DENTAL QUALITY ALLIANCE®

Improving Oral Health Through Measurement

GUIDANCE ON CARIES RISK ASSESSMENT IN CHILDREN

A REPORT OF THE EXPERT PANEL FOR USE BY THE DENTAL QUALITY ALLIANCE

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Background and Purpose

Dental caries is the most common chronic disease in children in the United States.[1] The American Dental Association (ADA) notes: "Systematic methods of caries detection, classification, and risk assessment, as well as prevention/risk management strategies, can help to reduce patient risk of developing advanced disease and may even arrest the disease process."[2] There is increasing emphasis on assessing and documenting caries risk not only for the purposes of **patient education** and **to guide prevention and treatment planning** but also for use in **quality improvement**, **benefit design** and **payment**. The Dental Quality Alliance (DQA) has developed measures that require practices to assess and document caries risk status. With greater interest in using CRA for multiple purposes, it is important that standardized guidance is established for determining and documenting risk status and using this information for individual care planning and population policy.

The ADA, AAPD, and DQA convened a 14-member expert panel (*Appendix 1*) comprised of cariologists, epidemiologists, pediatric and general dentists, educators, and individuals with expertise in health information technology standards. The panel was tasked with the following:

- review the current state of science on caries risk assessment; and
- develop comprehensive guidance on categorization of risk for the purposes of education, care planning, benefit design and quality improvement.

Identification of Existing CRA Tools

There are several caries risk assessment (CRA) tools in use today including tools from the American Dental Association (ADA) and the American Academy of Pediatric Dentistry (AAPD), tools based on the Caries Management by Risk Assessment (CAMBRA) philosophy, and software-based prediction tools such as Cariogram and PreViser. In addition, several state Medicaid programs are developing their own CRA tools to support quality measurement within their programs.[3,4] Project staff developed a matrix that compares the data elements contained in 5 commonly used CRA systems (AAPD, ADA, Cariogram, tools based on the CAMBRA philosophy and Previser).

Table 1. Caries Risk/Protective Factors in Existing CRA Tools

		AAPD	AAPD	ADA	ADA	Cariogram	CAMBRA	CAMBRA	PreViser	PreViser	PreViser
Population/ Age		0 - 5 years	>=6 years	0-6 years	> 6 years		0 - 5 years	> 6 years	1 - 4 years	5 - 18 years	19+ years

FACTORS (Pooled domains. Not worded exactly as they appear on the forms)											
Caries Lesions (Active or past)	Pit, fissure, White Spot lesion (WSL), non-cavitated or enamel defect	x	x	x	x		x	x	x	x	x
	>=1 interproximal lesion		x		x			x			
	ADA Caries Classification System (CCS) initial lesion								x	x	x
	ADA CCS moderate or advanced lesion								x	x	x
	dmf/DMF teeth	x				x					
	Obvious Caries					x	x	x			
	Missing due to caries			x	x				x	x	x
	Restorations or cavitated lesions			x	x		x	x			
Saliva flow/Dry mouth			x	x	x	x	x	x	x	x	x
Plaque/poor oral hygiene		x	x	x	x	x	x	x	x	x	x
Diet/frequent snacks/sugary foods/drinks		x	x	x	x	x	x	x	x	x	x
Appliances/ orthodontic appliance, space maintainer or obturator			x	x	x		x	x	x	x	x
General health conditions/major health change/ Special healthcare needs/ development that interferes with brushing/flossing		x	x	x	x	x	x		x	x	x
Eating Disorders					x						
Chemo/radiation therapy					x						
Mother, Caregiver and or siblings	Caries Experience			x	x (age 14)						
	Active Caries	x									
	Last 12 months						x		x		

