Letter

Candies and Jellies for Caries Prevention?

Concluding their paper, Llena and Forner [2008] wrote that the average weekly consumption frequency of sticky sugar-rich foods (i.e., sweet snacks, candied/dried fruit, sugar-containing sweets, honey, jams, jellies, etc.) was not a caries risk factor in their sample. Actually, according to the data displayed in their table 3, the association between sticky sugar-rich food intake and caries experience was not non-significant, but was inverse and statistically significant. The authors then inferred that: 'These aspects should be borne in mind when giving dietary advice to the public and in health education programmes for children'. On the basis of the results of this study, the latter sentence unequivocally induces the reader to think that a regular, frequent weekly intake of sticky sugar-rich foods, such as jellies and candies, would help prevent caries in primary schoolchildren.

The design of this study is subjected to several biases that deeply affect the reliability of the results. The sample ($n = 369$, 6- to 10-year-old children), mistakenly called 'population' or 'study population' by the authors, was consecutively collected in a dental clinic. A dental clinic cannot be the place where to recruit subjects for a cross-sectional study seeking to investigate the risk factors for dental caries, because the majority of children attending the clinic are affected by caries, so that caries frequency within this sample is necessarily higher than the frequency in the underlying children population which the authors define as 'a population of children with low caries prevalence'. Indeed, an extremely high proportion (more than two thirds) of the sampled children were diagnosed as affected by caries. The study population underlying the selected sample was not the population of children living in the Valencia Region, as the authors wrote, but the population of children attending the dental clinic of the Department 9 Dentistry Unit Clinic of the Valencia Region Health Agency. An important consequence of this selection bias is that the sample was rather homogeneous with respect to the outcome variable, that is, diagnosis of at least one caries lesion. Consequently, the average level of exposure to caries risk factors also was necessarily high and necessarily homogeneous. In a sample selected from a study population of homogeneously exposed subjects, the evergreen lesson taught by Rose [1985] reminds us that the most widespread risk factors within a population are those which cannot be detected using conventional observational studies like the present study. This means that non-significant risk factors could be those responsible for the high caries prevalence in the sample and the underlying study population. This selection bias is per se enough to invalidate the results of the study.

Caries experience was assessed at D_1/d_1 level (the authors called it C1) by one experienced examiner. However, caries diagnosis at this initial level requires much experience by the examiner, which must be well documented [see e.g. Jablonski-Momeni et al., 2008], while in the present case no information was provided on how the examiner was trained and which was the reproducibility of caries and non-caries diagnoses. With a statistical analysis using presence/absence of caries as outcome variable and in a sample characterised by high caries experience, such potential unreliability of diagnoses is likely to produce an excessively high proportion of false negatives, with detrimental consequences on the results of the statistical analysis investigating variables associated to caries diagnosis [Shoukri and Pause, 1999].

Food intake was assessed by parents without the help of their children using a self-administered food frequency questionnaire (FFQ), which was based on another FFQ 'used in a similar population' [García-Closas et al., 1997]. However, FFQs (including the FFQ cited by the authors) refer to a precise period, such as the previous year, month or week and not merely to average consumption, require pictures of the portion sizes, not only of the food items; they must be administered by a trained and calibrated interviewer, generally a nutritionist or a dietician, and not self-administered, and, if used in schoolchildren, require additional information concerning food/beverage intake consumed at school, which is generally provided by the teacher [Livingstone and Robson, 2000; Fumagalli et al., 2008]. In addition, the authors, who sought to assess the effect of sugar only, starch only and sugar plus starch on caries, made their nutritional investigation assuming that these food categories were consumed alone, not in association with foods from other categories, but this is very unlikely in real life. For example, how did the authors classify a breakfast based on milk (category 4 or 5), industrial bread (category 8) with honey or jam (category 1)? This information bias is enough to invalidate the results of the study concerning the effect of sugar alone and starch alone on caries, because the FFQ used in this study did not allow to assess whether sugar or starch were consumed alone or in association.

A serious limit of FFQs is that they are subjected to reporting bias. For example, obese subjects are more likely to under-report energy intake than their normal-weight counterpart [Champagne et al., 1998]. Selective misreporting of certain types of foods affects reporting accuracy and is particularly detrimental to understanding the role of nutrition in health [Heitmann and Lissner, 1995; Johansson et al., 1998]. For instance, subjects who under-report energy intake also report eating less sugar and carbohydrate, particularly from biscuits/pastries/puddings and sugar/confectionery [Pryer et al., 1997]. The non-significant association between confectionery intake and dental caries found by the authors cited by Llena and Forner [2008], which inspired them to design their FFQ, also was explained by selective under-reporting

of confectionery intake by children with high caries rates, or by a decreased confectionery intake by children with high caries scores who received dietary advice from their dentist [García-Closas et al., 1997]. In contrast, in the present study, the authors did not try to justify their results, but, in addition, proposed to use them for dietary advice aimed at preventing caries.

These biases not only invalidate the results of the study but also (and principally) do not allow to make inferences concerning dietary advice for caries prevention, which require that causal association between caries and a dietary variable is ascertained. Unfortunately, such a causal link was not investigated by the authors who have forgotten Hill's [1965] criteria for causation. More specifically, how criteria, such as temporality (are the authors sure that low sticky sugar-rich food intake preceded and did not follow dental caries development?), biologic plausibility (which is the anti-caries mode of sticky sugar-rich food proposed by the authors?) and coherence (why is the present paper not consistent with past studies, which used a well-designed experimental design?) [Hill, 1965] were satisfied?

