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## Reliability of a sugar consumption questionnaire for rural Haiti

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**Objective:** Studies of dental caries should account for sugar consumption as a potential confounder or effect modifier of other exposure-caries associations. The purpose of this study was to assess the reliability of a sugar consumption score for rural Haiti through correlation of test-retest scores derived from a structured, interviewer-administered questionnaire.

**Methods:** A structured, interviewer-administered questionnaire of sugar consumption was developed for rural Haiti to achieve contextual validity. The resulting questionnaire had two parts; one part captures the child's consumption of sugar products frequency; the second part captures sugar additions to the child's food preparation. A test-retest, one week apart, was conducted on a sample of 30 mother-child pairs (children ages 9-17). Test-retest correlations and paired

*t*-testing was conducted to assess the questionnaire's reliability.

**Results:** All test-retest (Part 1, children's questions; Part 2, mother's questions; the combined scores) had Pearson product correlation coefficients of 0.7 or greater, respectively. All test-retest scores had paired *t*-test *p*-values <sup>3</sup> 0.95.

**Conclusions:** A reliable, contextually valid relative sugar consumption questionnaire specific for rural Haiti is presented. The questionnaire and methodology employed in its development and testing may have utility for dental caries researchers in investigations in less developed countries.

**Key words:** Dental caries, Sugar, Reliability, Questionnaire.

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Dental caries is a multifactorial disease consisting of bacterial agent(s), host factors and factors of the oral and extra-oral environments, (1) e.g., fluoride and dietary sugars (1-7). Some sugars, as an environmental factor, provide the bacterial agents with a nutrient that has an acid byproduct, which demineralizes the surfaces of the teeth. Dietary sugars may also select for mutans streptococcus or mutans strains of increased virulence (1). Seow provides a particularly detailed and useful review of caries pathobiology that may be consulted (1).

Burt and Satishchandra have published a comprehensive review of the association between sugar and caries in the contemporary developed countries in which fluoride exposure is almost ubiquitous (4). These authors note the

solid historical evidence of a linear relationship between sugar consumption and dental caries in the pre-fluoride era, including the Vipeholm clinical trial (8). However, the evidence for such an association, particularly the linear consumption/caries relationship is much weaker for developed countries in the twenty-first century than has been observed in the past, though oral health promotion practices should still include encouraging decreased consumption of sugars.

In developing countries, the questions of the similarity of the strength of association and the correlational relationship between sugar consumption and dental caries compared to Burt and Satishchandra's evidence-based conclusions remains unanswered (9). This is particularly true when geographic sub-groups, e.g., urban vs. rural or temporal trends are considered, e.g., World Health Organization Basic Oral Health Surveys (10). As such, studies of dental caries should account for sugar consumption as an explanatory variable or a potential confounder or effect modifier of other exposure-caries associations being examined.

In retrospective study designs, including retrospective cohort investigations, past sugar consumption would be subject to recall bias (4,9,11). The use of current sugar consumption as a risk factor or confounder is well

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documented in the cariology literature, and has proven useful in caries modeling studies (4,9,12-13). However, the approach taken to ascertain sugar consumption measures have varied, e.g., 24-hour recall, food diaries, food frequency questionnaires, (14) and the 'best' approach is controversial (4). Willett comprehensively presents the strengths and weaknesses of the various methods. Coupled with food composition tables and nutrient computation software, e.g., Worldfood2, Food Intake Analysis System or the Minnesota Nutrition data System, these techniques offer broad and relatively precise nutritional details (14). However, the time and expense of these detailed dietary study instruments may be beyond the capacity of many investigations. Simpler, well constructed sugar ascertainment instruments may provide useful scientific information that complements caries surveys.

Further, considering sugar consumption as a potential confounder or effect modifier of other exposure-caries associations, rather than investigating this consumption purely as an etiological factor, eases the difficulty in developing a practical sugar consumption study instrument. Questions that will capture the subjects' *relative* sugar consumption, a behavior that potentially could confound or modify other variable parameter estimates, i.e., excessive sugar consumption within the study population, represents an important variable in caries analyses. Relative sugar consumption assessment within the study population that captures particularly high sugar consumption will benefit those investigations exploring other caries risk factors (4). The first key in using such an instrument is that there is real variability of the consumption within a population (14). The second key is a reasonable accurate list of high cariogenic sugar exposures (14).

