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Original Article

Integrating Dietary Questions into Caries Risk Assessment: Links to Caries Development

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ABSTRACT

This investigation reviewed clinical records to determine how dietary items included in caries risk evaluations correspond with the need for restorative care in a dental school environment. A dataset of 6,218 adults who attended the University of Iowa College of Dentistry between 2018 and 2019 was analyzed. Each patient had completed both a caries risk questionnaire and a full-mouth examination. Planned caries restorations were contrasted according to responses to selected dietary questions. Statistical approaches involved chi-square testing, Wilcoxon rank-sum comparisons, and logistic regression to identify significant predictors. Approximately 20% of participants required restorative intervention for caries. Younger age, irregular eating patterns, daily intake of sugar-containing drinks, and sipping those beverages for longer than 30 minutes all showed significant associations ($p < 0.01$) with restorative treatment needs. Focused dietary questioning appears to be strongly related to the likelihood of dental caries and may enhance the predictive value of caries risk assessments.

Keywords: Dental caries, Risk assessment, Nutrition, Oral disease, Restorative needs

Introduction

Dental decay remains one of the most common health conditions globally, impacting billions of individuals. In the United States, close to 90% of adults between 20 and 64 years of age have been affected [1]. Findings from the National Health and Nutrition Examination Survey (NHANES) show that although experience of caries accumulates with age, prevalence is already very high—82%—among adults aged 20–34. The same dataset revealed that 26% of U.S. adults live with untreated cavities. These untreated cases were unevenly distributed, with clear disparities linked to race, income, and education. The proportion of adults with untreated decay (26%) was markedly higher than rates observed in children (5%) or adolescents (17%) within the same survey [1].

Although dental decay continues to affect a large proportion of adults, investigations of caries risk factors in adult groups remain limited. Likewise, most caries risk assessment (CRA) instruments have been designed with children in mind, with only a few adjusted specifically for older age groups [2]. A notable issue is that even though diet—especially sugar intake—is widely recognized as a primary contributor to caries development [3], existing CRA instruments generally ask no more than one or two questions about sugar, and very few specifically address sugar-sweetened beverage intake. For instance, the Cariogram model contains two dietary components concerning "fermentable carbohydrates" (covering both frequency and content), dividing responses into four categories, but still requires clinicians to use additional methods such as food-frequency questionnaires or 24-h recalls for detailed information [4]. Similarly, the American Dental Association's CRA form for patients over 6 years of age includes just one question on "sugary foods or drinks," differentiating only between consumption during meals or between meals [5]. The CAMBRA protocol also contains a single item on "frequent snacking" defined as more than three

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times daily [6, 7], while the Previser approach uses one item addressing "snacks or drinks with sugar taken between meals or four or more times daily" [8].

Evidence from numerous pediatric studies highlights sugar-sweetened beverages as significant predictors of caries [9–11]. Although adult-specific studies are fewer, strong associations between sugar consumption and dental decay in adult groups have also been documented [12–14]. Nevertheless, current CRA systems for both children and adults rarely incorporate questions targeting sugary beverage habits [4–8]. Consequently, there is limited knowledge about how effective such questions might be for assessing caries risk or how practical they are in clinical CRA settings.

The present retrospective record review therefore sought to examine whether certain dietary questions used within CRA forms were associated with caries diagnoses among adult dental patients at a teaching clinic. The working hypothesis was that, in practice, selected dietary items included in CRA tools would show a measurable link with caries occurrence.

Materials and Methods

This study analyzed existing records from adults seen at the University of Iowa's student dental clinics during 2018–2019. Inclusion required that patients completed a caries risk assessment (CRA) and had a treatment plan documented within six months before or after the CRA. Certain specialty clinics—such as oral surgery, endodontics, and the Geriatric & Special Needs Dentistry Clinic—did not perform CRAs, so patients from these locations were excluded. Assessments were conducted by dental students across all four years (D1–D4). Students received guidance on CRA completion, but no formal calibration procedure was implemented.

The CRA instrument, developed at the University of Iowa, was based on several existing tools—both published [4, 5, 15] and unpublished—but was tailored to emphasize dietary contributions to caries risk. Key dietary variables included the number of meals and snacks per day, whether eating patterns were structured or unstructured, intake of sugar-containing beverages (noting consumption over 20 ounces/day and duration exceeding 30 minutes), and candy intake. Additional factors collected included fluoride exposure, tobacco use, general health conditions, xerostomia, prior caries experience, plaque level, and oral hygiene behaviors.

IT staff extracted records for all patients aged 18 years or older who had completed an initial CRA during the study period. Caries-related treatments were identified using procedure codes for composite resin restorations (D2330, D2331, D2332, D2335, D2391, D2392, D2393, D2394), glass ionomer restorations (D2330.1, D2331.1, D2332.1, D2335.1, D2391.1, D2392.1, D2393.1, D2394.1), and amalgam restorations (D2140, D2150, D2160, D2161). Demographic data included patient age, sex, and type of insurance (public, private, or self-pay). Race/ethnicity and income information were unavailable. After de-identification, the dataset was provided to the research team. The University of Iowa Institutional Review Board approved the study.

