher will ask you a few questions about your experience of using the diet diary. The researcher would record your talk with him. The researcher might also watch you while talking to your patient about diet. The researcher would take notes and we would also video this.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be asked to sign a consent form. You can still withdraw at any time. You do not have to give a reason.

Is there anything to be worried about if I take part?

There are no risks to you from taking part in the study. You do not have to talk about anything you don't want to. We will anonymise any information which you give us. Your information will be coded, so that neither you nor your practice can be identified by anyone.

What are the possible benefits of taking part?

The study will not benefit you right away. But we hope that the study will help improve dental care for children and young people in the future.

Further information:

You will be given a copy of this information sheet and a copy of your signed consent form to keep. If you have any queries or require further information relating to the project then please email Dr Arheiam Arheiam at arheiam@liverpool.ac.uk or telephone 0151 794 5598.

Thank you for reading this

Please feel free to ask any questions if you need to

Name of Supervisor: Professor Rebecca Harris

Name of Researcher: Dr Arheiam Arheiam

Participant information sheet (Parent/Carer)

Title of Project: Qualitative study of the use of diet diaries in clinical dentistry

You are being invited to take part in a research project. This research is undertaken by researchers at the University of Liverpool. Before you decide whether you want to take part it is important to understand why the research is being done and what it will involve.

What is the purpose of this research?

Dentists often ask children and their parents to keep a record of their food and drinks intake. This record is called a diet diary. Diet diaries help dentists to give diet advice to their patients. We would like to know more about people's experience of using diet diaries. This will help us improve the way we collect information like this.

Why have I been chosen?

You have been invited to take part in this study because you and your child are involved in filling in a diet diary. Completing a diet diary is part of routine dental treatment for many children.

What will happen if I agree to take part?

You and your child will be asked by your dentist to fill in a diet diary for three days. When you come back to see your dentist to discuss your child's diet, a researcher will ask you a few questions afterwards about your experience of using the diary. The researcher would record your talk with him. The researcher might also watch your dentist while talking to you about diet. The researcher would take notes and we would also video this. If you do not wish to be video-recorded, you still be able to take part in the interview.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep. You will be asked to sign a consent form. Your child will also be asked to sign an assent form. You can still withdraw at any time without it affecting your child's treatment. You do not have to give a reason.

Is there anything to be worried about if we take part?

There are no risks to you or your child from taking part in the study. You do not have to talk about anything you don't want to. We will anonymise any information which you or your child give us. Your information will be coded, so that neither you nor your child can be identified by anyone.

What are the possible benefits of taking part?

The study will not benefit you or your child right away. But we hope that the study will help improve dental care for children and young people in the future.

What happens when the research stops?

Your child will continue their regular dental care as normal. The outcomes of this study will be published and reported irrespective of the nature of the findings. A summary report will be made available to you if you would like a copy – just let the researcher know. Your names will not appear in any report written about the study.

What if I am unhappy or if there is a problem?

If you are unhappy or if there is a problem at any point please discuss this with us. If you would like to discuss the study with some-one not involved directly in the study, you can contact Dr Sharon Lee who is a Children's dentist who works for the Royal Liverpool Hospitals Trust. Her e mail is Lee.Sharon@rlbuht.nhs.uk

Can I or my child be identified?

All information collected about you and your child is confidential. Any information will have your names and address removed so that you cannot be identified. The only people who will see the information will be the researchers. All the information from the study will be kept securely at the University of Liverpool.

Further information:

You will be given a copy of this information sheet and a copy of your signed consent form to keep. If you have any queries or require further information relating to the project then please email Dr Arheiam Arheiam at arheiam@liverpool.ac.uk or telephone 0151 794 5598.

Thank you for reading this

Please feel free to ask any questions if you need to

Name of Supervisor: Professor Rebecca Harris

Name of Researcher: Dr Arheiam Arheiam

CHILD ASSENT FORM

(To be completed by the child and their parent or guardian)

Title of Project: Qualitative study of the use of diet diaries in clinical dentistry

Please tick in the box for your answer to each question below

1. I Have read (or had read to you) the information leaflet given to me about this project
2. I understand what this project is about
3. I had a chance to ask questions about the project
4. All of my questions have been answered
5. I understand it's OK to stop taking part in this project at any time

By signing your name below you will **only** be asked to do the parts you have signed **YES** to above.
If you **don't** want to take part at all, **don't** sign your name

Your name _____

Your signature _____

Date _____

Your parent/ guardian must also write their name here too if they are happy for you to do the project.

Print name _____

Signature _____

Date _____

The person who explained this project to you needs to sign too:

Print name _____

Signature _____

Date _____

Thank you for your help

Name of supervisor: Professor Rebecca Harris

Name of researcher: Arheiam Arheiam

CONSENT FORM (Parents/Carers)

Title of Project: Qualitative study of the use of diet diaries in clinical dentistry

Please
initial all boxes

1. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

2. I understand that participation in the above study is voluntary and that my child and I are free to withdraw at any time without giving any reason, without our dental care or legal rights being affected.

3. I understand that data collected during the study may be looked at by individuals from the University of Liverpool, where it is relevant to our taking part in this research. I give permission for these individuals to have access to my child's records.

4. I agree to my dentist being informed of my participation in the study.

5. I agree to me and my child to take part in the above study.

Name of Participant Date Signature

Name of Person Date Signature
taking consent.

Thank you for your help

Name of supervisor: Professor Rebecca Harris
Name of researcher: Arheiam Arheiam

CONSENT FORM (Dentist)

Title of Project: Qualitative study of the use of diet diaries in clinical dentistry

Please
initial all boxes

1. I confirm that I have read and understand the information sheet for the above study.
I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my legal rights being affected.

3. I understand that data collected during the study may be looked at by individuals from the University of Liverpool, where it is relevant to my taking part in this research.

4. I agree to contact my patients with any relevant information.

5. I agree to take part in the above named study.

Name of Participant Date Signature

Name of Person taking consent Date Signature

Thank you for your help

Name of supervisor: Professor Rebecca Harris

Name of researcher: Arheiam Arheiam

Appendix E.

Appendix F. Stratification of Local Authorities (LAs) in the Northwest of England into three levels of caries prevalence (high, medium and low)

Stratum	Local Authority	Mean DMFT
Low DMFT	Cheshire East*	0.58
	Blackburn with Darwen*	0.58
	Ribble Valley*	0.58
	Stockport	0.63
	South Lakeland	0.65
	Cheshire West and Chester*	0.68
	Trafford	0.86
	Sefton	0.90
	Fylde*	0.91
Moderate DMFT	Warrington	1.05
	Eden	1.05
	Wyre	1.07
	Tameside*	1.08
	Halton	1.09
	St. Helens	1.10
	Rossendale	1.11
	Allerdale*	1.13
	Wigan*	1.15
	Wirral	1.21
High DMFT	Carlisle*	1.26
	Copeland*	1.27
	Bury	1.28
	Lancaster	1.30
	West Lancashire	1.30
	South Ribble	1.30
	Chorley*	1.30
	Liverpool	1.42
	Preston	1.44
	Barrow-in-Furness	1.45
	Hyndburn	1.47
	Rochdale*	1.55
	Knowsley*	1.58
	Burnley*	1.69
	Manchester	1.78
	Blackpool	1.81
	Bolton	1.85
	Pendle	1.88
Salford*	1.96	
Oldham	2.10	

* Randomly selected LAs

Appendix G. Postal Questionnaire used in Studies I & II

The use of diet diaries in dental practice

This questionnaire has been developed by a research team based in Liverpool University. We are researching the use and interpretation of diet diaries in dental practice and particularly are interested in dentists' use and interpretation of diet diaries among children aged 5-11 years. We would be grateful if you would complete the questionnaire and return it in the pre-paid envelope provided.

Section A: About yourself

Gender: Male Female

Year of Qualification:

Practice owner Associate Dental Core Trainee (Vocational trainee) Other

Section B: Your practice

1. Based on patient numbers in your practice, approximately what percentage of your practice's work is NHS, and what if any is private? % NHS patients: % private patients:
2. What percentage of your case mix are children?
3. How many surgeries are in the practice?
4. How many dentists are in the practice (either full or part-time)?
5. Does the practice have any?
 - Hygienists Yes No
 - Therapists Yes No
 - Dental Nurses able to give health education advice Yes No
 - Dental Nurses trained to apply fluoride varnish Yes No

Section C: Dietary advice

1. Approximately what percentage of patients would you personally give diet advice to?
 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
2. **Of the remainder**, what percentage would you refer for diet advice?
 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

<p>3. Do you give or refer for diet advice to? <i>(Please tick all that apply)</i></p> <p><input type="checkbox"/> All children under 18 years old</p> <p><input type="checkbox"/> Children with past experience of dental caries</p> <p><input type="checkbox"/> Children from low socioeconomic families</p> <p><input type="checkbox"/> Medically compromised children</p> <p><input type="checkbox"/> Children with special needs</p> <p><input type="checkbox"/> Children aged 5-11 years old</p> <p><input type="checkbox"/> Children aged less than 5-11 years old</p> <p><input type="checkbox"/> Children with evidence of tooth wear</p> <p><input type="checkbox"/> Other groups not stated above, please explain:</p>	<p>4. Do you give or refer for diet advice to? <i>(Please tick all that apply)</i></p> <p><input type="checkbox"/> All adults</p> <p><input type="checkbox"/> Adults with past experience of dental caries</p> <p><input type="checkbox"/> Adults from low socioeconomic backgrounds</p> <p><input type="checkbox"/> Medically compromised adults</p> <p><input type="checkbox"/> Adults with special needs</p> <p><input type="checkbox"/> Adults with evidence of tooth wear</p> <p><input type="checkbox"/> Other groups not stated above, please explain:</p>
---	---

Section D: Collecting information about patients' diet

<p>1. Do you personally collect any information about patients' diet in order to inform the dietary advice? <input type="checkbox"/>Yes <input type="checkbox"/>No <i>If your answer is No, please go to section F.</i></p> <p>2. If you refer patients to other members of the team to provide prevention advice, do they collect any information about patients' diet in order to inform dietary advice? <input type="checkbox"/>Yes <input type="checkbox"/>No <input type="checkbox"/>Do not know</p>	
<p>3. Do you personally collect dietary information from? <i>(Please tick all that apply)</i></p> <p><input type="checkbox"/> All children under 18 years old</p> <p><input type="checkbox"/> Children with past experience of dental caries</p> <p><input type="checkbox"/> Children from low socioeconomic families</p> <p><input type="checkbox"/> Medically compromised children</p> <p><input type="checkbox"/> Children with special needs</p> <p><input type="checkbox"/> Carers of children aged 5-11 years old</p> <p><input type="checkbox"/> Carers of children aged less than 5-11 years old</p> <p><input type="checkbox"/> Children with evidence of tooth wear</p> <p><input type="checkbox"/> Other groups not stated above, please explain:</p>	<p>4. Do you personally collect dietary information from? <i>(Please tick all that apply)</i></p> <p><input type="checkbox"/> All adults</p> <p><input type="checkbox"/> Adults with past experience of dental caries</p> <p><input type="checkbox"/> Adults from low socioeconomic backgrounds</p> <p><input type="checkbox"/> Medically compromised adults</p> <p><input type="checkbox"/> Adults with special needs</p> <p><input type="checkbox"/> Adults with evidence of tooth wear</p> <p><input type="checkbox"/> Other groups not stated above, please explain:</p>

5. When you collect information on diet, what approximately % of times do you use the following methods?	0 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	100 %
<input type="checkbox"/> A record that patients keep and bring to you (diet diaries)											
<input type="checkbox"/> Asking patients about what they ate yesterday (24 hour recall)											
<input type="checkbox"/> Asking patients to recount their usual habits for a week											
<input type="checkbox"/> Other method, please explain:											

6. Do you use different methods to collect diet information for different patients? Yes No

If your answer is YES

7. What methods do you use for different patients?

8. How do you decide which method to use with which patient?

If you **DO NOT** use diet diaries to assess patients' dietary behaviour, please go to section **F**.

By a diet diary we mean any type of written record you ask the patients to bring to you.

Although the questions are phrased about your practice personally, if you refer to dental team member in the practice please answer the questions on their behalf.

Section E. Information about the usage of diet diaries:

1. Why do you use a diet diary? **(Please tick all that apply)**

As part of my assessment of patients' disease risk

To monitor the dietary behaviour of patients (see whether it is improving or worsening)

As a tool to prompt behaviour change

Other, please specify:.....

2. What are the considerations you make when deciding to use a diet diary?
(Please tick all that apply)

A high severity of caries experience

An appropriate ability (literacy) of parents, children or adult patients

Sufficient motivation of parents

Sufficient motivation of the children patients

Sufficient motivation of the adult patients

Other, please specify:.....

3. With what % of your adult patients do you use diet diaries?
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4. With what % of your children patients do you use diet diaries?
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

5. How many days do you ask your patients to keep diet diaries for?

6. Do you ask patients to include at least one week day and one weekend day? Yes NO

7. Do you ask patients to record the time the patient goes to bed? Yes No

8. Do you ask patients to record the context of each eating/drinking occasion? Yes No

9. Do you ask patients to record the timing of each eating/drinking occasion? Yes No

10. In the case of children aged 5-11 years old, who do you ask to keep the diet diary?
Child Parent or Guardian Both

11. Do you routinely review the diet diary with the patient/parent to clarify the information? Yes No

12. Do you routinely analyse the diet diary immediately when the patient returns the diary? Yes No

13. Do you routinely schedule a separate appointment to discuss the diary? Yes No

14. Overall how long does it take you to a complete analysis of a diet diary? (minutes):

Section F: Interpretation of diet diaries

<p>1. If you DO NOT use diet diaries in dental practice for children, why is this?</p> <p><input type="checkbox"/> The NHS remuneration is insufficient to cover my time for this</p> <p><input type="checkbox"/> I do not feel knowledgeable enough to analyse the information and to discuss diets</p> <p><input type="checkbox"/> I do not feel they are useful</p> <p><input type="checkbox"/> Other, please explain</p> <p>.....</p>	<p>2. If you DO NOT use diet diaries in dental practice for Adults, why is this?</p> <p><input type="checkbox"/> The NHS remuneration is insufficient to cover my time for this</p> <p><input type="checkbox"/> I do not feel knowledgeable enough to analyse the information and to discuss diets</p> <p><input type="checkbox"/> I do not feel they are useful</p> <p><input type="checkbox"/> Other, please explain</p> <p>.....</p>
---	---

3. Even if you do not routinely use a diet diary in your practice, what are the general principles that you would work to when analysing a diet diary?

Whether or not you use diet diaries, please read the following case vignette and answer the following questions

Case Vignette

An 11 year old girl is brought to your dental practice by her parents because of mild pain in her lower back teeth which is aggravated by hot and cold drinks and relieved by pain killers. She has been coming to the practice regularly for the last year. Her medical history has revealed nothing of significance and her dental history includes multiple extractions and fillings of primary teeth due to dental caries. Oral examination shows dentine caries in the permanent molars and white spots on the cervical third of maxillary incisors. She and her parents are NHS patients.

Day 1			Day 2		
Time	Food	Quantity		Food	Quantity
7.45 am	Glass of milk	1	9.45 am	Glass of milk	1
	Coco pops	1		Toast + Butter	2
	Pear	1		Pear	1
10.45 am	Ham sandwich	1	10.45 am	Tuna sandwich	1
	Yoghurt	1		Cheese strip	1
	Cheese strip	1		Actimel	1
12.30 pm	Actimel	1	12.30 pm	Orange juice	1
	Blackcurrant Fruit	3		Chocolate	3
	Chocolate milkshake	1		Toffee caramel	1
4 pm	Pizza (chees, tomato)	3 triangles	4.00 pm	Rice	1 small saucer
	Chips	1		Chips	1 small saucer
	Beans	1 small saucer		4.30 pm	Chicken wings
4.30 pm	Apple juice	1	7.00 pm	Apple juice	1
	Milkshake	1		Cake	1
	Milkshake	1		Milkshake	1
8.30 pm	Bed		8.30 pm	Bed	
8.45 pm			9.00 pm		

1. Please, circle 6 behaviours (on the diet record on the previous page) which in your view represent dental health issue, and number them 1-6 (1 being entry that concerns you most). Explain here what would concern you:

1-
2-
3-
4-
5-
6-

2. Are there any aspects of the above diary you would ask child/or the parents to give you more information about, and what would these be?