International studies present a particular challenge to caries research in terms of ascertaining sugar consumption due to dietary differences that may be due to local preferences or food availability. Time, funding and subject availability may limit the opportunities for long or repeated interviews or the use of expensive analytic software. Further, illiteracy rates may preclude the use of self-administered questionnaires or food diaries. Developmental methodologies and the testing of validity and reliability of geographical and cultural specific, rapidly administered instruments for measuring relative sugar consumption at the individual level are not reported in the oral health literature. Thus, there is a requirement for international cariology researchers to be able to develop and test a reliable, easily administered and low cost relative sugar consumption instrument for the populations sampled. Such instruments would add to the quality of analytic studies, dimensionally expand national caries

surveys, and provide a snap-shot of one important aspect of nutrition in the studied populations.

The purpose of this study was to assess the reliability of a sugar consumption frequency score through correlations of test-retest scores derived from a structured, interviewer-administrator questionnaire. We present a contextually valid relative sugar consumption questionnaire specific for rural Haiti and demonstrate its reliability. The questionnaire and methodology employed in its development and testing may have utility for dental caries researchers in investigations in less developed countries and given, the potential simplicity be an addition to national oral health surveys.

## Methods

**Overview:** A structured, interviewer-administered questionnaire of sugar consumption frequency exposure was developed based upon a sugar consumption questionnaire administered previously in rural Haiti in 1993 (15). The sugar consumption frequencies of children in that first questionnaire demonstrated a normal distribution with a between subject variability that suggested the instrument's use to determine relative sugar consumption frequency within the population (14). This questionnaire was updated and modified. The sugar consumption questionnaire was administered to a group of 30 mother-child pairs in Haiti in the summer of 2003, and was re-administered after a one-week period to each mother-child pair. Correlations between scores for the test and retest were utilized to assess the reliability of the questionnaire. Paired T-tests and multivariable regressions provided additional information regarding the stability of responses between weeks one and two. The study was approved by Institutional Review Boards (IRB) of New York University and the University of Haiti Dental School.

**Group under study:** A self-selecting group of sequentially presenting mother-child pairs for well-child and minor episodic pediatric care at the HHF facility were invited to participate in this study. All thirty of the first thirty invited mother-child dyads agreed to participate with a gender balanced group obtained. The mother's verbal informed consent and her child's assent for the two interviews were obtained following a reading of a consent script in Creole. The subjects were blinded to the study question. The inclusion criteria were: 1) mother and child could be interviewed at a one-week interval, 2) child aged 9-17-years old, and 3) sibling not interviewed, i.e., one child per family.

**Questionnaire:** The purpose of the questionnaire (Figure 1) was to establish relative sugar consumption frequency in a group of mother-child pairs in Haiti. The



two epidemiologists with research experience in Haiti. All food and beverages availability locally, as well as dining behaviors were considered by the research team. The resulting structured, interviewer-administered questionnaire is in two parts. One part captures the child's consumption of the most common sugar products frequency; the second part is to capture processed sugar additions to the child's food preparation.

Part 1, the children's section, is composed of 10 questions asked of children aged 9-17 years old. This series is based on questions that were administered in the rural Jeremie region of Haiti in 1993 to 293 children ages 5-15-years old to quantify weekly relative sugar product consumption (15). Part 2, the mother's section, has five questions to quantify added sugar to prepared foods or drinks. An example of this is the practice of adding sugar to fruit drinks. The questionnaire was translated from English into Creole by two translators. Any differences were discussed to achieve a consensus of translation.