For statistical analyses, participants were grouped according to their responses ("yes" or "no") to dietary CRA questions. The primary outcome was presence and number of planned restorative treatments. Initial comparisons utilized chi-square tests for categorical variables and Wilcoxon rank-sum tests for counts of planned treatments. Logistic regression models were constructed to identify dietary and demographic factors associated with planned caries interventions, adjusting for age, sex, and insurance type. A backward stepwise approach guided by Akaike's Information Criterion (AIC) was applied in multivariable modeling. Data were initially organized in Excel and subsequently analyzed using SAS and R. Statistical significance was set at $p < 0.05$.

Results and Discussion

The study included 6,218 adults who met eligibility criteria. Participants had an average age of 50.9 years, and 54% were female. Regarding insurance coverage, 35% were enrolled in public insurance (Medicaid), 30% had private plans, and 35% were self-paying.

Out of the full cohort, 1,246 individuals (20%) had one or more planned restorative procedures for caries, as indicated by CRT codes documented at the time of the CRA. Only a small portion of participants reported consuming more than three meals daily (9%) or exceeding three snacks per day (20%). Structured meal patterns were observed in 66% of the cohort, while the remainder reported unstructured, grazing-style eating. Daily intake of sugary beverages—including juices, sodas, and energy drinks—was reported by 39%, whereas 15% reported daily consumption of sugary candy.

Bivariate analyses using chi-square tests **(Table 1)** showed that all dietary factors were significantly related ($p < 0.05$) to planned caries treatment. Participants who consumed sugary drinks or candy daily, had more than three meals or snacks, or followed unstructured eating schedules were more likely to require restorative interventions than those with lower sugar intake or structured eating habits. Additionally, consuming over 20 ounces of sugary beverages or drinking over periods longer than 30 minutes was associated with a higher likelihood of having caries treatment planned.

Wilcoxon rank-sum tests comparing the number of planned restorative procedures between participants responding "yes" or "no" to each dietary question revealed similar patterns. Those with daily sugary beverage consumption, daily candy intake, more than three meals or snacks, or unstructured meal habits consistently had higher numbers of planned restorations than participants with healthier dietary behaviors (data not shown).

Table 1. Associations between dietary factors and planned caries treatment (bivariate analysis)

CRA Variable	Odds Ratio	95% Confidence Interval	Significance (p)
Age (years)	0.98	0.98 – 0.99	<0.001
Meals unstructured (grazing/on-and-off)	–	–	<0.001
No	Reference	–	–
Yes	1.31	1.14 – 1.51	–
Daily intake of sugary beverages (juice, soda, energy drinks)	–	–	<0.001
No	Reference	–	–
Yes	1.56	1.33 – 1.84	–
Sugary drinks consumed over 30 minutes	–	–	0.002
No	Reference	–	–
Yes	1.32	1.11 – 1.57	–

This analysis confirms that targeted dietary questions in a caries risk assessment (CRA) are meaningfully associated with caries in adult patients. Specifically, daily consumption of sugar-sweetened beverages and unstructured eating patterns were linked to higher rates of planned restorative dental procedures. These findings suggest that carefully chosen dietary items can enhance the predictive value of CRA tools.

The results are in line with extensive literature demonstrating the connection between sugar intake and caries [3] as well as the impact of irregular or unhealthy eating habits on caries development [16]. Most existing CRA instruments incorporate only limited dietary assessment, making these findings notable: even a few focused questions can provide significant insight into adult caries risk. Data were collected during routine dental appointments using a seven-item dietary section of the CRA, demonstrating that dietary information can be feasibly obtained for most patients [16]. Based on multivariable analysis, three dietary factors—consumption of sugared beverages, drinking over 30 minutes, and unstructured meals—appear to capture the highest risk and could be prioritized to streamline clinical risk assessment.

Several study limitations should be considered. First, restorative treatment plans were used as a proxy for active caries due to the lack of diagnostic coding. While most planned restorations likely addressed carious lesions, some procedures may have been planned for non-caries reasons such as restoration replacement, abrasion repair, or cosmetic concerns. Likewise, not all caries-related procedures may have been coded in the electronic records used. Second, the CRA was completed by dental students at different levels without formal calibration, which may have led to variability in both question delivery and response recording, introducing potential misclassification. Third, this study was confined to a single dental school within a fixed timeframe, limiting generalizability to other clinical or educational environments. Finally, because the CRA and planned treatment data were collected concurrently, these results establish associations rather than causation. The original design aimed to examine future caries treatment over a two-year period, but follow-up was incomplete as not all patients returned for restorative care, complicating longitudinal inference.

Numerous prior investigations have linked diet to dental caries, though these studies typically relied on comprehensive dietary records or lengthy food frequency questionnaires, which are impractical for in-office caries risk assessment [9–11]. In contrast, the present study found that a limited set of dietary factors—particularly daily consumption of sugar-sweetened beverages—was significantly associated with caries. These findings indicate that including targeted dietary questions could enhance both new and existing CRA instruments, helping clinicians guide patient counseling and promote behavioral changes [16].

Further research is needed to evaluate whether incorporating such dietary questions improves the predictive accuracy of CRA tools when combined with other risk factors. Additionally, replication in varied clinical settings and across diverse populations is necessary to confirm these results. Future work could also explore the influence of other dietary elements, both cariogenic and protective, on caries risk.

In summary, the evidence from this study suggests that specific, concise dietary questions included in CRA instruments—focusing on sugar-sweetened beverage intake, meal patterns, and duration of eating or drinking events—are strongly linked to caries and should be considered in the ongoing development of CRA protocols.

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