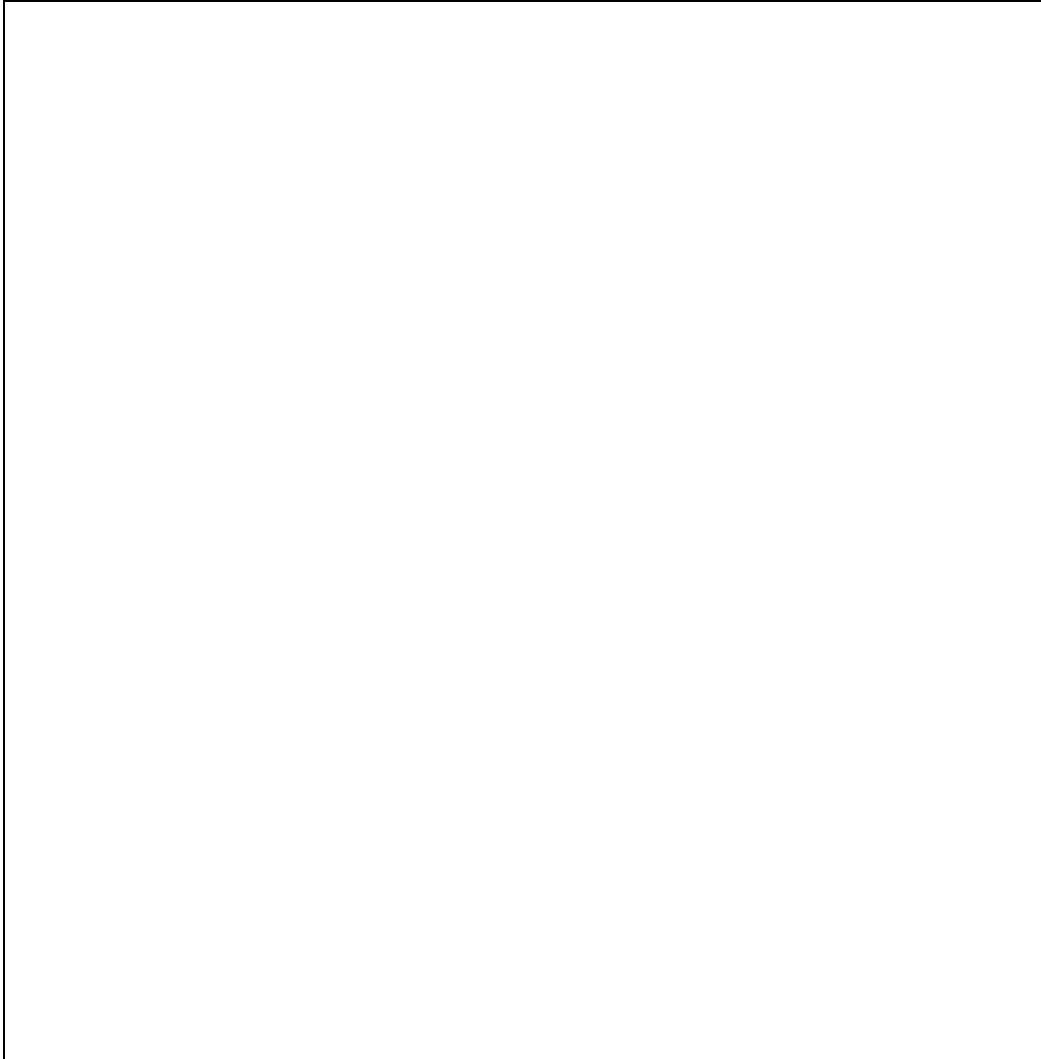
3. What would be the first dietary issue you would advise the child/her parents about?

4. Are there other areas of advice (if any) would you cover?

5. In your view, how important are the following approaches when analysing the diet diary?

Please tick how important each approach is to you: Not at all important 1 2 3 4 5 Essential					
	1	2	3	4	5
Limiting sugar to meal times					
Reducing total sugar content overall					
Removing all harmful food/drinks before bed time					
Substituting harmful food/ drinks					

Please feel free to write any comments about your thoughts and experience of giving dietary advice to 5-11 year old children in dental practice.

A large, empty rectangular box with a thin black border, intended for the respondent to write their comments and experiences regarding dietary advice for 5-11 year old children in dental practice.

Thank you for taking time to complete this questionnaire

Please return the questionnaire via the prepaid envelope provided to:

Dr: Arheiam Arheiam , Department of Health Service Research, University of Liverpool, Waterhouse building, Block B, 1st Floor, Room B111, 1-5 Brownlow Street, L69 3GL, Liverpool, United Kingdom

Email: Arheiam@liv.ac.uk. Telephone: 01517945598

Appendix H. Prevention Pro forma and patient assessment form used in Paediatric Dentistry Department at LUDH

Affix Patient Label

The Royal Liverpool and Broadgreen University Hospitals
NHS Trust

Prevention Clinic Proforma

Dental attendance and previous treatment

.....

.....

Tooth brushing

Frequency		Manual/Electric	
Toothpaste (fluoride conc)		Amount of paste	
Supervised brushing			

Diet

Frequency and timing of sugar attacks	
Favourite food and drink	
Relevant carious medication	

Additional information

.....

.....

.....

.....

.....

.....

Caries Risk Assessment (please select most applicable)

Frequency of routine dental visits	Poor <input type="checkbox"/>	Good <input type="checkbox"/>
High caries rate in mother or siblings	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Special healthcare needs	Yes <input type="checkbox"/>	No <input type="checkbox"/>
High and/or frequent sugar intake	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Child put to bed with bottle containing natural or artificial sugar	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Regular brushing (if appropriate with assistance)	No <input type="checkbox"/>	Yes <input type="checkbox"/>
Plaque visible on teeth	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Fluoride level in toothpaste correct for age	No <input type="checkbox"/>	Yes <input type="checkbox"/>
Child has decay	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Overall assessment of child's caries risk:	High <input type="checkbox"/>	Low <input type="checkbox"/>

REPRO-733-YL-02.13

Place patient I.D Label here

Paediatric Dentistry
New Patient Assessment

Date Seen by Clinic Age
Attended with

Referred by (please tick) GDP CDS GMP AHH ORTHO Orther

Reason for referral

Presenting complaint

History of presenting complaint

Medical History (please highlight those points from the MH questionnaire)

Previous Dental History (tick as appropriate)

GDP CDS GMP AHH

Patient's experience of dental treatment:	None	Fills, no LA	Fill with LA
	XLA	IHS	GA

Additional Details (e.g. reasons for any dental anxiety / phobia)

Appendix I.

Social History

Lives with

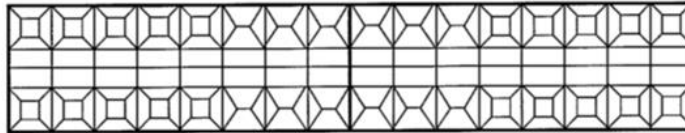
Parent's marital status

Additional information (including details of oral hygiene habits)
.....
.....
.....

Examination

Extra Oral (TMJ, Lymph Nodes, Trauma)

Intra Oral - Dental Charting (use capital letters for primary teeth)



Annotate
teeth
present

Additional Intra Oral Findings (including soft tissue exam and special investigations)
.....
.....
.....
.....

Oral hygiene Gingival Health
(BPE if necessary) | |

Other information

.....
.....
.....
.....
.....

Orthodontic Examination

Tick as appropriate: incisor and molar relationships are important for patients with first permanent molars of poor prognosis, maxillary canines should be palpated in all children over 9 years of age)

Incisor relations: Class I Class II Div I Class II Div II Class III

Molar relations: Class I Class II Class III 1/2 unit

Canines palpable: Bucally Palatally Not palpable N/A

Additional information (e.g. teeth in crossbite)

.....

.....

.....

Radiographic Examination

Radiograph: BWs OPT PA USO

Justification: Caries Assess developing detention canines 2nd molars

Trauma Other

Findings

.....

.....

Teeth present

Unerupted	_____
Erupted	_____
Erupted	_____
Unerupted	_____

Missing teeth

Caries Risk Assessment(Please tick)

Low High

Does this patient need a prevention appointment?

Yes No

Diagnosis

.....

.....

.....

Treatment Plan

Checklist

- Informed consent
- Alternative treatments discussed
- Discussed options LA / RA / GA
- Risks GA discussed with parent/guardian
- Procedure explained
- Written instructions for given

Next steps: PREV GA Chairs GA Cons GA AHH Staff Treatment
 Pre-sedation RA/IHS IVS UG Treatment Discharged

If the patient required a GA then please ensure the treatment plan is signed off by a consultant / specialist

*** For GA chairs and MOS lists only ***

Teeth to be extracted under GA →

Signature of consultant or specialist in Paediatric Dentistry only

Staff name and Signature

Date and Time

Student name and Signature

Date and Time

Appendix K. Topic guides for interviews and observations guides used in Study IV

Parent/Child Interview topic guide

First Interview:

- **Preamble**
- Introduction of interviewer and Explanation of research purpose
- Confirmation of interview confidentiality, anonymity in reporting the data and the interview length
- Confirmation of interviewee's name and that he is happy for interview to be taped
- **Questions**
- Can you tell me about yourself (your family, who you live with, what you do)?
- Can you tell me about the appointment today and what brought you here? (have you been here before, has your child been here before, reason for referral)
- Did you find the appointment useful (did they tell you things you didn't know before, was there anything new?)
- The dentist asked you to fill in a food diary – what do you think about that?
- Have you ever filled in a food diary? When, why, who asked you to fill it in?
- Do you think a food diary is relevant to you? Who do you think it is relevant for?
- Whose job will it be to complete the diet diary? Who in your family do you think might complete it?
- Do you think it would be helpful for you to complete this? Who might it be helpful for? What do you expect to learn by completing the diary?
- Do you think it is important for you to complete this? Is it important for some people?
- Are there any reasons you might not be able to complete this?
- **Concluding comments**

Would it be useful for you to have a copy of the report and recommendations from this study?

Thank you for your time. If I find that I need further clarification on any of the issues that we have talked about today, would it be OK to contact you again?

Follow up interview:

- Please tell me about your experience of using food diary?
- Can you describe how you filled in the food diary did? Where and when did you fill it in? Was it immediately after each meal or intake?
- Tell me what were the difficult and easy parts of completing it?
- Did anybody else was involved in completing it? **Who and why?**
- What prevents you from completing the food diary?
- Do you notice any differences in your eating behaviour?
- Do you think your behaviour is changed from doing?
- Do you think you will change your behaviours after doing it?
- Can you think of easier way to do this?

Dentists' interview- topic guide

Preamble

- Introduction of interviewer and Explanation of research purpose
- Confirmation of interview confidentiality, anonymity in reporting the data and the interview length
- Confirmation of interviewee's name and that he is happy for interview to be taped

Questions

- Please tell me about yourself (education, work experience, etc) experience of using food diary?
- Please tell me about your experience of using food diary?
- What are you aiming for by using diet diaries?
- In your opinion, what are the weaknesses and strengths of using diet diaries?
- Which kind of patients do you think diet diaries should be used for?
- Do patients usually return diet diaries? If not why? What are the common excuses given by patients who do not return the diaries?

- What kind of information do patients usually forget to record
- What do you usually do when the patients do not bring back the diet diary or bring incomplete ones?

Concluding comments

- Would it be useful for you to have a copy of the report and recommendations from this study?
- Thank you for your time. If I find that I need further clarification on any of the issues that we have talked about today, would it be OK to contact you again?

Observation Performa

location	Date	Reference code	Start time	End time
Dental Hospital				
Actors	Dentist:	Parent:	Child:	

- Sequencing of events
- Who come in?
- Who come first?
- Do they shake hands?
- Who start the conversation?
- Where the mother does sit?
- What is the child doing?
- Who is it addressed to?
- Where is the eye contact?
- What is happening at the time of giving instruction? (Passive vs active involvement)
- Was it like a lecture, passive?
- What is body language that makes you think that?
- Was the child interested?
- Do they asked questions or clarify points
- Parent and child interactions:
- Nonverbal responses:
- Other notes:
- Post observation summary:

Appendix L. Original research papers and conference presentations based on the thesis studies

Appendix M.

Community Dental Health (2016) 33, 267–273
Received 12 January 2016; Accepted 12 February 2016

© BASCD 2016
doi:10.1922/CDH_3928Arheiam07

The use of diet diaries in general dental practice in England

A. Arheiam¹, S.L. Brown², G. Burnside³, S.M. Higham¹, S. Albadri¹ and R.V. Harris¹

¹Department of Health Services Research/ School of Dentistry, Institute of Psychology, Health and Society, University of Liverpool, Liverpool, UK; ²Department of Psychological Sciences/School of Dentistry, Institute of Psychology, Health and Society, University of Liverpool, Liverpool, UK; ³Department of Biostatistics, Institute of Translational Medicine, University of Liverpool, Liverpool, UK

Objectives: Diet diaries are recommended as a tool to support behaviour change in dental patients at high risk of dental diseases. However, little is known about their use in dental practice. This study aimed to investigate whether and how general dental practitioners (GDPs) use diet diaries and identify factors which influence their use. **Methods:** A postal questionnaire was sent to a stratified random sample of general dental practitioners. The questionnaire asked about demographic and professional characteristics of the GDPs and their practices regarding diet advice, collection of dietary information, diet diaries usage (e.g. frequency, considerations and barriers), and interpretation of diet diaries. Descriptive, bivariate and multivariate analyses were conducted. **Results:** From 972 eligible GDP participants, 250 (26%) responses were received. Whilst almost all of these GDPs reported giving diet advice to patients routinely, and 40% reported also referring to dental care professionals in the practice to deliver dietary advice, only 28% (70) reported that they are involved in using diet diaries. GDPs appeared to target patients for dietary advice: GDPs reported they personally gave diet advice to an estimated 63% of their patients, and referred patients to DCPs for diet advice for 11% of their (GDPs') patients. GDPs used diet diaries more often for child than adult patients. Diet diaries usage was lower among younger dentists and in practices with higher percentages of NHS patients ($p < 0.05$). Perceived insufficient remuneration for time involved in using diet diaries was the main reason given for their lack of use. **Conclusion:** Although recommended as best practice, most English GDPs do not frequently use diet diaries to collect diet information in dental practice, mainly due to perceived financial and time constraints. Development of a more efficient tool to assess the dietary habits of dental patients is needed.

Key words: diet, dental practice, health education, caries, diary, England

Introduction

Dental caries is a major public health issue worldwide, affecting a full spectrum of age groups (Marcenes *et al.*, 2013). Although there has been some debate about the place of sugar in caries aetiology in view of the now widespread use of fluoride toothpaste (Burt and Pai, 2001; Marthaler, 1990; Moynihan and Kelly, 2014; Selwitz *et al.*, 2007), there is a general consensus that strategies targeting harmful sugar consumption behaviours both at the individual and population level are still needed to improve oral health; resting on evidence such as the existence of a dose-response relationship between sugar and caries, even in areas where fluoridated water and toothpaste are available (Moynihan and Kelly, 2014). Moreover, with recent data showing that the average amount of free sugars consumed per person in the UK exceeds the current recommended reference value (<5% of daily energy), and particularly so among children from the lowest socio-economic groups (Bates *et al.*, 2014; Rugg-Gunn *et al.*, 2007), ambition to improve sugar consumption behaviour from a dental perspective now increasingly chimes with higher profile interests from a range of other health professions, public policy makers

and the media (Capewell, 2016).

However, the relationship between sugar consumption and the development of caries is not straightforward, because the amount of sugar consumed is not the only concern. Frequency of intake, timing, sequencing (combination with caries protective foods such as milk), drinking style (with or without a straw), and the length of exposure all modify the cariogenicity of sugar intakes (Touger-Decker and Van Loveren, 2003). Since dietary counselling for dental patients has to take account of this complex situation, detailed dietary accounts from patients are necessary to identify dietary sugar patterns which may be cariogenic (Marshall, 2009; Moynihan, 2002; Rugg-Gunn and Nunn, 1999; Watt *et al.*, 2003; Woodward and Walker, 1994). This also enables the tailoring of diet advice to specific consumption patterns that are harmful; optimises the advice and encourages behaviour change (Wanyonyi *et al.*, 2011).

Diet diaries are the primary means by which such information may be gathered in dental care setting (PHE, 2014; Rugg-Gunn and Nunn, 1999; Watt *et al.*, 2003). Patients are asked to record on a template, the type, timing and amount of food and drink consumed, as well as the timing of bed-time, for a defined period (usually three days, comprising a combination of week and weekend

Correspondence to: Arheiam Arheiam, Room 113, Block B Waterhouse Building, 1-5 Brownlow Street, University of Liverpool, Liverpool L69 3GL, UK. Email: Arheiam@liverpool.ac.uk

Appendix N.

days). This dietary record allows the identification of cariogenic dietary habits, prompts discussion between the dentist and patient, and helps to identify behaviour change goals (Watt *et al.*, 2003). The use of diet diaries as a tool of dietary assessment has been recommended by standard dental textbooks in this area (Rugg-Gunn and Nunn, 1999; Wilkins and Wyche, 2013) as well as clinical guidelines and policy documents for preventive dental practice in the UK (PHE, 2014; SDcep, 2010). In England, the current guidance from a panel of experts recommends the use of diet diaries (PHE, 2014). This guidance is circulated to all English NHS practices and dentists and has been incorporated into clinical care pathways which now form the basis of commissioning and delivery of dental care in England (Harris and Bridgman, 2010).

However, despite the recognised merits of diet diaries as dietary assessment and self-monitoring tools, little is known about the prevalence of their use of diet diaries in dental practice. A recent systematic review shows that there is only one other study in this area (Franki *et al.*, 2014) - undertaken among American hygienists; only 4% of whom reported using diet diaries (Levy and Raab, 1993). In light of the general recognition that tailored dietary advice may facilitate behaviour change (Harris *et al.*, 2012), and the consequent necessity to obtain detailed dietary information to allow effective tailoring, we set out to investigate the prevalence and frequency of diet diary use in English dental practices and to examine the factors which influence their use.

