# Are diet diaries of value in recording dietary intake of sugars?

# A retrospective analysis of completion rates and information quality

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# ABSTRACT:

## **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 bed-time intakes (17.0%, n=28) were reported in fewer diaries.

## **Conclusions:**

### The return rate of diet-diaries in this setting was low, and associated with patient’s 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 10th most prevalent health condition worldwide2. Although Sheiham and James, amongst 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 available4-7. 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 back-bone 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 the ‘eatwell’ plate. Whilst the guidance does 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 days. 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 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 correctly12 ; 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. However, completing diet diaries prospectively and in timely manner over several days is essential for their successful use since these ensure the accuracy of the record and its representativeness of the habitual intake 14. Therefore, non-compliance with diet diaries does not only mean that the patient does not return the diet dietary but also denotes a situation where the patient presents incomplete record which might be cause by backfilling of diet diaries 15. Missing information may undermine the validity of diet diaries and breach the rationale for their use which is tailoring dietary advice to patient’s dietary behaviours.

Whilst the individualisation of chair-side dietary advice has been widely advocated in dentistry for some time 16-19, it is somewhat surprising that such little evidence exists on the use of diet diaries in dental practice. In health care more generally, there is concern that poor patient compliance can compromise the efficient use of diet-diaries 12 ,14. A recent study of the use of diet diaries in general dental practice, suggests this might be the case, although the 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 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 which 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. Clinicians 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, 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 6 months, this was considered regular; if not, dental visiting was considered irregular). Post codes 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 dental literature 17 18 23-25 and an earlier study involving GDPs responses to a diet diary vignette 26.

Content from the 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 for 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, κ = (0.72 to 1.00), p ≤ 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.

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 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. In order, to compensate for missing values, additional analysis using multiple imputations (MI) was performed. Five imputations, departing from the assumption that values were missing at random, were created using multivariate imputation and fully conditional specification method 28.

**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). Whilst the majority of sample were from areas 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 / 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 where 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 bed-time (18, 30.0%), (Table 1).

**DISCUSSION:**

Firstly we must recognise the study limitations such as missing data which are inevitable in this type of studies 29. 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 ± 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 (60, 34.5%), 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 patient’s 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 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 30, this comes as no surprise. However, 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 31, 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 recognised as being detrimental to developing dental caries 17, 23, 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 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 32, 33; 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 patient. Since we know that dentists see reducing frequency of sugar consumption as more practical than reducing the amount 23, the second explanation here is a real possibility.

Delivering Better Oral Health guidance 10 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 chairside interpretation of diet diaries would probably not be realistically able to also drawn 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 chairside 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 18. Moreover, given that distinguishing a dietary record that reflects actual consumption from dishonest or incomplete ones is seen as nearly impossible 34, because diet diaries are often subject to recall bias 18 and patients are known to tend to simplify or alter recordings to avoid negative feedback 35; 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 36. 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 37. In line with the explosion of innovation in this area, Public Health of England, has recently launched the "sugar smart app" which help users to recognise total sugar in different dietary products, as part of Change4Life advertising campaign 38. However, whilst 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 31, 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, adopting 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.

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**TABLES**

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| **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 (e.g. 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. (e.g. 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%) |
| Bed-time consumption | Recording the time the child goes to the bed is necessary | 17 (28.0%) |

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| **Table 2: Study sample description and bivariate comparisons of diet diaries return rate (N=174)** |
| **Variables** | **Sample distribution** | **Returned diaries** | **No diaries returned**  | **p value** |
|  | **N (%)** | **N (%)** | **N (%)** |
| 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) | 0.860 |
| 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. \* p ≤ 0.05, Statistically significant, ¶ N=131¥ IMD denotes Index of Multiple Deprivation QuintilesDMFT-dmft denotes decayed, missing and filled teeth |

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| **Table 3: Multiple regression analysis of factors associated with diet diaries return rate** |
|  | **Unadjusted models** | **Adjusted** **models** | **Adjusted model after imputations (Pooled)** |
| **Variables** | **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) |
| \* p ≤ 0.05, Statistically significant † P ≤ 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 |