My opinion is that the design of the study by Llena and Forner [2008] is the antithesis of a methodologically rigorous study design, as it is invalidated by selection, information, reporting biases, which may lead to aberrant conclusions, which, contrarily to what they wrote, cannot be borne in mind when caries education programmes for children are implemented.

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Reply

Obviously Not

We wish to clarify one or two points in response to the letter from S. Petti addressed to the editor of *Caries Research* concerning the article 'Dietary habits in a child population in relation to caries experience' [Llena and Forner, 2008].

With regard to the methodology, at all times when we refer to the 369 participants in the study, we use the word 'sample', although the section is headed 'study population' as the section refers to the population from which the sample was extracted.

The 'Department 9 Dentistry Unit Clinic of the Valencia Region Health Agency' is a Preventive Dentistry unit within the Spanish Public Health System available to all children from 0 to 15 years old referred by the paediatrician or at their parents' request, whether they are healthy or ill, to receive preventive care, as we explain in the text. It is not a dental clinic where children with caries go for treatment. Therefore, we consider the sample to be sufficiently representative. At no time did we use the inclusion criterion of having at least one caries lesion or any other criteria to make the sample more uniform. With regard to the caries prevalence in the sample, 64.2% were caries-free in permanent dentition, and 57.2% in primary dentition. The latest epidemiological study for the Valencia Region (Spain) in 2004 [Almerich and Montiel, 2006] found that 57.5% of 12-year-old children were caries-free in the permanent dentition, and 67.8% of 6-year-olds in the primary dentition; although our sample age is between 6 and 10, we found the caries prevalence to be similar to that of the general population.

As Petti says, caries experience was assessed at D₁/d₁ level. The examiner was always the same person, a dentist with 20 years' professional experience in a Preventive Dentistry Unit. Throughout the study period, examiner reproducibility was analysed once a month using Cohen's kappa. In total, 10% of the sample was re-examined, the subjects were randomly assigned by another person for a new exploration and the kappa values remained between 0.82 and 1, using the variable caries present/absent.

Food consumption frequency was analysed using a Food Frequency Questionnaire (FFQ), which was self-administered by the parents since, in the age range of the children in the study, the parents generally supervise their child's diet. There was a question on the daily, weekly and monthly frequency of consumption of the food items and when they were eaten (between meals or at main meals). The nutritional and energetic values of the diet were not analysed as this was not the object of the study. The foods consumed at school, i.e. the mid-morning and mid-afternoon snacks, are provided by the parents and, in the case of the children who have school lunches, the parents are informed in advance on what the children are given in the school canteen so that they can plan the rest of the children's daily intake. Familiar foods which are often consumed by children in this age range were chosen, including different types of foods, consistencies and composition, including foods with hidden sugars such as tomato sauces, etc., and even foods considered as protective, such as cheese. Then, as explained in the 'Material and Methods' section, the foods were divided into nine groups. We know the limitations with this type of questionnaire due to omissions, response bias, ignorance of some foods, etc., which can obviously influence the results. How-

ever, questionnaires are frequently used to evaluate individual food consumption and may also be self-administered [Naganuma et al., 2008; Wang and Wang, 2008; Yahia et al., 2008].

At no point in the study does the paper say that 'sticky sugar-rich food intake' protects against caries. What it does say is that we are surprised by the result obtained in the logistic regression for this group of foods (table 3). One reason for this result could be the low intake of this group of food reported through the questionnaires. As shown in table 1, the average intake of foods in the sticky sugar-rich group was 1.6 times a week, while the weekly intakes of sugary liquids and foods rich in semi-hydrolysed starch were 6.9 and 2.9, respectively. A possible answer is that the connection of sticky sugar-rich foods with caries is better known by the population than that with other food groups. As the survey has been developed in a Preventive Dentistry Unit, some answers could have had a tendency to under-report foods included in the sticky sugar-rich food group. This situation can be seen in the study by García-Closas et al. [1997] carried out in a population of 6- to 15-year-olds with a caries-free prevalence (permanent teeth) of 60%. Other studies [Palin-Palokas et al., 1987; Lachapelle et al., 1990] did not find any association between cariogenic food consumption and caries increment in a population of children and in a group of mentally retarded children, respectively. Rather, poor oral hygiene status appeared to be a more important caries risk factor. It is obvious that while dietary sugars are a determinant of caries risk, they are not the only factor in the aetiology of the disease. In developed industrialised countries there is a lack of correlation between the decline of caries prevalence and average sugar consumption, so other important factors such as, for example, frequent use of fluoride dentifrices must be considered, because they can modify the impact of dietary factors on dental caries [König, 2000]. In our study 77.8% reported brushing their teeth at least once a day.

Lingström et al. [1993] have shown that acid formation in plaque after chewing soft bread or potato chips is more intense and lasts longer than after intake of sucrose. However, in our context at least, there is little awareness of the possible cariogenic ef-

fect of foods rich in semi-hydrolysed starch with or without sugar and sugary drinks, aspects which we consider should be taken into account in health education programmes. A specific analysis of risk factors per risk group is necessary, and a specific package of preventive measures should be composed.

The content of the last three lines of our article cannot be taken out of context as they refer to the set of conclusions. Therefore: candies and jellies for caries prevention? Obviously, not.

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