Methods

A postal survey of general dental practitioners (GDPs) was carried out in the North West region of England between September 2014 and January 2015. Ethics (reference 14/LO/1204) and NHS research governance approvals were obtained before commencing the study.

A cluster sampling strategy was used to select study participants from both NHS and fully private practitioners. Although the sample was drawn from a sampling frame of GDPs from the North West of England, stratification according to dental caries prevalence data was used to enable the dataset to be more generalizable. A sample size of 385 GDPs was identified as sufficient to allow an estimate of the proportion of GDPs using diet diaries in their everyday practice, with 95% confidence. Given that no previous investigations have addressed the issue of diet diaries use in English dental practices, the calculation of sample size was based on the assumption that half the GDPs would use diet diaries. This sample size was expanded to compensate for 30-40% expected response rate which was based on findings of recent surveys among UK GDPs (Aggarwal *et al.*, 2012; Yip *et al.*, 2013).

A total of 1,060 practitioners, including 102 GDPs from completely private practice, were recruited in a two-stage cluster sampling process. We firstly selected a number of Local Authorities (LAs) in the North West of England (in a stratified random sample of LAs which reflected the proportion of LAs having low, medium or high levels of caries prevalence across a national picture). We then identified all GDPs practising in

the LA areas selected. Stratification of LAs into three levels of caries prevalence (high, moderate and low), was done using the latest dental health data of routine national survey of 5-year-olds (PHE, 2012). Lists of the names and addresses of dentists practising in each LA were obtained from Care Quality Commission (CQC) in combination with information displayed on the NHS Choices website (publicly available information giving reviews and information on all local dental practices), to allow both NHS and private practitioners to be included in the sample. All practitioners in each practice, including newly qualified dentists, were included in the sample list, with GDPs asked about their individual work rather than that of their dental practice as a whole. Orthodontists and dentists providing service to prisons and providing care in dental access practices, dental hospitals and community dental service were excluded. LAs from each stratum were randomly listed and then sequentially added to the sample frame until the optimum number of participants in each stratum was reached or exceeded. The total sample size was equally divided between the three strata.

A socio-economic descriptor of the area in which the practice was located was included in the dataset by linking practice postcodes to area data on the Index of Multiple Deprivation (IMD) in which IMD scores of national data are divided into quintiles with areas ranked in a five-point scale from the most deprived 20% of areas (first quintile) through to the least deprived 20% (fifth quintile). The dataset also included whether the practice was located in a high, medium or low caries prevalence area, by linking practice postcodes to locally collected epidemiological data on the caries experience of five-year-olds described by LA area.

A self-administered questionnaire was developed from the available dental literature about diet diaries (Rugg-Gunn and Nunn, 1999) and through discussion among the research team. The questionnaire was pre-tested for clarity and face validity among 20 dentists at Liverpool University Dental Hospital (LUDH), who were asked to complete the questionnaire and provide feedback regarding each question. Two participants were interviewed while completing the questionnaire, in a thought-listing exercise to fully understand any area of ambiguity in the questionnaire content and layout. The participants in the questionnaire piloting process were not included in the final sample.

The questionnaire comprised these sections: 1, GDPs' demographic, professional and dental practice characteristics; 2, types of patient groups, whether any particular groups were targeted to receive dietary advice, and whether dietary advice was given personally by the dentist or through referral to a dental team member; 3, clinical practice regarding dietary advice, and in particular the use of diet diaries; and 4, any reasons for using diet diaries and the usual routines and considerations regarding this. GDPs were asked to estimate the approximate percentage of their patients for whom they would personally give or refer to others in the dental team, for dietary advice. Likewise they were asked to estimate the proportion of their patients (children and adults), for whom they used certain dietary assessment methods.

Following best practice in maximising response rate in postal questionnaires (Edwards *et al.*, 2002), the questionnaire was printed in the form of a coloured booklet and mailed to participants, in a pre-paid return envelope along with a covering letter which was personally addressed and signed by the principal investigator. After three weeks a second mailing was sent and a third, three weeks after the second.

Data were analysed using SPSS v.22.0 (Armonk, NY: IBM Corp.), first to describe demographics and professional characteristics of the respondents, dental practices' characteristics and responses to closed questions. Then chi-squared tests, independent samples t test and Mann-Whitney U test were used to predict the use of diet diaries from respondents' characteristics. Binary logistic regression models were fitted to compare the use with non-use of diet diaries across a range of demographic, professional and dental practice variables, with both univariate and multivariate analyses undertaken.

Comparing the characteristics of early and late respondents has been suggested as one of the strategies that can assess the threat of response bias on results generalisability (Lindner *et al.*, 2001), based on many observations which show that late respondents show more similar characteristics to non-respondents (Tickle *et al.*, 2003). We therefore compared respondents to the first, second and third mailings according to their gender, role in the practice, area's caries level, IMD quintiles and years practising since qualification. Chi-squared tests and one way Anova test were used.

Results

Of the 1,060 questionnaires mailed to GDPs, 250 responses were received. A further 88 were returned to the sender because the dentist had left the practice, had retired, was on maternity leave, the practice had closed or the dentist had declined to participate. The overall response rate was therefore 26.0% (250/972). Demographic, professional and practice characteristics of respondents are summarised in Table 1. Respondents had a mean 21.5 (SD 12.1) years of service since qualification, 90.0% (234) of them undertook some NHS work and the majority were males (58.0%, 146) and associate dentists (dentists sub-contracting to the practice owner) (60.0%, 149). Although most respondents worked in practices located in first and second quintile IMD areas (most deprived), there was a relatively even spread of practices according to LA caries prevalence (high, medium and low). The reason for this difference is accounted by the fact that LA areas represent a generally larger catchment area than the electoral ward areas represented by IMD scores. On average, GDPs responding reported that 69.0% (SD 35.0%) of their patients were NHS patients, and 24.0% (SD 17.0%) were children.

Almost all GDPs (99.2%, 248) responding reported personally giving diet advice of some sort to patients, with 40.0% (100) reporting that they also referred patients to dental care professionals such as dental hygienists (DCPs) for diet advice. The general picture is that dietary advice was not provided to all patients, with GDPs estimated that they personally gave diet advice to a mean of 63.0% (SD 30.0%) of their patients, and that they undertook dietary

advice referrals to DCPs for an average of 11.0% (SD 23.0%) of GDPs' patients. GDPs collected information in a number of ways in order to personalise the advice given; most often (41.0%, 101) by simply asking patients to recount their usual dietary habits for a week (Figure 1). Diet diaries were reportedly used by 28.0% (70) of GDPs, for, on average, 18.0% (10) of their patients. Another 21.0% (53) of GDPs used a 24-hour diet recall method to capture diet information.

Table 1. Characteristics of the study sample (n=250)

Variables	Categories	N	(%)
Gender	Men	146	(58.4)
	Women	104	(41.6)
Role	Practice Owner	101	(40.4)
	Associate/other	149	(59.6)
Practice sector	NHS	234	(93.6)
	Private	16	(6.4)
Year of service		Mean(SD)	
		21.5(12.1)	
Size of the practice		Median	(Range)
	N ^o of dentists in the practice	4	(1-11)
	N ^o of surgeries in the practice	4	(1-15)
Percentages of patients in the practice		Mean(SD)	
	NHS	69	(35.5)
	Private	31	(35.4)
	Case Mix children	23	(17.3)
Dental Auxiliaries in the practice		N	(%)
	Hygienist	153	(61.2)
	Therapists	109	(43.6)
	Nurse giving dietary advice	146	(58.4)
	Nurse applying fluoride varnish	103	(41.2)
Practice area characteristics		N	(%)
	Caries level	87	(34.8)
	Moderate	73	(29.2)
	High	90	(36.0)
Index of Deprivation quintiles	1 (Most deprived)	82	(32.9)
	2	76	(30.5)
	3	33	(13.3)
	4	34	(13.7)
	5 (Least deprived)	25	(10.0)

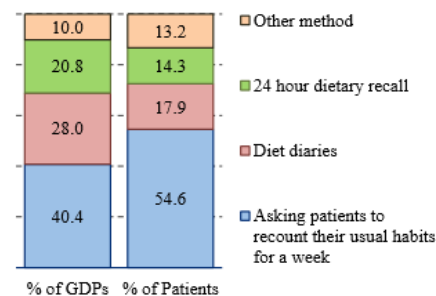


Figure 1. Distribution of methods used for collection of diet information (n=50) as percentages of GDPs reporting using each method, and for the average estimated proportion of their patients

Table 2. The usage of diet diaries (n=70)

	Mean	(SD)
Average percentage of children for whom diet diaries are used	26.7	(21.3)
Average percentage of adults for whom diet diaries are used	14.0	(16.5)
<i>Reasons for using a diet diary</i>	N	(%)
To assess patients' disease risk	45	(64.3)
To monitor patients' dietary behaviour	35	(50.0)
As a tool to prompt behaviour change	62	(88.6)
Other	5	(7.1)
<i>Considerations when deciding to use a diet diary</i>	N	(%)
A high severity of caries experience	63	(90.0)
An appropriate ability (literacy)	26	(37.1)
Sufficient motivation of parents	37	(52.9)
Sufficient motivation of the children patients	29	(41.4)
Sufficient motivation of the adult patients	25	(35.7)
Other	2	(2.9)
<i>Routines when using diet diary</i>	N	(%)
Ask patients to include at least one weekend day	67	(95.7)
Ask patients to record the time the patient goes to bed	24	(34.3)
Ask patients to record the context of each eating/drinking occasion	46	(65.7)
Ask patients to record the timing of each eating/drinking occasion	59	(84.3)
Review the diet diary with the patient/parent to clarify the information	62	(88.6)
Analyse the diet diary immediately when the patient returns the diary	64	(91.4)
Schedule a separate appointment to discuss the diary	29	(41.4)
In the case of children aged 5-11 years old	N	(%)
Ask the child to keep the diet diaries	0	(0.0)
Ask the parent or guardian to keep the diet diaries	29	(41.4)
Ask both to keep the diet diaries	41	(58.6)
	Median	(Range)
For how long patients are asked to keep diet diaries (Days)	3	(1-7)
Time needed to a complete analysis of a diet diary (Minutes)	10	(1-23)

Table 3. Bivariate analysis and binary logistic regression models for diet diary use by demographic, professional and practice characteristics of participants (N=134)

Variable	Bivariate analysis			Binary logistic regression models				
	Using diet diaries (n=70)	Do not use diet diaries (n=64)	P value	Unadjusted model		Adjusted model		
				OR	CI (95%)	OR	CI (95%)	
Gender	Women [†]	30 (42.9)	30 (46.9)	0.64	1.00	Reference	1.00	Reference
	Men [†]	40 (57.1)	34 (53.1)		1.18	(0.60,2.33)	1.87	(0.77, 4.38)
Role	Practice Owner [†]	27 (38.6)	25 (39.1)	0.95	1.00	Reference	1.00	Reference
	Associate/other [†]	43 (61.4)	39 (60.9)		1.02	(0.51,2.05)	1.06	(0.29,3.01)
Years of service [‡]		19.4 (12.9)	21.6(11.8)	0.28	0.97	(0.96,1.01)	0.96	(0.92,1.00) *
N [‡] of dentists in the practice [‡]		4 (1-11)	4 (1-10)	0.81	0.95	(0.82,1.11)	1.23	(0.93, 1.62)
N [‡] of surgeries in the practice [‡]		4 (1-13)	4 (1-13)	0.55	1.00	(0.86,1.15)	0.81	(0.61, 1.06)
% of NHS patients in the practice [‡]		66.9 (35.0)	74.9 (30.9)	0.03*	0.99	(0.98,1.00)	0.97	(0.95, 0.99) ^
% of Case Mix children in the practice [‡]		28.2 (19.4)	23.4 (13.6)	0.34	1.02	(0.99,1.04)	1.05	(1.01,1.08) ^
Practice has Hygienist(s) [†]		46 (65.7)	36 (56.3)	0.28	1.49	(0.74,2.99)	2.09	(0.81,5.34)
Practice has Therapist(s) [†]		40 (57.1)	27 (42.2)	0.12	0.58	(0.23,1.16)	2.07	(0.89,4.80)
Practice nurse gives dietary advice [†]		45 (64.3)	36 (56.3)	0.34	0.71	(0.36,1.43)	1.50	(0.59,3.83)
Practice nurse applies fluoride varnish [†]		31 (44.3)	39 (54.9)	0.81	0.91	(0.46,1.82)	0.95	(0.37,2.43)
Caries Level [†]	High	24 (34.3)	25 (39.1)	0.82	1.00	Reference	1.00	Reference
	Moderate	19 (27.1)	15 (23.4)		1.17	(0.54,2.57)	1.02	(0.34,3.04)
	Low	27 (38.6)	24 (37.5)		1.32	(0.55,3.18)	1.59	(0.52, 4.88)
Index of Multiple Deprivation [†]	1 (Most deprived)	17 (27)	21 (30)	0.66	1.00	Reference	1.00	Reference
	2	23 (36.5)	27 (38.6)		0.94	(0.41,2.20)	0.87	(0.31,2.43)
	3	10 (15.9)	8 (11.4)		0.65	(0.21,2.00)	0.82	(0.20,3.42)
	4	6 (9.5)	7 (10.0)	0.96	0.94	(0.27,3.43)	0.61	(0.23,2.90)
	5 (Least deprived)	7 (11.1)	7 (10.0)		0.81	(0.38,2.76)	0.84	(0.77,4.39)

[†]Count (%), X²; [‡]Mean (SD), independent samples t test, [†] median (Min-Max), Mann-Whitney U test, *P<0.05, ^P<0.01; Binary logistic regression models were fitted and Odds ratios (OR) at 95% confidence interval (CI) are reported.

Further information provided by the 70 GDPs reporting their use of diet diaries indicated that they targeted their use more towards children than adults, with patient's high levels of caries experience as the main consideration (Table 2). Bivariate comparisons and binary logistic regression models revealed that having a lower proportion of NHS patients was predictive of clinical practice geared towards the use of diet diaries with patients, (OR=0.97, 95%CI 0.95,0.99), as well as a higher child patient case mix (OR=1.05, 95%CI 1.01,1.08) (Table 3). Table 4 summarises GDPs reasons given for not using diet diaries for children (168 responses) and adults (172 responses). The predominant concern appears to be issues related to insufficient NHS remuneration to support the time spent, although about a quarter of GDPs also perceived that the tool was not useful (Table 4).

There were no significant differences between those who replied to the first, second or third mailings according to demographic (p=0.22 for gender), professional (p=0.97 for years in service, p=0.54 for dentist's role in the practice), practice area characteristics (p=0.70 for area's caries level) and the proportion of dentists who reported they use diet diaries (p=0.44).

Discussion

Before interpreting findings, it is necessary to acknowledge that the response rate for the study was 26%, despite a range of recommended approaches being taken to maximise response rate (Edwards *et al.*, 2002). However, this level of response rate is not unusual for studies of this type involving health care practitioners, for whom response rate is known to be relatively low (Cummings *et al.*, 2001), and following a downward trend (Cook *et al.*, 2009). In these types of studies, response rates of below 50% are not uncommon, for instance, a response rate of 30% was reported in a recent survey on how UK dentists deal with adverse drug reaction reporting (Yip *et al.*, 2013).

However, response rate is not necessarily a key indicator of collected data quality (Shelley *et al.*, 2012). A more important and direct indicator of response quality is the non-response bias which results from differences between respondents and non-respondents (Dillman *et al.*, 2014), and this can occur equally in surveys with high and low response rates (Groves and Peytcheva, 2008). We therefore undertook a response bias analysis to explore this further before findings can be interpreted fairly. One approach to investigating potential response bias is by comparing respondents' data and/or characteristics with that of non-respondents obtained through direct contact

or follow up study (Vink *et al.*, 2004). However, this approach is expensive and time consuming. It also has the potential for practical and ethical difficulties as well as introducing a potential sampling error (O'Neill *et al.*, 1995; Sivo *et al.*, 2006). An alternative is to compare early and late responders - based on the assumption that delayed and non-respondents have similar characteristics (Locker, 2000; Miller and Smith, 1983; Tickle *et al.*, 2003). This approach has become increasingly applied to assess the non-response bias since it does not incur additional costs or data sources (O'Neill *et al.*, 1995; Sivo *et al.*, 2006). Using this approach our response bias analysis proved to be reassuring; showing the use of diet diary and demographic characteristics of early responders and late responders to be similar. Moreover, profile of our responders in terms of gender distribution (40.0% females) and NHS work (75.0%), is similar to the profile of GDPs according to these characteristics in nationally held statistics (Kravit and Treasure, 2009).