**Administration of questionnaire:** Prior to the field operations, the interviewer was trained by an experienced researcher in the administration of a structured questionnaire. Mock interviews were conducted. In order to standardize the responses and quantify the mother's sugar additions to food preparation, appropriate visual only prompts were employed, e.g., a teaspoon, a bottle of soda. Mothers and children who presented for services at the Haitian Health Foundation were invited to participate. Invitations to participate were made sequentially to eligible mother-child pairs. This self-selected recruitment continued until thirty mother-child pairs (14 males, 16 females) were interviewed; no invited dyad refused to participate. The interviewer administered, in Creole, the sugar consumption questionnaire and scheduled a return interview time for a one-week follow-up interview. Following the completion of the interview, the mother was given a paper chit with her study ID number for her return interview and to receive compensation (\$U.S. 5) for study participation. The chit included: 1) study ID #, 2) Mothers name, 3) child's name, 4) signature of interviewer. At the follow-up interview, the sugar consumption questionnaire was re-administered by the same interviewer. The interviewer was blinded to the original questionnaire responses, i.e., the first interview, and the mothers were not informed prior to the first questionnaire administration that the identical instrument would be re-administered.

**Statistical analyses:** Data was entered and verified by double entry of all data into Excel.

The question of interest in this investigation was the

questionnaire reliability in terms of overall sugar consumption frequency scores. Reliability of the questionnaire was assessed by parametric correlations of the test and retest total scores for Part 1, Part 2, and the combined scores (16). Additionally, descriptive statistics of the data, paired *t*-tests, and age adjusted multivariable regressions were conducted for a fuller comparison between the test and retest results.

## Results

All thirty study dyads completed both of the interviews. The mean age of the gender balanced sample of 30 children (fourteen males and sixteen females) was 14 years old (sd: 2.3 years). All test-retest scores (Part 1, children's section; Part 2, mother's section; the combined scores) had intraclass correlation coefficients greater than 0.8 (0.916, 0.818 and 0.881, respectively). Pearson product correlation coefficients of 0.7 or greater (0.844, 0.71 and 0.803, respectively) (Table 1). These correlations were robust in that multivariable regression adjusting for age increased the correlation coefficients slightly; for children's and mothers' test-retest regressions  $r = 0.853$ ,  $R^2 = 0.728$ , and  $r = 0.746$ ,  $R^2 = 0.544$ , respectively. Age was not statistically significant in these models, ( $p = 0.235$  for the children's and 0.089 for the mothers' models). The total sugar consumption age-adjusted regression  $R^2$  was 0.719. These

**Table 1.** Sugar consumption questionnaire in Haiti, test-retest (one week) sugar exposures (frequencies), Intraclass correlation coefficients & Pearson product correlation coefficients

	<b>Intraclass correlation coefficient</b>	<b>correlation coefficient (p-value)</b>	<b>R<sup>2</sup> from Age Adjusted Regression</b>
Children's questions (Part 1)	0.916	0.844 (<0.001),	$R^2 = 0.728$
Mother's questions (Part 2)	0.818	0.71 (<0.001),	$R^2 = 0.554$
Aggregate score (Parts 1 + 2)	0.881	0.803 (<0.001)	$R^2 = 0.719$

findings support the reliability of the questionnaire.(16)

Table 2 presents the mean and standard deviations for the weekly sugar consumption (frequency) scores for the questionnaire Part 1 (children), Part 2 (mothers) and aggregate scores, as well as the test-retest difference, standard error and standard deviation for each of these scores. All of these weekly sugar consumption (frequency) scores had paired *t*-test *p*-values <sup>3</sup>0.95. Interestingly, age adjusted regressions for the mother's score as a predictor of the child's score for both the test and retest were not statistically significant ( $p = 0.29$  and 0.71, respectively for the test and retest analyses).

**Table 2.** Sugar consumption questionnaire in Haiti, test-retest (one week) sugar exposures (frequencies), paired *t*-test results

	Mean (SD) test 1	Mean (SD) test 2	Mean Difference (SE)(SD)	Paired <i>t</i> -test <i>p</i> -value
Children's questions (Part 1)	15.90 (5.11)	15.87 (5.18)	0.033 (0.52) (2.87)	0.95
Mother's questions (Part 2)	27.00 (8.54)	27.06 (6.81)	-0.067 (1.11) (6.07)	0.95
Aggregate score (Parts 1 + 2)	42.90 (10.66)	42.93 (8.79)	-0.033 (1.16) (6.37)	0.98

## Discussion

Sugar consumption may be an important variable in investigations of dental caries. While concurrent sugar intake data has the possibility of leading to misclassification in an individual's historical dietary sugar intake, nevertheless, concurrent sugar intake ascertainment is an accepted and useful component of caries studies (4,9,12,14). Caries studies in developing countries presents a particular challenge in sugar consumption ascertainment. Easily administered, inexpensive, yet valid and reliable relative sugar consumption instruments will enhance such investigations. This study presents the short term reliability findings of one such sugar consumption frequency instrument.