Although the response rate was low, because of the large sample size, the number of responses received still gives a relatively narrow margin of precision ($\pm 0.06\%$) around our estimate of the proportion of using diet diaries. Our study therefore gives us an idea of what is happening in the English dental practice setting, and suggests that while diet advice is a role undertaken by the vast majority of GDPs, relatively low proportion (28.0%) use diet diaries as a tool to support this activity. Bearing in mind that respondents are likely to be that most interested in this area (Kaner *et al.*, 1998; Tan and Burke, 1997), and some degree of social desirability in responses may be present (Van de Mortel, 2008), this is likely to represent the maximum figure of the population of GDPs using diet diaries in their clinical practice.

Also of interest in this study, is that giving diet advice to patients is clearly part of accepted clinical practice for dental practitioners where almost all GDPs reported giving diet advice of some sort. It should however be noted that clinical practice in this area was widely variable. The mean number of patients to which dietary advice was given was 63.0%, but with a standard deviation of 30.0%. For practitioners using diet diaries, this study provides some details as to approaches used. GDPs appear to prefer asking patients to recall their usual diet habits, which is less time-consuming than introducing records, although arguably more subject to errors and distortions of memory. This is in keeping with findings from a previous qualitative observational study involving 35 English GDPs which identified very little dietary information was communicated between dentists and their patients (Barton *et al.*, 2001). Table 4 shows a number of reasons that GDPs reported discourage the use of diaries.

Table 4. GDPs' reasons for not using diet diaries in dental practice for child and adult patients

General Dental Practitioners' reasons for not using diet diaries	Children (N=168)		Adults (N=172)	
	n	(%)	n	(%)
The NHS remuneration is insufficient to cover my time spent on a diet diary	82	(48.8)	80	(46.3)
Lack of knowledge needed for diet analysis	27	(16.1)	26	(15.0)
I do not feel they are useful	42	(25.0)	48	(27.7)
No need for their use	22	(13.1)	18	(10.5)
Time consuming	13	(7.7)	11	(6.4)
Poor compliance	24	(14.3)	27	(15.7)
Feels patronising and intrusive	2	(1.2)	3	(1.7)

One prominent reason is that GDPs have concerns about time and financial constraints associated with English NHS remuneration arrangements. This is supported by two strands of evidence. First, GDPs directly stated this and, second, in the multivariate analysis diary use was associated with a lower case mix percentage of NHS patients. With attention now shifting in recent years towards more fully rewarding prevention practices within the NHS dental remuneration system (Department of Health, 2015), what represents 'best practice' in terms of dental practice dietary advice needs to be clarified; with discussions around how remuneration and rewards might be set to fully recognise the time required.

Respondents reported a perception of poor patient compliance, and this formed a further barrier to diet diaries usage. Certainly, it is well recognised that user's compliance and motivation are essential to obtain reliable dietary information and hence the successful use of diaries (Thompson and Subar, 2013). However, there are no previous studies of patients' perceptions of dietary advice given in dental practice and the place of diet diaries in this, therefore further research is needed in this area. Nevertheless, collecting dietary history information on a paper template in the form of a diet diary may seem out-moded, given more recent technological interventions in the field of self-monitoring of health related data. A recent study has shown that mobile apps have the potential to motivate patients to adopt evidence based health behaviour (Underwood *et al.*, 2015). Techniques such as ecological momentary analysis which can record information on behaviour and attitudes in a real-time way, in a smart-phone application, also offer possibilities (Schüz and Ferguson, 2015). Taking photographs of food/drink using smart phones might also give a more authentic picture of patients' habits and be useful, although the impact of a social class digital divide needs to be considered and explored.

The use of diet diaries as a prompt to giving tailored health education advice is just one mechanism by which counselling may increase patient engagement and motivation to change behaviour. There is growing current emphasis on the use of risk assessment tools to highlight patients' responsibility to maintain their own health (Bratthall and Hänsel Petersson, 2005; Crall *et al.*, 2015; Featherstone *et al.*, 2007). Likewise, Motivational Interviewing (MI) which also takes a patient-centred approach, has been used to facilitate the giving of health education messages in dental practice with some success (Gao *et al.*, 2014; Harrison *et al.*, 2007). In all these approaches, however, discussions regarding dietary pattern may still be detailed, complex and necessary. The use of dietary assessment tools may therefore still be useful alongside broader risk assessment and MI methods. The issue remains however that whilst our study shows that diet-related discussions are appropriately held in dental practice setting, the tools to support this are currently underused and probably under-developed.

Conclusion

Although recommended as best practice, most English GDPs do not use diet diaries to collect diet information in dental practice, probably because of perceived constraints related to finance and time. Development of a more time efficient tool, which can assess diet and help stimulate behaviour change is needed to tackle high sugar consumption and other related dietary issues pertinent to the dental health setting.

References

- Aggarwal, V.R., Joughin, A., Zakrzewska, J., Appelbe, P. and Tickle, M. (2012): Dentists' preferences for diagnosis, management and referral of chronic oro-facial pain: Results from a national survey. *Health Education Journal* 7, 662-669.
- Barton, K.L., Anderson, A. S., Pine, C. M., Paterson, M. G., and Burnside, G. (2001): Dietary interventions in general dental practice: an unexplored opportunity for promoting dietary change in low income communities? *Proceedings of the Nutrition Society* 60, 5A.
- Bates, B., Alison, L., Ann, P., Chris, B., Polly, P., Sonja, N. and Gillian, S. (2014): *National Diet and Nutrition Survey: results from Years 1 to 4 (combined) of the rolling programme for 2008 and 2009 to 2011 and 2012*. London: PHE & FSA.
- Bratthall, D. and Hänsel Petersson, G. (2005): Cariogram – a multifactorial risk assessment model for a multifactorial disease. *Community Dentistry and Oral Epidemiology* 33, 256-264.
- Burt, B.A. and Pai, S. (2001): Sugar consumption and caries risk: a systematic review. *Journal of Dental Education* 65, 1017-1023.
- Cook, J.V., Dickinson, H.O. and Eccles, M.P. (2009): Response rates in postal surveys of healthcare professionals between 1996 and 2005: an observational study. *BMC Health Services Research* 9, 160.
- Crall, J.J., Quinonez, R.B. and Zandoná, A.F. (2015): Caries risk assessment. *Early Childhood Oral Health*. John Wiley & Sons: 193-220.
- Cummings, S.M., Savitz, L.A. and Konrad, T.R. (2001): Reported response rates to mailed physician questionnaires. *Health Services Research* 35, 1347.
- Department of Health, DH (2015): *Dental contract reform: Prototypes - Overview document*. London: DH.
- Dillman, D.A., Smyth, J.D. and Christian, L.M. (2014): *Internet, Phone, Mail, and Mixed-Mode Surveys: The Tailored Design Method, 4th Edn*. Somerset : Wiley.
- Edwards, P., Roberts, I., Clarke, M., DiGiuseppi, C., Pratap, S., Wentz, R. and Kwan, I. (2002): Increasing response rates to postal questionnaires: systematic review. *British Medical Journal* 324, 1183.
- Featherstone, J.D., Domejean-Orliaguette, S., Jensen, L., Wolff, M. and Young, D. (2007): Caries risk assessment in practice for age 6 through adult. *Journal of the California Dental Association* 35, 703.
- Franki, J., Hayes, M. and Taylor, J. (2014): The provision of dietary advice by dental practitioners: A review of the literature. *Community Dental Health* 31, 9-14.
- Gao, X., Lo, E.C.M., Kot, S.C.C. and Chan, K.C.W. (2014): Motivational interviewing in improving oral health: a systematic review of randomized controlled trials. *Journal of Periodontology* 85, 426-437.
- Groves, R.M. and Peytcheva, E. (2008): the impact of non-response rates on nonresponse bias. *Public Opinion Quarterly* 72, 167-189.
- Harris, R. and Bridgman, C. (2010): Introducing care pathway commissioning to primary dental care: the concept. *British Dental Journal* 209, 233-239.
- Harris, R., Gamboa, A., Dailey, Y. and Ashcroft, A. (2012): One-to-one dietary interventions undertaken in a dental setting to change dietary behaviour. *Cochrane Database of Systematic Reviews* 3, CD006540.
- Harrison, R., Benton, T., Everson-Stewart, S. and Weinstein, P. (2007): Effect of motivational interviewing on rates of early childhood caries: a randomized trial. *Pediatric dentistry* 29, 16-22.
- Kaner, E., Haighton, C.A. and McAvoy, B.R. (1998): 'So much post, so busy with practice—so, no time!': a telephone survey of general practitioners' reasons for not participating in postal questionnaire surveys. *British Journal of General Practice* 48, 1067-1069.

The information filter: how dentists use diet diary information to give patients clear and simple advice

Arheiam Arheiam¹, Stephen L. Brown²,
Susan M. Higham¹, Sondos Albadri² and
Rebecca V. Harris¹

¹Department of Health Services Research/
School of Dentistry, Institute of Psychology,
Health and Society, University of Liverpool,
Liverpool, UK, ²Department of
Psychological Sciences/School of Dentistry,
Institute of Psychology, Health and Society,
University of Liverpool, Liverpool, UK

Arheiam A, Brown SL, Higham SM, Albadri S, Harris RV. The information filter: how dentists use diet diary information to give patients clear and simple advice. *Community Dent Oral Epidemiol* 2016; 44: 592–601. © 2016 John Wiley & Sons A/S. Published by John Wiley & Sons Ltd.

Abstract – Objectives: Diet diaries are recommended for dentists to monitor children's sugar consumption. Diaries provide multifaceted dietary information, but patients respond better to simpler advice. We explore how dentists integrate information from diet diaries to deliver useable advice to patients. **Methods:** As part of a questionnaire study of general dental practitioners (GDPs) in Northwest England, we asked dentists to specify the advice they would give a hypothetical patient based upon a diet diary case vignette. A sequential mixed method approach was used for data analysis: an initial inductive content analysis (ICA) to develop coding system to capture the complexity of dietary assessment and delivered advice. Using these codes, a quantitative analysis was conducted to examine correspondences between identified dietary problems and advice given. From these correspondences, we inferred how dentists reduced problems to give simple advice. **Results:** A total of 229 dentists' responses were analysed. ICA on 40 questionnaires identified two distinctive approaches of developing diet advice: a summative (summary of issues into an all-encompassing message) and a selective approach (selection of a main message approach). In the quantitative analysis of all responses, raw frequencies indicated that dentists saw more problems than they advised on and provided highly specific advice on a restricted number of problems (e.g. not eating sugars before bedtime 50.7% or harmful items 42.4%, rather than simply reducing the amount of sugar 9.2%). Binary logistic regression models indicate that dentists provided specific advice that was tailored to the key problems that they identified. **Conclusion:** Dentists provided specific recommendations to address what they felt were key problems, whilst not intervening to address other problems that they may have felt less pressing.

Key words: advice; dentists; diet; diet diaries; prevention

Arheiam Arheiam, Room 113, Block B
Waterhouse Building, 1–5 Brownlow Street,
Liverpool, UK, L69 3GL
Tel: +44 (0) 151 794 5598
Fax: +44 (0)151 794 5604
e-mail: Arheiam@liverpool.ac.uk

Submitted 21 April 2016;
accepted 3 August 2016

Background

The aetiology of dental caries involves a complex interplay of social, biological, environmental and behavioural factors¹. Recently, the role of free sugar as a modifiable dietary and behavioural risk factor for dental caries has been reemphasised². Systematic review evidence concludes that the contribution of free sugars to total daily energy should

be reduced to less than 5% in order to reduce the incidence of dental caries³. However, frequency, timing of consumption and duration in the mouth all impact the cariogenic potential of sugar consumed⁴. In addition, the dynamic nature of the mineralisation/demineralisation process involved in the development of dental caries makes advice much more complex than simply emphasise the overall amount of sugar⁵.

Dental practitioners are encouraged to provide dietary advice that is 'systematic, comprehensive and tailored to patients' needs' in order to support behaviour change in patients at high risk of dental caries⁶. A careful assessment of patients' dietary habits is indicated in order to understand dietary practices and to allow a tailoring and optimising of advice⁷. Current guidance recommends diet diaries as good practice for diet assessment in dental practice⁸. Patients are typically asked to keep the diary for three consecutive days including at least 1 weekend day. They are asked to record type, amount and timing of dietary intakes as well as timing of bedtime⁹. This information provides a contemporaneous account of dietary intakes, as a basis for discussions between dentists and patient and the identification of appropriate behaviour change goals⁷.

However, information provided by diet diaries is nuanced and multifaceted, yet behavioural change is most likely to be affected by simple, focussed and easily implemented advice¹⁰. It is unclear how dentists handle the task of reducing this information to simple messages. Current literature provides little insight into this problem. Using complex information to best inform decision-making is an issue that is common to many areas of clinical practice^{11,12}, but few studies have investigated how dentists process diagnostic information in order to provide clinical advice^{13,14}. This study therefore aimed to explore how dentists navigate the problem of integrating complex information from diet diaries to deliver useable dietary advice to patients.

Methods

Ethics (reference 14/LO/1204) and research governance approvals were obtained before commencing this study.

This study used a case vignette comprising a two-day diet diary of a child with dental caries^{15,16}. Multiple problem behaviours were specified; eating immediately before bedtime, snacking, sticky and hidden sugars, amount and frequency of intake and alternate sequence of sugar intake with protective food as well as varies general eating behaviours. Dentists were asked, in separate items with free-text responses, to specify what they thought were the problematic entries in terms of caries risk in the vignette, and to state advice that they would give to the patient.

Dentists were presented with a single case vignette (supplemental file 1). Contextual dental and medical history was given, and the diary was identified as being from an 11-year-old, NHS dental patient at high risk of developing dental caries, who presented to the dentist with mild dental toothache due to dentine caries. She had a clear medical history whilst dental history showed multiple extractions and regular dental visits in the last year. A 2-day diet diary was structured to allow a record that included multifaceted and varied information related to type, amount and time of dietary intakes and time the patient went to the bed. For example, on day 1, the vignette included information on finishing the meal with cheese after yoghurt whereas in day 2 cheese was in the middle of the meal which is finished by hidden sugar in Actimel. Also, on day 1, two milkshakes were taken 1 hour apart and near bedtime, and on day 2, cake and milkshake were consumed together though near bedtime. The vignette was followed by four open-ended questions with sufficient space to provide a detailed open text response to each. Dentists were asked to:

- indicate up to six behaviours, on the two-day diet diary, which represented dental health issues
- indicate any aspects of the diet diary that child or the parents would be asked to give more information about
- state the first dietary issue that the child/parents would be advised about
- specify any other areas of advice (if any)

The diet diary case vignette was included in a wider postal questionnaire about dietary advice to general dental practitioners (GDPs) in Northwest England. The methodology of the questionnaire is described in detail elsewhere¹⁷. In summary, the questionnaire was sent to 972 GDPs between September 2014 and January 2015. A two-stage cluster sampling method was used to stratify areas according to practice location in areas of low, medium and high caries prevalence. A total of 229 questionnaires with completed vignette responses were received.

Data analysis

To the best of our knowledge, there is no pre-existing research on how dentists use diet diary information to formulate diet advice. Thus, a sequential approach, comprising qualitative and quantitative analyses, was used. An inductive content analysis (ICA) was initially carried out in a subsample of

questionnaires, to understand how dentists used diet diary information to formulate their advice for patients and to develop a coding system for dentists' interpretations of the dietary information given in the diet diary. The coding framework was then applied to the wider sample in a quantitative phase of the analysis.

Inductive content analysis

ICA was carried out in a subsample of 40 cases (questionnaires) with completed open text responses. These were purposefully selected for their completeness and variability of the responses. All cases were anonymised using serial numbers and letters indicating the area's caries level (L=Low, M=Moderate, H=High) and practice type (N=NHS, P= private). Open text responses for all selected cases were transcribed verbatim and coded using a qualitative analysis software package, the NVIVO 9.2 (QSR International). A constant comparison method was used, where data were coded and concurrently compared for the occurrence and interrelation between codes across different cases¹⁸. The process of cases selection and coding was iterative until data saturation was reached¹⁹. Data saturation was observed after 35 cases. A further five cases were analysed to validate the coding and ascertain the saturation.

ICA commenced with repeated readings through the data to gain thorough understanding and to make sense of the data. Data were then analysed inductively at the level of words, sentences and phrases. A coding system was generated and continually refined as an ongoing process during the

course of the analysis, leading to the identification of emerging themes and subthemes regarding what did dentists viewed as important information in the diet diary (identified problems) which was identified from responses to vignette's questions 1 and 2 and what dentists included in their diet advice, which was identified from responses to vignette's questions 3 and 4 (Fig. 1). By investigating what dentists recognised as issues from the diet diary information and what they suggested as solutions in the diet advice they would give, we made assumptions on how dentists approached formulating dietary advice from diet diary information presented to them.

Quantitative analysis

The coding scheme generated from qualitative analysis (Tables 1 & 2) was applied to all questionnaires with completed open text responses (n = 229). The variables were coded as 1 = the identified problem or advice was indicated by the dentist or 0 = not indicated. The coding process was carried out by a single investigator and verified by an independent assessor for the first 20 questionnaires. Absolute agreements of 90%-100% were reached.

Data were analysed using statistical software SPSS Version 22.0. (Armonk, NY: IBM Corp.). Counts and proportions were used to describe the frequency of each code for what dentists identified as problems and what they included in their suggested dietary advice to the patient. Binary logistic regression models were used to explore associations between identified problems and advice. A

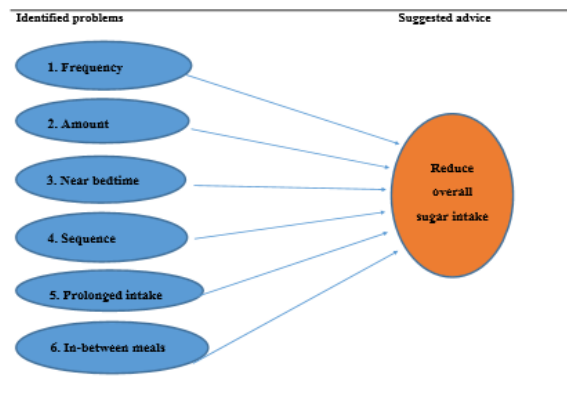


Fig. 1. A summative approach to delivering diet advice based on dietary assessment.

Table 1. Dietary information regarded as important by GDPs

Theme	Conceptual definition	Supporting quotation(s)
Harmful items	Items which have cariogenic or erosive potential represent risk to oral health	MN33: 'Apple juice, both sugary and acidic' HN 215: 'The type of food consumed. acidic/cariogenic'
Consumption patterns	The way in which a harmful item is consumed raises the risk of caries/erosion.	
Subtheme		
Frequency	A high number of intakes per day	LN116 'High frequency of sugar throughout the day'
Amount	A large amount of sugar/acid	MN201 'How much sugar is in the milkshake she has?'
In-between meals	Sugar consumption between meals	MP6 'Milkshake high in sugar+ taken before bed'
Near bedtime	Sugar consumption close to bedtime	HN6 'milkshakes last thing at night'
Prolonged exposure	Consumption manners and food form that extend the duration of sugar exposure	LN31 'Caramel is sticky and chocolate is high in sugar' HN6 'Are milkshakes consumed quickly in one go or lots of sips?'
Sequence	The order of items intake within the meal/snack	HN31 '7:45 am, day 2, is milk last thing after coco pops/pear?'
Hidden sugars	Patient's unawareness of sugar content in the diet	HN6 'Are they aware of hidden sugars in food?'
Personal oral health care	Oral hygiene practices and use of fluoridated toothpaste may modify the effect of harmful items	HN6 'Does she brush her teeth before bedtime?' LN311 'Brushing habits (before or after breakfast) 2 x days'
Environmental influences	Patients' ways of living, values and routine behaviours may influence the consumption of sugary/acidic items	HN31 'Does the child take a packed lunch or have a school dinner?' MN212 'Who buy the chocolate + drinks?'
General dietary issues	Unbalanced diet of poor nutritional value and irregular eating habits affect the general health	MN212 'Absence of guideline "5 - A-Day" healthy fruit and veg foods concern over some possible sequelae for general health'

multivariate model regressed each binary outcome (advice) variable (yes/no) onto the predictor (identified problem) variables. The regression model was adjusted for the dentists' demographic and professional characteristics (gender, years in service and role in practice) as well as characteristics of their dental practice (area's caries level, index of multiple deprivation quintiles and the proportion of practice case mix reported to be NHS or private).

Results

The results are outlined to reflect the order of methods and analysis used, with the findings of ICA presented first, followed by results of the quantitative analysis.

Results of qualitative analysis

The coding framework: important dietary issues and advice topics. ICA themes and subthemes with

their conceptual definitions and supporting data are given in Tables 1 and 2. Many dentists approached their analysis of the diary by identifying items that they considered as harmful to oral health by the virtue of their cariogenic and erosive potential. The GDPs, also, addressed such items in their suggested dietary advice.

'Apple juice, both sugary and acidic'

MN33: (Response to Q1 – identified problem)

In many cases, dentists identified the ways in which sugar was consumed as problematic. Information which identified by GDPs as important included the amount, frequency, timing and duration of exposures to items with cariogenic potential, as well as the hidden sugars and sequencing of sugar with alkaline intakes. For example:

'Frequent eating and snacking of sugar leads to too frequent acid attacks'

HN20: (Response to Q1 – identified problem)

Table 2. Topics to be covered by GDPs giving dietary advice

Theme	Conceptual definition	Supporting quotation(s)
Harmful items	A recommendation to reduce the intake of cariogenic/erosive items	MN35 'Reduce sugary, acidic drinks to a minimum' HN 215: 'reduce overall sugar consumption'
Consumption patterns	Reduce or avoid ways of consumption that raise the risk of caries/erosion.	
Subtheme		
Frequency	Reduce the number of intakes per day	LN113 'Sugar frequency should be limited to 4 a day or less'
Amount	Reduce amount of sugar in diet	HN6 'Reduce the amount and frequency of consumption of sugar'
In-between meals	Avoid sugar consumption between meals	MP6 'Milkshake high in sugar+ taken before bed'
Near bedtime	Avoid sugar consumption close to bedtime	LN306 'Only have water or plain milk between meals'
Hidden sugars	Raise patient's awareness of unseen sugars in diet	MN256 'Go through foods which contain hidden sugars, e.g. tomato sauce in beans'
Personal oral health care	Maintenance of good oral hygiene and fluoride use	HN6 'Tooth brushing/oral hygiene/fluoride use advice'
Environmental influences	Provide advice to child carers including those outside home	HN13 'Awareness of same advice to grandparents as well' LN 316 'Involve parents and other members of family'
General dietary issues	General diet, nutrition and eating habits recommendations	HP8 'Choice of evening meal contains a lot of fat. Lack of fibre in diet' MN212 'Balanced diet - more vegetables etc.'

Environmental factors and patient's behaviours that were not strictly dietary but might act to modify either the intake or the effect of harmful items (such as oral hygiene practices, parental attitude and motivation) were identified as important information and also would have been discussed by GDPs when giving advice. For example, the GDPs, in their responses to question (3), indicated that they would ask the child/parents about oral hygiene habits and how the child access sugary snacks.

'Who buys the chocolate + drinks?'
MN212 (Response to Q3 – advice)

General dietary issues were also reported as important diet diary information and in the advice topics.

'Choice of evening meal contains a lot of fat. Lack of fibre in diet'
HP8: (Response to Q1 – identified problem)

Approaches to formulating dietary advice

From correspondences between problem and advice codes, we identified two approaches of formulating advice from identified problems. These were a) a summative approach and b) a selective approach.

A summative approach

Some GDPs made an effort to sum up the complex register of important dietary issues and deliver this in an all-encompassing set of advice (Fig. 1). This appeared to be a reflection of GDPs' interpretation of what constitutes a common factor among the issues they had identified. These GDPs recognised many different items and dietary behaviours in the diet diary as important (e.g. amount, frequency, hidden sugars and between meals and near bedtime intake of sugars), but did not focus on any particular issue. Some gave general advice, addressing a common aspect among various issues (usually sugar consumption). For example, the dentist may deliver an all-purpose statement with a core message to restrict all forms of harmful intakes (e.g. *reduce the intake of sugary foods and drinks* or *reduce the amount and frequency of sugar intakes/reduce sugar intake to minimum*).

A selective approach

In this approach, some GDPs gave their advice by picking up one or two from many issues from the diet diary which they considered as important. In doing so, they addressed specific dietary problems; possibly what they considered the most important (Fig. 2). Put more simply, these GDPs highlighted in their response to vignette's question (1) a range

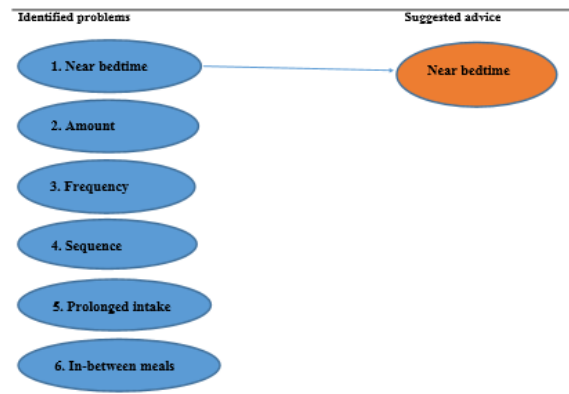


Fig. 2. A selective approach to delivering diet advice based on dietary assessment.

of important issues (e.g. frequency, amount, near bedtime and sequence of sugary items intake), but when it comes to delivering advice (vignette's questions 3 & 4), they took a very specific approach and select one or two particular topics to address (e.g. avoid near bedtime intake of sugars or reduce the frequency of sugar intake to less than four times a day).

Results of quantitative analysis

Sample profile. Table 3 shows characteristics of the 229 participants who completed the vignette section of the questionnaire. These respondents had a mean 20 (±12) years of service since qualification, most of them undertook some NHS work (97%, 219) and the majority worked in practices located in first and second quintile IMD areas (most deprived). There was a relatively even distribution of respondents by their gender and by caries prevalence (high, medium and low), of areas in which their practices were located.

Frequencies of important dietary issues and diet advice topics. Generally, the number of diet advice topics addressed (advice) was fewer than the number of identified problems (Table 4). The most frequently identified problems were near bedtime (180, 79%) and frequency (59, 26%) of consumption of sugar as well as general dietary habits (54, 25%), whereas sequence and prolonged intake of sugars were the least frequently recognised dietary issue. On the other hand, most frequently observed advice was near bedtime consumption of sugars (116, 51%), harmful items (97, 42%) and frequent sugar intakes

Table 3. Characteristics of the study sample (n = 229)

Variables	Summary N	Statistic (%)
Sex		
Men	126	(55)
Women	103	(45)
Role		
Practice Owner	96	(41.9)
Associate/other	133	(58.1)
Caries Incidence		
Low	84	(36.7)
Moderate	67	(29.3)
High	78	(34.1)
Index of Multiple Deprivation quintiles		
Quintile 1 (Most deprived)	69	(30.1)
Quintile 2	76	(33.2)
Quintile 3	30	(13.1)
Quintile 4	36	(15.7)
Quintile 5 (Least deprived)	18	(7.9)
Practice sector		
NHS	219	(96.6)
Private	10	(3.4)
Years in service	Mean	(SD)
	20.9	(12.0)

(89, 39%). The amount of sugar intake was among the least common advice topics (21, 9%). Sequence of intake and prolonged contact time was absent in dietary advice.

Predictors of diet advice topics. Summaries of binary logistic regression models are presented in Table 5. These show a high level of specificity in the correspondence between advice and identified problems for nearly all analyses, the odds ratio (OR) of each item of advice being given were uniquely and

Table 4. Frequencies of important dietary issues and diet advice topics: (N = 229)

	Important issues	Advice topics
Harmful items	142 (62)	97 (42.4)
Frequency	59 (25.8)	89 (38.9)
Amount	44 (19.2)	21 (9.2)
Between meals	125 (54.6)	87 (38)
Near bedtime	180 (78.6)	116 (50.7)
Sequence	13 (5.7)	–
Hidden sugars	31 (13.5)	15 (6.6)
Prolonged contact time	22 (9.6)	–
General dietary issues	54 (24.9)	67 (29.3)
Personal oral health care	83 (36.2)	47 (20.5)
Environmental factors	35 (15.3)	4 (1.7)
Count (%)		

significantly ($P < 0.05$) higher if the corresponding problem was identified. Further, the advice given was generally the only significant predictor. The only exception for this was giving advice about harmful items which was not predictable from its identification as a problem (identifying harmful items as problem). Instead, this was predicted from general diet and frequency and near bedtime consumption of sugars being noted in the identified problems (Table 4). We observed very few associations between background variables and whether specific advice topics were given. Dentists from quintile 3 were more likely to give advice related to between meals, whereas those from quintile 5 to give advice related to between meals and near bedtime intake of sugars, ($P < 0.05$).

Discussion

The qualitative and quantitative components of this study showed that, when interpreting a child's diet diary and giving advice, dentists chose fewer issues on which to provide advice than the number of problems that they identified in the diary. The logistic regression analyses showed that the advice provided was highly specific to the problems that they had identified. Thus, we suggest that dentists filtered information in such a way that they focussed on what they saw as key areas at the time.

We interpret dentists' behaviour as an intelligent adaptation to a key practice dilemma; how to provide the best evidence-based advice to patients whose understandings of preventive dental health, attention to detail, and their motivations and opportunities to change their behaviour may be suboptimal. Thus, we argue that dentists reduced

the amount of advice given to provide a coherent and easily implemented recommendation, whilst prioritising the key problems that would otherwise have an appreciable impact on dental health. In particular, dentists preferred to address specific and contextualised problems, such as frequency and timing of sugar consumption that they identified. For instance, the majority of dentists focused on near bedtime intake of sugars which, whether it is high or not, can increase caries risk because it is associated with reduced salivary flow during sleep and consequently lower protective effects of saliva^{20,21}. They did not often give general advice such as to reduce the amount of sugar consumed.

In filtering information, dentists make it both more comprehensible and easier to implement for patients. Their efforts are supported by theory. For example, fuzzy trace theory demonstrates that a simple and coherent message is more likely to be remembered, retrieved and implemented than a more detailed message²². The latter may be more comprehensive and accurate, but these advantages are lost because they are complex and difficult to remember and use in decision-making²². Thus, dentists' filtering of information can be seen in much the same way; they presented a simplified message rather than a more comprehensive message that is less likely to have an influence. The specific principles that dentists use to prioritise and select information are currently unclear and require further research.

However, we emphasise that we describe in this study a process whereby dentists provide simplified advice, but did not directly ask dentists why they simplified this advice. Thus, our claim that dentists do this to improve patients' adherence is an untested inference. Other explanations for this may exist; dentists may provide simpler advice in response to pressures on their time¹⁷ or because they wish to preserve good relationships with patients by being overly critical of them.

Whilst dentists' choices of what advice to give appear to be logical, they run partially counter to current guidance that emphasises only the amount and frequency of sugar consumption and bedtime consumption⁷. This may be attributable to dentists more specific focus on dental health rather than more general health problems such as weight control. Although very recent evidence indicates that amount may be more important than frequency of sugar intake for controlling dental caries²³, sugar amount has been shown to be a poor indicator of food's cariogenic potential compared to a more

Table 5. The association between given diet diary information and their coverage as diet advice topic

Important issues	Diet advice									
	Harmful items OR (95% CI)	Frequency OR (95% CI)	Amount OR (95% CI)	Between meals OR (95% CI)	Near bedtime OR (95% CI)	Hidden sugars OR (95% CI)	General diet OR (95% CI)	Personal oral health care OR (95% CI)		
Harmful items	1.28 (0.65, 2.22)	0.89 (0.46, 1.75)	2.49 (0.68, 9.06)	0.76 (0.39, 1.49)	0.42 (0.21, 0.83)	1.70 (0.43, 6.76)	1.25 (0.57, 2.75)	0.67 (0.29, 1.54)		
Frequency	0.48 (0.23, 1.00)	3.39 (1.39, 6.82)	1.61 (0.53, 4.92)	0.56 (0.27, 1.16)	1.00 (0.49, 2.04)	0.45 (0.08, 2.45)	0.84 (0.38, 2.81)	2.21 (0.97, 4.05)		
Amount	0.67 (0.31, 1.46)	1.25 (0.57, 2.75)	2.37 (0.68, 8.33)	1.90 (0.87, 4.15)	0.94 (0.43, 2.05)	0.34 (0.04, 3.11)	1.17 (0.50, 2.76)	1.28 (0.51, 3.20)		
Between meals	0.65 (0.33, 1.27)	0.97 (0.49, 1.94)	0.80 (0.25, 2.55)	3.00 (1.49, 6.04)	1.11 (0.56, 2.21)	1.61 (0.39, 6.67)	1.81 (0.84, 3.91)	0.41 (0.18, 0.97)		
Near bedtime	0.37 (0.17, 0.87)	1.05 (0.47, 2.37)	1.61 (0.40, 6.44)	1.64 (0.69, 3.89)	2.40 (1.05, 5.49)	1.80 (0.31, 10.47)	0.30 (0.12, 0.75)	2.11 (0.75, 5.94)		
Sequence	1.19 (0.33, 4.24)	1.19 (0.34, 4.20)	-	0.91 (0.25, 3.30)	3.89 (0.94, 16.03)	1.63 (0.16, 17.18)	1.79 (0.43, 7.53)	2.59 (0.67, 1.02)		
Hidden sugars	0.70 (0.29, 1.68)	0.62 (0.24, 1.57)	0.32 (0.03, 2.91)	1.13 (0.47, 2.70)	0.96 (0.40, 2.29)	3.56 (0.91, 13.93)	1.68 (0.63, 4.51)	0.95 (0.29, 3.20)		
Contact time	1.98 (0.74, 5.25)	0.88 (0.31, 2.53)	-	1.21 (0.44, 3.29)	0.95 (0.34, 2.70)	2.45 (0.54, 11.11)	0.17 (0.03, 0.88)	0.50 (0.12, 2.03)		
General diet	2.35 (1.15, 4.80)	0.94 (0.41, 2.14)	1.55 (0.43, 5.64)	1.34 (0.65, 2.74)	0.73 (0.36, 1.48)	0.93 (0.21, 4.16)	8.88 (4.00, 19.71)	0.29 (0.11, 0.89)		
Personal oral health care	1.68 (0.89, 3.16)	1.03 (0.55, 1.94)	1.39 (0.47, 4.14)	0.74 (0.39, 1.40)	0.92 (0.39, 2.15)	1.79 (0.45, 7.10)	1.11 (0.55, 2.27)	4.07 (1.87, 8.86)		
Environmental factors	1.24 (0.54, 2.89)	1.61 (0.75, 3.64)	0.72 (0.18, 2.93)	1.08 (0.47, 2.51)	1.52 (0.81, 2.85)	0.09 (0.37, 1.53)	0.82 (0.32, 2.14)	0.90 (0.30, 2.69)		
Chi-square	0.013*	0.022*	0.308	0.012*	0.001**	0.757	≤0.001***	0.006**		
Nagelkerke R ²	0.192	0.190	.205	0.149	0.245	0.169	0.292	0.248		

*P < 0.05, **P < 0.01, ***P < 0.001. Bold: significant p value P < 0.05.

specific focus on the frequency, timing and context in which it is consumed²⁴. Another possibility may be that dentists are aware that their patients find it easier to visualise frequency and timing of sugar intake than amount and that reducing the frequency of sugar intake is more practical than reducing amount⁶.