The findings reported here demonstrate the high (one week between administrations) reliability of a relative sugar consumption questionnaire for Haiti that includes both sweet snacking and food preparation sugar exposures. These two sugar exposures can be used individually or in aggregate in the analysis, as a researcher chooses. The content validity of the individual questions was established through expert opinion and on-site observation by resident professional researchers. This relative sugar consumption questionnaire can provide a basis for studies in countries other than Haiti. The content validity of such instrument adaptation to other countries can be established by expert observation in the field, as was done for this study. Such an instrument may have utility, particularly in national oral health surveys, confounder control for sugar, and hypothesis generation when the limitations are appropriately considered.

Strengths of the methodology are several. The determination of availability and types of sugar in the local area by local professionals coupled with caries epidemiologists with long experience in the area, (17-18). Diets tend to be relatively stable year to year, and by phrasing questions such as to get averages, seasonal variation is reasonable captured (14). The necessity to capture the between person variability is enhanced by an open-ended frequency response approach, (19) and little if any useful information is gained by exposures occurring less than once a week (14).

There are several limitations in regards to the methodology and findings of this investigation. First, the primary limitation is that of criteria validity, i.e., does the instrument truly measure sugar consumption frequency. This could be established by 24-hour food questionnaires or better still, using multiple 24-hour food questionnaires. While a weekly diet journal would be useful, high illiteracy may preclude its use in many less developed areas such as Haiti. Second, there may be major seasonal variation in sugar consumption that is not capture by one-time instruments such as the questionnaire presented here and would require multiple (seasonal) questionnaire administrations. Third, no attempt was made in the questions for children to quantify the sugar exposure other than in terms of its frequency; hence some misclassification of absolute exposure levels will result, though Samet et al have reported that food portions vary less between individuals than frequencies (20).

The sugar consumption frequency ascertainment instrument and its development methodology should have utility in international caries research. The low cost, short time for administration, high reliability and content validity, may offer a reasonable data collection instrument controlling sugar consumption potential confounding in investigations of dental caries and providing a descriptive epidemiological look at risk in national oral health surveys.

## Resumen

**Propósito:** Los estudios de caries dentales tienen que tomar en consideración la ingesta de azúcar como un posible confundidor o modificador del efecto de otras posibles asociaciones entre exposición y las caries dentales. Este estudio evalúa la confiabilidad de un indicador de ingesta de azúcar para la zona rural de Haití utilizando la correlación entre los resultados de una prueba re-prueba recogidos mediante un cuestionario estructurado para entrevistas personales. **Diseño:** Se preparó un cuestionario estructurado para entrevistas personales para medir la ingesta de azúcar en la zona rural de Haití para verificar su validez contextual. El cuestionario tiene dos secciones: una recoge de parte del hijo(a) la frecuencia de la ingesta de productos alimenticios con contenido de azúcar, la otra sección recoge información

ofrecida por la madre con respecto a la utilización de azúcar en los alimentos ingeridos por el hijo(a)s en el hogar. Una prueba re-prueba del cuestionario fue realizada con un lapso de una semana a un grupo de 30 pares de madres e hijo(a)s con edades entre 9 a 17 años. Las correlaciones lineales tipo Pearson entre los resultados de las pruebas re-pruebas y pruebas estadísticas de hipótesis de t-pareada fueron realizadas para evaluar la confiabilidad del cuestionario. **Hallazgos:** Todas las correlaciones entre las relaciones de hijo(a), madre y valor agregado fueron por lo menos iguales a 0.70 ( $r^2 = 0.49$ ). Las pruebas estadísticas para t-pareadas no fueron estadísticamente significativas a un nivel de 0.05 para la hipótesis nula de igualdad entre los resultados. **Conclusiones:** El cuestionario preparado específicamente para la zona rural de Haití permite medir la ingesta de azúcar de una manera confiable y con validez contextual. La metodología utilizada en este estudio podría ser replicada en futuras investigaciones en países en desarrollo relacionadas con caries dentales.

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