To the authors' best of knowledge, this is the first study to investigate how dentists interpret and use diet diaries for dietary advice. This study used a case vignette in a survey of dentists which combines the internal validity of the vignette as an experiment with the external validity of the survey¹⁵. Although it might be argued that there are inherent differences between vignette's responses and actions in real life²⁵, this was not an issue in this study because the focus was on how dentists process the information rather than what they actually do in real world. The latter is preferably assessed by observations and interviews²⁶.

Conclusion

At a broader level, this research contributes to a small but growing literature that examines the cognitive strategies that dentists use to make clinical decisions^{13,14}. Here, we demonstrate that, faced with the constraints of providing information that is both simple and easy to implement, dentists rely upon a strategy of intelligent selection to filter out dietary information. Challenged with a large field of information, they select what they see as a subset of either the most useful or the easiest information to understand and implement. Contrary to the current focus in dental literature, dentists pay a relatively little attention to amount of sugar in diet and instead deal with a wide range of sugar consumption-related aspects. Further research is needed to understand the specific principles behind these choices.

References

- Selwitz RH, Ismail AI, Pitts NB. Dental caries. *Lancet* 2007;369:51–9.
- Sheiham A, James WP. Diet and dental caries: the pivotal role of free sugars reemphasized. *J Dent Res* 2015;94:1341–7.
- Moynihan PJ, Kelly SA. Effect on caries of restricting sugars intake: systematic review to inform who guidelines. *J Dent Res* 2014;93:8–18.
- Touger-Decker R, van Loveren C. Sugars and dental caries. *Am J Clin Nutr* 2003;78:881S–92S.
- Navia JM. Carbohydrates and dental health. *Am J Clin Nutr* 1994;59:719S–27S.
- Moynihan PJ. Dietary advice in dental practice. *Br Dent J* 2002;193:563–8.
- Watt RG, McClone P, Kay EJ. Prevention. Part 2: dietary advice in the dental surgery. *Br Dent J* 2003;195:27–31.
- Public Health England. Delivering better oral health: an evidence-based toolkit for prevention, 3rd edn. London: Public Health England, 2014.
- Rugg-Gunn AJ, Nunn JH. Nutrition, diet and oral health. Oxford: Oxford University Press, 1999.
- Wanyonyi KL, Themessl-Huber M, Humphris G, Freeman R. A systematic review and meta-analysis of face-to-face communication of tailored health messages: implications for practice. *Patient Educ Couns* 2011;85:348–55.
- White BA, Maupome G. Clinical decision-making for dental caries management. *J Dent Educ* 2001;65:1121–5.
- Gafni A, Charles C, Whelan T. The physician–patient encounter: the physician as a perfect agent for the patient versus the informed treatment decision-making model. *Soc Sci Med* 1998;47:347–54.
- Maupome G, Sheiham A. Clinical decision-making in restorative dentistry. Content-analysis of diagnostic thinking processes and concurrent concepts used in an educational environment. *Eur J Dent Educ* 2000;4:143–52.
- Maupome G, Schrader S, Mannan S, Garetto L, Eggertsson H. Diagnostic thinking and information used in clinical decision-making: a qualitative study of expert and student dental clinicians. *BMC oral health* 2010;10:11.
- Evans SC, Roberts MC, Keeley JW, Blossom JB, Amaro CM, Garcia AM et al. Vignette methodologies for studying clinicians' decision-making: validity, utility, and application in icd-11 field studies. *Int J Clin Health Psychol* 2015;15:160–70.
- Loftus S, Smith M. A history of clinical reasoning research. In: Higgs J, editor. *Clinical reasoning in the health professions* [electronic book]. Oxford: Butterworth-heinemann, 2008.
- Arheiam A, Brown S, Bruinside G, Albadri S, Higham S, Harris R. The use of diet diaries in general dental practice in England. *Community Dent Health* 2016;33:1–7.
- Bowen GA. Naturalistic inquiry and the saturation concept: a research note. *Qual Res* 2008;8:137–52.
- Ritchie J, Lewis J, Elam G, Tennant R, Rahim N. Designing and selecting samples. In: Ritchie J, Lewis J, McNaughton Nicholls C, Ormston R, editors. *Qualitative research practice: a guide for social science students and researchers*, 2nd edition. London: SAGE; 2013.
- Dawes C. Salivary flow patterns and the health of hard and soft oral tissues. *J Am Dent Assoc* 2008;139:185–245.
- Humphrey SP, Williamson RT. A review of saliva: normal composition, flow, and function. *J Prosthet Dent* 2001;85:162–9.

How dentists use diet diaries to advise patients

22. Reyna VF. A theory of medical decision making and health: Fuzzy trace theory. *Med Decis Making* 2008;28:850-65.
23. Bernabé E, Vehkalahti M, Sheiham A, Lundqvist A, Suominen A. The shape of the dose-response relationship between sugars and caries in adults. *J Dent Res* 2016;95:167-72.
24. Sanders TA. Diet and general health: dietary counselling. *Caries Res* 2004;38(Suppl 1):3-8.
25. Hughes R. Considering the vignette techniques and its application to a study of drug injecting and hiv risk and safer behaviour. *Sociol Health Illn* 1998;20:381-400.
26. Barter C, Renold E. The use of vignettes in qualitative research. *Soc Res update* 1999;25:1-6.

Are diet diaries of value in recording dietary intake of sugars? A retrospective analysis of completion rates and information quality

A. Arheim,^{*1} S. Albadri,² S. Brown,³ G. Burnside,⁴ S. Higham¹ and R. Harris¹

In brief

Describes the return rate of diet diaries in a teaching dental hospital.

Gives an idea about possible demographic and oral health factors that might affect the return rate of diet diaries

Evaluates to what extent diet diaries are capable of capturing complex diet diary information and what are the commonly missing information.

Objectives Current guidance recommends that dental practitioners should routinely give dietary advice to patients, with diet diaries as a tool to help diet assessment. We explored patients' compliance with diet-diaries usage in a paediatric clinic within a teaching hospital setting, where remuneration is not an issue. Objectives were to investigate associated factors affecting diet diaries return rate and the information obtained from returned diaries. **Methods** A retrospective study of 200 randomly selected clinical records of children aged 5–11 years who had received diet analysis and advice as part of a preventive dental care programme at a dental teaching hospital between 2010 and 2013. Clinical records, with a preventive care pro forma, were included in the study. Data on social and family history, DMFT–dmft, oral hygiene practices, dental attendance and dietary habits were obtained and compared with information given in completed diet-diaries. A deductive content analysis of returned diet-diaries was undertaken using a pre-developed coding scheme. **Results** Of 174 complete records included in this study, diet diaries were returned in 60 (34.5%) of them. Diet diaries were more likely to be returned by those children who reported that they regularly brushed their teeth ($P < 0.05$), and those who came from smaller families ($P < 0.05$). Content analysis of diet diaries enabled the identification of harmful types of foods and drinks in 100% of diaries. General dietary issues, frequency and between-meals intake of sugars were also all captured in the majority of diaries (95.0%, $N = 56$). Information on sugar amount (53.0%, $N = 32$), prolonged-contact with teeth (57.0%, $N = 34$) and near bedtime intakes (17.0%, $N = 28$) was reported in fewer diaries. **Conclusions** The return rate of diet-diaries in this setting was low, and associated with patients' demographic and oral health characteristics. Returned diet-diaries showed a varied range of missing important dietary information, such as sugar amount, which appears to compromise their validity as a diet assessment tool. Development of a more reliable and acceptable dietary assessment tool for use in the dental setting is needed.

Introduction

Dental caries is a considerable global health problem affecting many children.¹ According to the Global Burden of Disease study, caries in primary teeth affects 9% of children and is the tenth most prevalent health condition worldwide.² Although Sheiham and James,

among others, have argued that one of the reasons for the failure in combating this epidemic, is that insufficient attention has been hitherto paid to its primary cause – namely high sugar consumption,³ others have counter-argued that fluoride, particularly in toothpaste, makes dietary sugar control less necessary. However, there is now growing evidence that sugar is still a key player in dental caries incidence – even in areas where fluoride is widely available.^{4–7} Bearing in mind a growing national focus on efforts to limit dietary sugar consumption in order to address a growing obesity problem,^{8,9} it is now timely to consider how dentists address dietary issues when caring for children with dental caries.

National guidance from Public Health England in the form of 'Delivering better oral

health',¹⁰ forms the backbone of recommended evidence-based preventive dentistry in English general dental practice. This positions issuing dietary advice as central to the everyday clinical practice of general dental practitioners (GDPs); stating that: 'healthier eating advice should routinely be given to patients to promote good oral and general health'. The guidance is explicit, that the main dietary messages given should be 'to reduce both the amount and frequency of consuming foods and drinks that have added sugar'.¹⁰ It also mentions that there is a consensus that avoiding sugar-containing foods and drinks at bedtimes is beneficial to caries prevention, and draws attention to what a generally healthy diet looks like, in the form of an 'eatwell' plate. While the guidance does

¹Department of Health Services Research, School of Dentistry, ²School of Dentistry, Institute of Learning and Teaching, ³Department of Psychological Sciences, ⁴Department of Biostatistics, University of Liverpool, Liverpool, UK.

*Correspondence to: Dr A. Arheim
Email: arheim@liv.ac.uk

Refereed Paper. Accepted 4 September 2016

DOI: 10.1038/sj.bdj.2016.824

©British Dental Journal 2016; 221: 571–576

not tackle issues related to how GDPs should approach the delivery of advice, it does suggest that 'in some cases it can be helpful to use a diet diary', and an exemplar is given.¹⁰ This template used contains a three-day diary, with space to record time of consumption, alongside a space for a free text entry describing the item consumed.

In diet diaries, patients are typically asked to keep diet records for three consecutive days including at least one weekend day. This detailed dietary assessment is meant to enable both a tailoring of dietary advice for individual patients, as well as prompting a detailed discussion between dentist and patient which opens channels of communication and thus makes the forming of a therapeutic alliance more likely.¹¹ A further benefit envisaged, is that because diet diary keeping represents a real-time method of self-monitoring if used correctly,¹² this can, in itself, effect a positive change in behaviour – for evidence shows that incorporating self-monitoring tools into behaviour change interventions increases their effectiveness significantly.¹³ While the individualisation of chair-side dietary advice has been widely advocated in dentistry for some time,^{14–17} it is somewhat surprising that such little evidence exists on the use of diet diaries in dental practice.

In healthcare more generally, there is concern that poor patient compliance can compromise the efficient use of diet-diaries.^{18,19} Completing diet diaries prospectively and in a timely manner over several days is essential for their successful use since these ensure the accuracy of the record and its representativeness of habitual intake.²⁰ Therefore, non-compliance with diet diaries usage does not just concern the problem of a patient failing to return with a completed diary, but also where patients fail to keep a full, contemporaneous account of their diet and return either incomplete diaries or those which have been backfilled.¹⁹ Missing information may undermine the validity of diet diaries and breach the rationale for their use, which is to enable a tailoring of dietary advice to the patient's dietary behaviours. Of course low completion rates of diet diaries may also be due to a failure of clinicians to issue them to patients in the first place.

A recent study of the use of diet diaries in general dental practice, suggests low compliance might be an issue, although the matter was overshadowed by practitioners' perceptions that the use of diet diaries in NHS dental practice is insufficiently supported by

the current system of dental remuneration.²⁰ Therefore, in order to look more closely at issues to do with patients' compliance with the use of diet diaries in dentistry, and whether useful information is yielded by their use, we set out to study the use of diet diaries in a dental setting where clinician remuneration is not an issue – a teaching hospital situation, where care protocols currently advocate their use. The primary aim of this study was therefore to investigate the return rate of diet diaries issued to child patients aged 5–11 years old in a teaching hospital setting, and whether this was associated with certain demographic or oral health-related factors. A secondary aim was to look at what type of information was yielded by diet diaries, which had been completed and returned, in order to investigate the extent to which this tool is capable of capturing the variety of dietary behaviours relevant to developing dental caries.

Methods

Ethics (reference 14/LO/1204) and NHS research governance approvals were obtained before commencing the study.

Setting and sampling

The study was carried out in the paediatric dentistry department of Liverpool University Dental Hospital (LUDH) – a teaching hospital that provides secondary dental care for children referred from NHS dental practices in the region. All children/parents with dental caries attending this centre are routinely asked to keep diet diaries as part of their caries risk assessment, at the start of their care. Clinic data shows that on average, 10% of children fail to keep this first appointment. Twenty percent of those attending the first appointment also fail to attend a subsequent appointment when the diet diaries would be reviewed. In Liverpool clinicians routinely complete prevention pro formas (information of social and dental history and oral health behaviours) for all these patients as part of the caries risk assessment process, and so completion of a prevention pro forma in the clinical record, was taken as an indicator that a diet diary had been issued. We retrospectively evaluated a random sample of records of children aged 5–11 years attending prevention clinics in LUDH between January 2010 and December 2013. According to the teaching hospital database, 519 eligible children attended during this period. Based on previous audit information suggesting that 30% of these

patients returned the diet-diaries, a sample size of 200 records was identified as sufficient to allow an estimate of the proportion of returned diet diaries to within 5%, given predicted 95% confidence intervals. Using record tracking codes, a random sample of 200 clinical records was selected. When retrieved, only 174 of these clinical records contained completed prevention pro formas and so only these records were included in the study

Data extraction from clinical records

The following information was retrieved from the prevention pro formas in case notes: social history (child's age, gender and post code of residence, number of siblings and parents in the household; and whether the grandparents lived with them in the same home); DMFT-dmft (number of decayed, missing and filled permanent and primary teeth); oral hygiene practices (tooth brushing was considered regular if reported to be twice or more per day); and dental attendance (if patients reported a dental visit of any kind within the last six months, this was considered regular; if not, dental visiting was considered irregular). Postcodes were used to identify the corresponding Index of Multiple Deprivation quintiles (IMD),²⁰ ranging from Quintile 1 (the most deprived) through to Quintile 5 (the least deprived). Any completed diet-diaries included in clinical records were photocopied after anonymising the patient's identity.

Content analysis of diet-diaries

In order to address objective 2, a content analysis was applied to dietary information contained for all completed diet-diaries. This form of analysis requires the use of a coding framework, comprising categories with conceptual definitions, in order to inform the identification and classification of data.²¹ We undertook this analysis deductively using a coding framework which had been previously developed from the dental literature^{17,18,22–25} and an earlier study involving GDPs responses to a diet diary vignette.²⁶

Content from photocopies of diet-diaries was transcribed verbatim before being transferred into NVIVO software-version 10, to facilitate coding and analysis. The coding framework used contained 11 aspects of dietary assessment previously identified as potentially relevant to the giving of dietary advice by GDPs (Table 1). To help ascertain whether a food/drink item should be coded as harmful, or containing hidden sugars, information in the diary was at

times supplemented by referring to UK food tables and nutritional labels on market websites. Each of the 11 aspects of dietary assessment was coded as being missing from the diary when there was either no description (defined as complete lack of relevant information) or insufficient description (defined as limited information rendering the data misleading or judgement impossible) contained in the diary for that category.

Data were coded by one investigator (AA) and verified by another independent assessor in the first 15 (25.0%) diet-diaries. Both assessors were qualified dentists. Cohen's κ was run to determine the level of agreement between the two coders. There was strong agreement in most of the codes, $\kappa = (0.72 \text{ to } 1.00)$, $P \leq 0.05$. Frequencies of these codes were obtained by simply counting the observations of each code.

Statistical analysis

Data management and statistical analysis were performed using statistical software SPSS Version 22.0. (Armonk, NY: IBM Corp.). Descriptive statistics were used to profile the study sample and to describe the return rate of diet-diaries, with comparisons across socio-demographic characteristics, oral health related practices and dental caries experience of the study sample using the Chi-squared test and the Mann-Whitney U test. Binary logistic regression models were used to identify potential predictors of returning diet-diaries. A significance level of 20% in univariate analyses

was used as a cut-off point to include variables in the multivariate model.

While a cut-off for the acceptable proportion of missing data in a data set that allow valid statistical inferences to be made has never been established, it has been suggested that if more than 10% of data is missing, this is likely to cause biased analysis.²⁷ Nearly 25% of values related to family size, number of siblings, household parents and grandparents were found to be missing from prevention pro formas. So in order to explore the potential impact of missing data, an additional sensitivity analysis using multiple imputations (MI) was performed. Five complete imputed data sets were created using the fully conditional specification method, assuming that values were missing at random.²⁸ The results from the analyses of the five imputed data sets were combined to give pooled estimates for the effects of the predictors.

Results

Of 200 records sampled, 174 had prevention pro formas, and were included in the analysis. Diet diaries were found in 60 out of 174 records, giving a return rate of 34.5% (95% confidence interval 27.4% to 41.6%). The socio-demographic and oral health-related characteristics of the sample, as well as a comparison of diet-diaries return rate by these characteristics are shown in Table 2. The final study sample comprised records of children

with a mean age 7.2 (± 1.7), and mean DMFT-dmft of 6.1 (± 2.8). While the majority of sample was from areas of the most deprived IMD quintile (121, 69.5%). The majority of the sample also reported regularly visiting the dentist (129, 74.1%) and regularly brushing their teeth (132, 75.9%). The sample also had an even gender balance; with a roughly equal balance also, between single parent/dual parent households.

Bivariate comparisons of the return rate of diet-diaries by sample characteristics showed a higher return rate among regular brushers ($P = 0.016$) and small families ($P = 0.035$), Table 2. These differences disappeared in the adjusted multiple regression models. Yet, when the multiple imputations were applied, adjusted models showed that regular brushers were more likely to return diet-diaries (Table 3).

Content analysis of the 60 completed diet-diaries is presented in Table 1. It was possible to identify consumption of 'harmful items' in all diaries, and also the frequency and between-meals consumption of sugars, as well as general aspects of the diet, from more than 90% of diaries. However, information on the sequence of food/drink consumption could not be elicited at all, and information on sugar amount and prolonged contact with teeth could only be identified from just over half of diaries. The least frequently extracted information was the context of the intake (17, 28.0%) and whether the consumption was near bedtime (18, 30.0%) (Table 1).

Table 1 Coding framework used in the content analysis of diet diaries and frequency of information extracted from diet diaries

Code	Conceptual definition	Frequency recorded in diet diaries
Harmful items	Items were categorised as harmful based on their cariogenic potential. These are foods with high sugar content. These included dairy sweetened (yoghurt, milk drinks), confectionery (sweets, chocolate), cereals (Coco Rocks, Coco Pops, cereal bars), baked goods (cakes, biscuits), soft drinks and juice (drinking chocolate, sweetened carbonated beverages), and fresh as well as dried fruits (apples, banana, dates, raisins)	60 (100.0%)
Sugar frequency	Possible to identify how many times per day the child was exposed to sugar/acid items	56 (93.0%)
Sugar amount	The quantity of sugar/acid exposure per intake presented as number or portion size of items, servings or spoons	32 (53.0%)
Between meals sugars	A meal defined as: an intake representing a substantial contribution of daily energy, comprised many food groups and more than one course including at least one savoury course. It usually requires preparation and eaten at recognised meal-times snack: any single intake that does not meet the criteria of a meal	56 (93.0%)
Prolonged contact	A prolonged exposure to sugary/acidic items which involves the consumption of sticky food, slow intake and sipping of drinks. This included also sugary foods mixed with starch (eg bread)	34 (57.0%)
Sequence	The order of items intake in each intake	0 (0.0%)
Hidden sugars	Type of foods and brands with unseen sugar content and which have the potential of being perceived as sugar free or very low in sugar. (eg fruit juices, salad dressings, soups and ketchup, yoghurt, ready meals, marinades, chutneys and crisps)	50 (83.0%)
Combination	Items eaten together which may aggravate or alleviate the cariogenic/potential of one of them	48 (80.0%)
Context	The setting or the social event of sugar consumption	18 (30.0%)
General dietary issues	Unbalanced diet of poor nutritional value and irregular eating habits	56 (93.0%)

Discussion

Firstly we must recognise the study limitations such as missing data which are inevitable in this type of study.²³ Some case notes were excluded from the final analysis because they did not contain prevention pro formas, and this effectively reduced our sample size a little. Nevertheless, given the confidence intervals involved in the study, we were able to establish the diet diary return rate at a precision rate of $\pm 6\%$; although we have also made the assumption that completion of the prevention pro forma meant that a diet diary had been issued, and we have no independent verification of this, and so this should also be borne in mind when interpreting findings.

Our study shows that a relatively low proportion of diet-diaries are returned (34.5%, 60), even in a dental setting where NHS remuneration is not an issue. This study also found that regular brushers, and children from small families, were more likely to return diet diaries. Since regular tooth brushing is a sign of the patients' and parents' motivation and positive attitudes towards oral health, and a smaller family size probably indicates that these families are those with more time to complete a diary task, collectively our findings suggest that many of those children/parents who would benefit most from detailed dietary advice for caries prevention, lack the necessary motivation and time to comply with their usage. The

low return rate of diet-diaries observed in this study, may also have something to do with the fact that the majority of records included in this study were related to patients from the poorest end of the socioeconomic status (SES) spectrum. Given that patients' poor compliance in health care settings is not uncommon, for example, non-compliance rates of 19–28% for attendance at medical appointments²⁰ and 30–50% for treatment regimens²¹ have been reported, a compliance rate of 35% for diet diaries usage among a predominantly low SES is not unexpected bearing in mind the motivation required to complete the diary task. In addition, diet diaries are found to be the least preferred method of dietary assessment by people from low SES backgrounds when compared with other diet assessment methods; owing to low literacy, numeracy and language skills.²² Given that our sample were also those who evidently experienced high rates of dental caries, it is a concern that those most in need of help with caries prevention, appear not to find the current approach to dietary assessment methods appealing. With caries now focused among low socio-economic groups in many countries,²³ our study therefore calls into question whether the routine use of diet diaries in dentistry is appropriate.

A second objective of the study was to examine the quality of information yielded by completed diet-diaries, which could be seen as relevant to informing patients' dietary

advice aimed at preventing dental caries. Our content analysis of completed diaries showed an important and clinically relevant finding: that diet diaries did not consistently capture the full range of complexities relevant to giving dietary advice to dental patients. Information on sugar amount, consumption context, sequence of intake within meals, prolonged contact with teeth and sugars consumed near bed-time – all of which are recognized as being detrimental to developing dental caries,^{15,22,24} was often partially or completely missing from returned diet-diaries. Most striking on this list is that amount of sugar consumed could not be extracted from many diaries, even though national dental guidance¹⁰ articulates this consideration as one of the main dietary messages which should be covered when giving advice. This is of particular concern given very recent evidence which indicates that dietary sugars amount may be a more important factor related to caries development, than frequency of sugar intake.⁶ Although it is beyond the remit of the study to explain the reasons why information on sugar 'amount' is not given by patients completing diet diaries, we can surmise that there are two possibilities – either patients see this as unimportant, or too bothersome to report,^{24,25} or that dentists, when issuing the diet diary, place more emphasis on recording behaviours that they personally perceive as particularly important (and effectively prime their patients). Since we know that dentists see

Table 2 Study sample description and bivariate comparisons of diet diaries return rate (N = 174)

Variables		Sample distribution N (%)	Returned diaries N (%)	No diaries returned N (%)	P value
Gender	Male	82 (47.1)	29 (47.5)	53 (46.9)	0.936
	Female	92 (52.9)	31 (52.5)	65.2 (53.1)	
IMD*	Quintile 1	121 (69.5)	39 (65)	82 (71.9)	0.345
	Quintiles 2-5	53 (30.5)	21 (35)	32 (28.1)	
Regular dental attendance		129 (74.1)	44 (73.3)	85 (74.6)	0.86
Regular tooth brushing		132 (75.9)	52 (86.7)	80 (70.2)	0.016†
Parents in household‡	Single parent	66 (50.4)	24 (58.5)	42 (46.7)	0.144
	Both parents	65 (49.6)	17 (41.5)	48 (53.3)	
		Mean (SD)	Mean (SD)	Mean (SD)	
Family size‡		3.2 (1.1)	3.0 (1.1)	3.37 (1.1)	0.035†
Age		7.2 (1.7)	7.1 (1.7)	7.03 (1.6)	0.837
DMFT–dmft		6.1 (2.8)	5.7 (2.7)	6.36 (2.8)	0.109

Chi-squared test and Mann-Whitney U test were used to compare study sub-groups.
*Index of Multiple Deprivation quintiles. †P < 0.05. ‡Statistically significant. †N = 131.
DMFT–dmft means decayed, missing and filled permanent and primary teeth.

reducing frequency of sugar consumption as more practical than reducing the amount,²⁷ the second explanation here is a real possibility.

'Delivering Better Oral Health' guidance¹⁰ also identifies that identifying 'hidden sugars' in the diet is a key objective. It is important, therefore, to recognise that in our study, extraction of data from diet diaries allowed the seeking of additional information from other sources such as food tables where hidden sugars/harmful dietary items required clarification. A GDP undertaking a chair-side interpretation of diet diaries would probably not be realistically able to also draw on these additional resources. On the other hand, one could probably argue that what would happen in clinical practice in the event of such uncertainties, is that the GDP would probe for this missing information during a chair-side discussion of the diary with the patient. However, relying on further prompting then effectively compromises the prospective nature, temporal proximity of recording and accuracy of recording dietary intake, which are all, considered to be the major strengths of diet diary usage.¹⁴ Moreover, given that distinguishing a dietary record that reflects actual consumption from dishonest or incomplete ones is seen as nearly impossible,²⁸ because diet diaries are often subject to recall bias¹⁴ and patients are known to tend to simplify or alter recordings

to avoid negative feedback,²⁷ we are left asking – are diet diaries any use?

Thus we may need to look for more modern tools to support dietary assessment in dentistry. Certainly digital technology offers new, more modern alternatives to the traditional paper diet diary record. Such alternatives may enhance patients' compliance and engagement in dietary assessment and self-monitoring activities by reducing the participant burden.²⁸ A recent systematic review of health interventions, including dietary interventions administered using mobile apps, indicates that mobile apps supporting the self-monitoring of health related data have a high level of feasibility and acceptability.²⁹ In line with the explosion of innovation in this area, Public Health England has recently launched the 'sugar smart app' which helps users to recognise total sugar in different dietary products, as part of the Change4Life advertising campaign.⁴⁰ However, while this app may be helpful in identifying the presence of sugar in diet, it still fails to account for the complex nature of the association between other aspects of sugar consumption behaviours and dental caries.

Finally, bearing in mind the social gradient of dental caries distribution, with higher prevalence in children from socially deprived groups,²⁵ such technology-based interventions need to be evaluated for their affordability and

accessibility for these high risk groups and also for different age groups. Until this happens, working on more upstream approaches to tackle sugar consumption related to dental caries prevalence in these groups could be a better option.

Conclusion

The return rate of diet diaries by children and their families in a dental hospital setting is low, and appears to be associated with patients' demographic and oral health maintenance habits. Returned diet diaries showed a varied range of frequently missing, important dietary information. This included the amount of sugar consumed which is one of the main aspects of the diet recommended to be covered by dentists in national guidance, and thus effectively compromises the validity of diet diaries as a diet assessment tool for everyday clinical practice. This then raises questions as to whether this tool is the most appropriate means to support caries prevention for groups most in need of advice.

Table 3 Multiple regression analysis of factors associated with diet diaries return rate

Variables		Unadjusted models	Adjusted models	Adjusted model after imputations (pooled)
		OR (95% CI)	OR (95% CI)	OR (95% CI)
Gender	Male	Reference	--	--
	Female	1.0 (0.6, 1.9)	--	--
IMD*	Quintile 1	Reference	--	--
	Quintiles 2-5	1.4 (0.7, 2.7)	--	--
Dental attendance	Irregular	Reference	--	--
	Regular	1.01 (0.5, 2.2)	--	--
Teeth brushing	Irregular	Reference	Reference	Reference
	Regular	2.4 (1.1, 5.4)†‡	1.9 (0.7, 4.9)	2.7 (1.1, 6.3)†
Parents in household	Single parent	Reference	Reference	Reference
	Both parents	0.6 (0.3, 1.2)‡	0.9 (0.4, 2.2)	1.0 (0.8, 1.1)
Family size		0.7 (0.5, 1.0) †‡	0.7 (0.5, 1.1)	0.8 (0.5, 1.1)
Age		1.0 (0.8, 1.2)	--	--
DMFT–dmft		0.9 (0.8, 1.0)‡	0.98 (0.85, 1.12)	0.9 (0.8, 1.1)

--Not included in the adjusted models.

*Index of Multiple Deprivation quintiles. †P < 0.05. Statistically significant. ‡P < 0.2, eligible for inclusion in adjusted models. DMFT–dmft means decayed, missing and filled permanent and primary teeth.

- Albino J, Tiwari T. Preventing childhood caries: A review of recent behavioural research. *J Dent Res* 2016; **95**: 35–42.
- Marques W, Kassebaum N J, Bernabe E et al. Global burden of oral conditions in 1990–2010: a systematic analysis. *J Dent Res* 2013; **92**: 592–597.
- Sheiham A, James W P. Diet and dental caries: The pivotal role of free sugars reemphasized. *J Dent Res* 2015; **94**: 1341–1347.
- Moynihan P J, Kelly S A. Effect on caries of restricting sugars intake: systematic review to inform WHO guidelines. *J Dent Res* 2014; **93**: 8–18.
- Marthaler T M. Changes in the prevalence of dental caries: How much can be attributed to changes in diet? *Caries Res* 1990; **24**: 3–15.
- Bernabé E, Vehkälähti M, Sheiham A, Lundqvist A, Suominen A. The shape of the dose-response relationship between sugars and caries in adults. *J Dent Res* 2016; **95**: 167–172.
- Bernabé E, Vehkälähti M M, Sheiham A, Aromaa A, Suominen A L. Sugar-sweetened beverages and dental caries in adults: A 4-year prospective study. *J Dent* 2014; **42**: 952–958.
- World Health Organization. Sugars intake for adults and children. Geneva, Switzerland: World Health Organization, 2015.
- Public Health England. Scientific Advisory Committee on Nutrition (SACN). Carbohydrates and Health report. London: Public Health England, 2015.
- Public Health England. Delivering better oral health: An evidence-based toolkit for prevention. Third ed. London: Public Health England, 2014.
- Freeman R. The psychology of dental patient care: Communicating effectively: some practical suggestions. *Br Dent J* 1999; **187**: 240–244.
- Glanz K, Murphy S, Moylan J, Evensen D, Curb J D. Improving dietary self-monitoring and adherence with hand-held computers: a pilot study. *Am J Health Promot* 2006; **20**: 165–170.
- Michie S, Johnston M. Theories and techniques of behaviour change: Developing a cumulative science of behaviour change. *Health Psychol Rev* 2012; **6**: 1–6.
- Marshall TA. Chairside diet assessment of caries risk. *J Am Dent Assoc* 2009; **140**: 670–674.
- Watt R G, McGlone P, Kay E J. Prevention, Part 2: Dietary advice in the dental surgery. *Br Dent J* 2003; **195**: 27–31.

16. Rugg-Gunn A J, Nunn J H. *Nutrition, diet and oral health*. Oxford: Oxford University Press, 1999.
17. Mobley C, Dounis G. Evaluating dietary intake in dental practices: doing it right. *J Am Dent Assoc* 2010; **141**: 1236–1241.
18. Thompson F E, Subar A F. Chapter 1–Dietary Assessment Methodology. In Ferruzzi A M, Coulston C J, Boushey M G, (eds) *Nutrition in the prevention and treatment of disease. 3rd ed.* pp 5–46. USA: Academic Press, 2013.
19. Burke LE1, Warziski M, Starrett T et al. Self-monitoring dietary intake: current and future practices. *J Ren Nutr* 2005; **15**: 281–290.
20. Arheiam A, Brown S, Bruinside G, Albadri S, Higham S, Harris R. The use of diet diaries in general dental practice in England. *Community Dent Health* 2016; In press.
21. McLennan D, Barnes H, Noble M, Davies J, Garratt E. *The English Indices of Deprivation 2010*. London: Department for Communities and Local Government, 2011.
22. Schamber L. Time-line interviews and inductive content analysis: their effectiveness for exploring cognitive behaviours. *J Am Soc Inf Sci* 2000; **51**: 734–744.
23. Touger-Decker R, van Loveren C. Sugars and dental caries. *Am J Clin Nutr* 2003; **78**: 881S–892S.
24. Moynihan PJ. Dietary advice in dental practice. *Br Dent J* 2002; **193**: 563–568.
25. Morgan M, Fairchild R, Phillips A, Stewart K, Hunter L. A content analysis of children's television advertising: focus on food and oral health. *Public Health Nutr* 2009; **12**: 748–755.
26. Arheiam A, Brown S, Albadri S, Harris R. Dental Practitioners' Interpretation of a Diet-diary Vignette: a Content Analysis. *J Dent Res* 2015; **94**: 1819.
27. Dong Y, Peng C-Y J. Principled missing data methods for researchers. *SpringerPlus* 2013; **2**: 222.
28. Rezvan P H, Lee K J, Simpson J A. The rise of multiple imputation: a review of the reporting and implementation of the method in medical research. *BMC Med Res Methodol* 2015; **15**: 30.
29. Gearing R E, Mian J A, Barber J, Ickowicz A. A methodology for conducting retrospective chart review research in child and adolescent psychiatry. *J Can Acad Child Adolesc Psychiatry* 2006; **15**: 126–134.
30. Smith C M, Yawn B F. Factors associated with appointment keeping in a family practice residency clinic. *J Fam Pract* 1994; **38**: 25–29.
31. Patient compliance [editorial]. *Annals Pharmacother* 1999; **27**: S5–S24.
32. Holmes B, Dick K, Nelson M. A comparison of four dietary assessment methods in materially deprived households in England. *Public Health Nutr* 2008; **11**: 444–456.
33. Steele J, White D, Rolland S, Fuller E. Child Dental Health Survey 2013. Report 4: The burden of dental disease in children England, Wales and Northern Ireland. 2015. Available online at <http://www.hsdic.gov.uk/catalogue/PUB17137/CDHS2013-Reports-Burden-of-Dental-Disease.pdf>. (accessed March 2016).
34. Knudsen V K, Gille M-B, Nielsen T H, Christensen T, Fagt S, Biltoft-Jensen A. Relative validity of the pre-coded food diary used in the Danish National Survey of Diet and Physical Activity. *Public Health Nutr* 2011; **14**: 2110–2116.
35. Gondolf U H, Tetens I, Hills A P, Michaelsen K F, Trolle E. Validation of a pre-coded food record for infants and young children. *Eur J Clin Nutr* 2012; **66**: 91–96.
36. Sawaya A L, Tucker K, Tsay R et al. Evaluation of four methods for determining energy intake in young and older women: comparison with doubly labelled water measurements of total energy expenditure. *Am J Clin Nutr* 1996; **63**: 491–499.
37. Vuckovic N, Rittenbaugh C, Taren D L, Tobar M. A qualitative study of participants' experiences with dietary assessment. *J Am Diet Assoc* 2000; **100**: 1023–1028.
38. Boushey C J, Kerr D A, Wright J, Lutes K D, Ebert D S, Delp E J. Use of technology in children's dietary assessment. *Eur J Clin Nutr* 2009; **63**: S50–S57.
39. Payne H E, Lister C, West J H, Bernhardt J M. Behavioural functionality of mobile apps in health interventions: a systematic review of the literature. *JMIR Mhealth Uhealth* 2015; **3**: e20.
40. Public Health England. Change4Life advertising campaign, sugar smart app. 2016. Available online at <https://www.nhs.uk/change4life-beta/campaigns/sugar-smart/home> (accessed March 2016).

Appendix O.

Dental Practitioners' Interpretation of a Diet-diary Vignette: a Content Analysis

Oral presentation at IADR/AADR/CADR General Session & Exhibition. March 11-14, 2015, Boston, Massachusetts

CONTROL ID: 2117024

TITLE: Dental Practitioners' Interpretation of a Diet-diary Vignette: a Content Analysis

AUTHORS (FIRST NAME INITIAL LAST NAME): A. Arheiam¹, S. Brown¹, S. Albadri¹, R. Harris¹

AUTHORS/INSTITUTIONS: A. Arheiam, S. Brown, S. Albadri, R. Harris, Institute of Psychology, Health and Society, University of Liverpool, Liverpool, UNITED KINGDOM]

Group Author Abstracts:

ABSTRACT BODY:

Objectives: Although evidence suggests that sugar consumption behaviour is amenable to change, there is relatively little dental research in this area. For patients identified as being at high risk of dental disease, a dietary history is recommended. Whilst literature indicates that sugar frequency, amount and timing are the main concerns, we do not know how dentists approach the interpretation of dietary histories. 'Fuzzy Trace Theory' suggests that professionals process information based on a few important dimensions, or 'gist based representations' when making clinical decisions. This study aims to identify how dental practitioners approach the interpretation of diet diaries.

Methods: A postal questionnaire was sent to a stratified sample of English general dental practitioners (GDPs). This included a vignette of a 2-day diet diary for an 11-year-old with high caries. In an open response format GDPs were asked to list up to 6 behaviours which might concern them, and the first behaviour they would discuss with the patient. Responses were transcribed and coded using NVIVO software, with data analysed using an inductive content analysis approach.

Results: 98 GDPs provided responses to the vignette. The majority approached their analysis by first identifying a cariogenic or erosive item in the diet, and then considering its timing of consumption (proximity to bed-time, sequencing). Another 22% (22) approached the analysis by identifying a harmful item in conjunction with its frequency of consumption. Only 7% (7) of GDPs identified item amount as the first issue to address with the patient. Whilst sugar consumption emerged as the prime concern for the majority (84%, 82), issues concerned with the acidity of food/drink were also noted, as were general dietary issues such as a lack of vegetables in the diet.

Conclusions: Dentists appear to place more emphasis on sugars timing than frequency or amount when interpreting diet diaries.

TABLE TITLE: (No Tables)

(no table selected)

TABLE FOOTER: (No Tables)

(No Image Selected)

KEYWORDS: Dental practitioners, clinical decision making, diet, sugars.

Support Funding Agency/Grant Number:

Financial Interest Disclosure: NONE

Patients' Compliance with Diet Diaries Issued in Dental Hospital Setting

Poster presentation at IADR General Session. June 22-25, 2016 - Seoul, Republic of Korea

Poster #: 1762

UNIVERSITY OF LIVERPOOL

Patients' compliance with diet diaries issued in dental hospital setting



*Arheiam@liv.ac.uk

Authors: Arheiam Arheiam*, Stephen Brown, Susan Higham, Sondos Albadi, Rebecca Harris

Department of Health Services Research/ School of Dentistry, University of Liverpool, Liverpool, UK

Introduction

- Dental caries is a significant global health problem affecting children and adults ⁽¹⁾, with sugar still as a key player in the disease incidence - even in areas where fluoride is widely available ^(2,3).
- Diet diaries are recommended as a tool of dietary assessment to support dietary advice for patient with high caries risk ⁽⁴⁾.
- This helps in tailoring diet advice to individual patient's needs and in prompting discussions between dentist and their patients to achieve therapeutic alliance.
- However, a recent survey of English dentists showed that they perceive poor patient's compliance among barriers of diet diaries usage ⁽⁵⁾.

Time	Food	Quantity
7.30am	Two slices of toast with jam and a glass of milk	2
7.30am	Two slices of toast with jam and a glass of milk	2
12.00pm	Two slices of ham on bread	2
12.00pm	Two slices of ham on bread	2
3.00pm	Fruit smoothie + bread with jam	1
4.00pm	Two slices of toast with jam and a glass of milk	2
5.30pm	Two slices of toast with jam and a glass of milk	2
6.00pm	Two slices of toast with jam and a glass of milk	2
8.00pm	Two slices of toast with jam and a glass of milk	2
9.00pm	Two slices of toast with jam and a glass of milk	2

Objectives

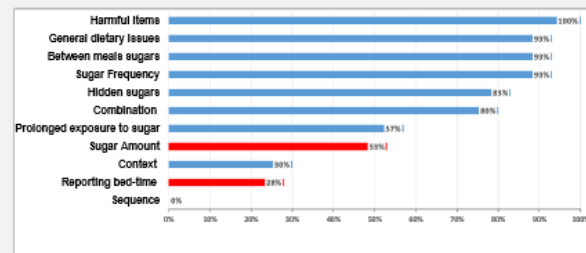
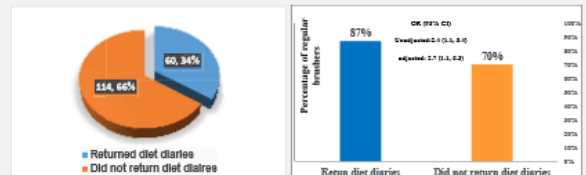
- To investigate the return rate of diet diaries issued in a teaching hospital setting, and its associated demographic and oral health-related factors.
- To investigate the extent to which this tool is capable of capturing the variety of dietary behaviours relevant to developing dental caries.

Materials and Methods

- A retrospective study of 200 randomly selected clinical records of children aged 5-11 years who had received dietary advice at a dental teaching hospital between 2010 and 2013.
- Clinical records, with a preventive care pro forma, were included in the analysis.
- Data on social and family history, caries experience, oral hygiene practices, and dental attendance were obtained and compared with the information given in completed diet-diaries.
- Statistical analysis was conducted using SPSS software.
- A deductive content analysis of returned diet-diaries was undertaken using a pre-developed coding scheme.

Results

- Of 200 records sampled, 174 had prevention pro formas, and were included in the analysis. Only 60 (34%) records had completed diet diaries
- When the multiple imputations were applied, adjusted models showed that regular brushers were more likely to return diet-diaries
- Returned diet diaries showed a varied range of frequently missing, important dietary information.



Conclusions

- The return rate of diet diaries by children and their families in a dental hospital setting is low and it appears to be associated with patients' demographic and oral health maintenance habits.
- Some of the main aspects of the diet recommended to be covered by dentists in national guidance, were missing and thus effectively compromises the validity of diet diaries as a diet assessment tool for everyday clinical practice.
- This then raises questions as to whether this tool is the most appropriate means to support caries prevention for groups most in need of advice.

Literature cited

- Mechanic D, Kalkstein N, Benak D, et al. Global burden of oral conditions in 1990-2010: a systematic analysis. J Dent Res 2012;91:185-191.
- Moylan P, Kelly SA. Effect on caries of restricting sugar intake: systematic review to inform WHO guidelines. J Dent Res 2014;93:1-18.
- Bennett R, Robinson M, Sheiham A, et al. The Stage of the Diet-Response Relationship between Sugars and Caries in Adults. J Dent Res 2014;93:1671-72.
- Public Health England. Delivering better oral health: An evidence-based toolkit for prevention. Third ed. London: Public Health England, 2014.
- Arheiam A, Brown S, Bennett C, et al. The use of diet diaries in general dental practice in England Community Dent Health 2016 (accepted for publication).

Funnelling information: how dentists use diet-diaries to advice patients

Poster presentation at BASCD Spring Presidential meeting 2016. Lakes district, UK

Funnelling information: how dentists use diet-diaries to advice patients

Authors: Arheiam Arheiam*, Stephen Brown, Susan Higham, Sondos Albadri, Rebecca Harris

Introduction

- Guidance from Public Health England in the form of 'Delivering Better Oral Health' recommends that dental practitioners should routinely give dietary advice to patients, with diet diaries as a tool to help diet assessment.
- Diet considerations relevant to dental caries are multi-faceted. Diet diaries contain a range of important information, but we do not know how clinicians translate this into the advice they give to patients.

Aim

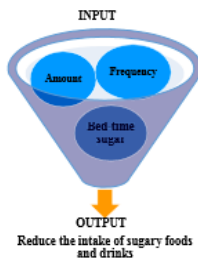
To explore how dentists integrate complex information from diet diaries to deliver useable advice to patients

Material and methods

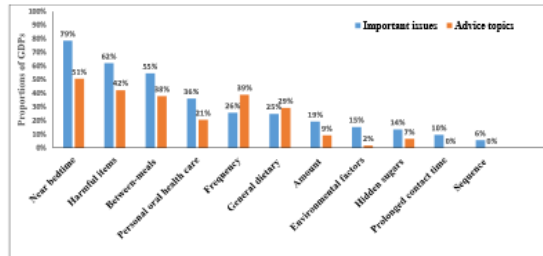
- Data from 229 general dental practitioners (GDPs) in Northwest England was collected using a diet-diary case vignette as part of a questionnaire study.
- We asked dentists to specify the advice they would give a hypothetical patient based upon a complex diet-diary case vignette.
- A sequential-mixed method approach was used for data analysis:
 - An initial inductive content analysis (ICA) to develop coding system to capture the complexity of dietary assessment and delivered advice.
 - Using these codes, a quantitative analysis was conducted to examine correspondences between identified dietary problems and advice hypothetically given.
- From these correspondences, we inferred how dentists reduced complex problems to give simple advice.
- A multivariate model was fitted for each advice topic as binary outcome variable (yes/no), with identified problems from the diary as predictor variables.

Results

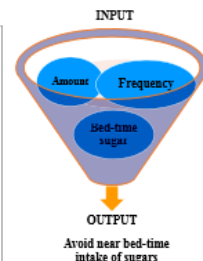
Summative approach



Bar chart depicting the frequencies of dietary aspects identified as important issues (INPUTS) and addressed in advice topics (OUTPUTS) by GDPs.



Selective approach



Important issues (inputs)	Diet advice (outputs)							
	Harmful items OR (95% CI)	Frequency OR (95% CI)	Amount OR (95% CI)	Between-meals OR (95% CI)	Near bedtime OR (95% CI)	Hidden sugars OR (95% CI)	General diet OR (95% CI)	Personal oral health care OR (95% CI)
Harmful items	1.28 (0.65, 2.22)	0.89 (0.46, 1.75)	2.49 (0.68, 9.06)	0.76 (0.39, 1.49)	0.42 (0.21, 0.83)	1.70 (0.43, 6.76)	1.25 (0.57, 2.75)	0.67 (0.29, 1.54)
Frequency	0.48 (0.23, 1.00)	3.39 (1.39, 6.82)	1.61 (0.53, 4.92)	0.56 (0.27, 1.16)	1.00 (0.49, 2.04)	0.45 (0.08, 2.45)	0.84 (0.38, 2.31)	2.21 (0.97, 4.05)
Amount	0.67 (0.31, 1.46)	1.25 (0.57, 2.75)	2.37 (0.68, 8.33)	1.90 (0.87, 4.15)	0.94 (0.43, 2.05)	0.34 (0.04, 3.11)	1.17 (0.50, 2.76)	1.28 (0.51, 3.20)
Between-meals	0.65 (0.33, 1.27)	0.97 (0.49, 1.94)	0.80 (0.25, 2.55)	3.00 (1.49, 6.04)	1.11 (0.56, 2.21)	1.61 (0.39, 6.67)	1.81 (0.84, 3.91)	0.41 (0.18, 0.97)
Near bedtime	0.37 (0.17, 0.87)	1.05 (0.47, 2.37)	1.61 (0.40, 6.44)	1.64 (0.69, 3.89)	2.40 (1.05, 5.49)	1.80 (0.31, 10.47)	0.30 (0.12, 0.75)	2.11 (0.75, 5.94)
Sequence	1.19 (0.33, 4.24)	1.19 (0.34, 4.20)	---	0.91 (0.25, 3.30)	3.89 (0.94, 16.05)	1.63 (0.16, 17.18)	1.79 (0.43, 7.53)	2.59 (0.67, 10.2)
Hidden sugars	0.70 (0.29, 1.68)	0.62 (0.24, 1.57)	0.32 (0.03, 2.91)	1.13 (0.47, 2.70)	0.96 (0.40, 2.29)	3.56 (0.91, 13.83)	1.68 (0.63, 4.51)	0.95 (0.29, 3.20)
contact time	1.98 (0.74, 5.25)	0.88 (0.31, 2.55)	---	1.21 (0.44, 3.29)	0.95 (0.34, 2.70)	2.45 (0.54, 11.11)	0.17 (0.03, 0.88)	0.50 (0.12, 2.05)
General diet	2.35 (1.15, 4.80)	0.84 (0.41, 2.14)	1.55 (0.43, 5.64)	1.34 (0.65, 2.74)	0.73 (0.36, 1.48)	0.93 (0.21, 4.16)	8.85 (4.00, 19.71)	0.29 (0.11, 0.89)
Personal oral health care	1.68 (0.89, 3.16)	1.03 (0.55, 1.94)	1.39 (0.47, 4.14)	0.74 (0.39, 1.40)	0.92 (0.39, 2.15)	1.79 (0.45, 7.10)	1.11 (0.55, 2.27)	4.07 (1.87, 8.86)
Environmental factors	1.24 (0.54, 2.89)	1.61 (0.75, 3.64)	0.72 (0.18, 2.93)	1.08 (0.47, 2.51)	1.52 (0.81, 2.85)	0.09 (0.37, 1.53)	0.82 (0.32, 2.14)	0.90 (0.30, 2.69)

Bold: significant p value < 0.05

- Binary logistic regression models show a high level of specificity in the correspondence between advice and identified problems
- Odds ratio (OR) of each item of advice being given (outputs) were uniquely and significantly ($p < 0.05$) higher if the corresponding problem (inputs) was reported

Conclusions

- Faced with the constraints of providing information that is both simple and easy to implement, dentists rely upon a strategy of intelligent selection to filter out complex dietary information.
- Challenged with a large field of information, they select what they see as a subset of either the most useful or the easiest information to understand and implement.