Bottle Use		x					x		x		
Socio-demographic/Eligible for government programs		x	x	x			x				
Parent/caregiver low health literacy							x		x		
Immigrant		x	x								
Defective restorations			x								
Insufficient dental care frequency									x	x	x
Access to care/ Dental Home		x	x	x	x		x				
Restorations with overhangs/ Open margins					x						
Unusual Tooth Morphology/ Deep P & F					x			x			
Exposed root					x			x			x
Microflora/bacteria culture		x	x			x	x	x	x	x	x
Saliva Buffer						x					
Clinical Judgment						x					
Drug, Alcohol abuse					x			x		x	x
Brushing with fluoride toothpaste		x	x				x	x			
Fluoride exposure/fluoridated water/fluoride nonprescription fluoride product/fluoride varnish		x	x	x	x	x	x	x	x	x	x
Calcium phosphate paste								x			
Chlorhexidine								x			
Xylitol Use			x				x	x			
Chews sugar-free gum										x	x
Number of risk categories											
Low		Φ	Φ	Φ	Φ	Φ	Φ	Φ	Φ	Φ	Φ
Medium		Φ	Φ	Φ	Φ	Φ	Φ	Φ	Φ	Φ	Φ
High		Φ	Φ	Φ	Φ	Φ	Φ	Φ	Φ	Φ	Φ
Extreme							Φ	Φ			

State of Science: Validity of Existing CRA Tools

The ADA's Center for Evidence Based Dentistry (CEBD) reviewed published systematic reviews that have evaluated the validity of existing CRA tools as well as other prediction models. Systematic reviews published between January 2007 and March 2017 were included. There was no language restriction. Searches were conducted in MEDLINE and EMBASE via Ovid. A total of

268 reference titles and abstracts were obtained with 45 full text reviews. Three systematic reviews, representing 62 primary studies, were identified. None of the studies evaluated the current ADA or AAPD tools. Several studies evaluated the Cariogram and CAMBRA-based tools (Table 2). The systematic reviews themselves were assessed to be of moderate to high quality. However, the evidence presented within the reviews was of varied quality. There was large variation on selection criteria of primary studies, inconsistency in estimates reported in the reviews, and inflation in estimates due to potential collinearity issues that was poorly explored in the studies.

Table 2: Summary of studies assessing validity of current CRA tools

	AAPD	ADA	Cariogram	CAMBRA
No. of factors/population included	14/ Children	14/ Children 19/ Adults	9/ Adults	20/ Children 25/ Adults
Studies assessing predictive accuracy of CRA tools	Not found	Not found	Holgerson et al., 2009 Hänsel P et al., 2010a Hänsel P et al., 2002 Hänsel P et al., 2013 Hänsel P et al., 2010 Gao et al., 2010	Domejean 2011 Chaffee 2015*
Summary of results	Not available	Not available	Sensitivity: 73 (65-81) Specificity: 60 (54-66)	RR (Low reference) Moderate: 1.01 (0.83-1.23) High: 1.28 (1.10-1.52) Extreme: 1.52 (1.23-1.87)

A key goal of this project was to reconcile existing tools to develop guidance on categorization of risk for the purposes of education, care planning, benefit design and quality improvement. The panel evaluated the current evidence on (1) individual factors predictive of caries risk to inform the selection of factors that need to be included within a standardized CRA tool and (2) the strength and magnitude of those associations to inform approaches for weighting those factors to determine overall risk status.

Risk Assessment: Identification of factors predictive of risk

Project staff developed a comprehensive list of all factors thought to contribute to caries risk based on: (1) existing CRA tools, (2) factors evaluated within the published studies, and (3) individual panelist recommendations (expert opinion). A total of 57 CRA factors were identified. The panel used a modified Delphi process (2 rounds) along with significant discussions to identify predictive factors. Panel discussions were informed by an additional review of the evidence that was undertaken to evaluate the predictive ability of each risk factor based on published evidence on outcome statistics such as odds ratios, risk ratios, sensitivity and specificity (*Appendix 2*). This review included 33 primary studies that were rated as moderate to high quality in the three systematic reviews. Staff summarized the findings at the factor level including the outcome statistic and statistical significance. An additional 3 studies were identified by panel members and were independently assessed (Appendix 3)

Following these discussions, the panel identified the following 15 factors as being predictive of risk and able to be effectively operationalized into a clinical tool (Table 3). Appendix 4 provides details of the panel's deliberations on each of the 57 factors initially identified.

Table 3. Factors To Consider When Assessing Risk for New Carious Lesions in Children

PROTECTIVE FACTORS*
Brushes twice a day with toothpaste containing fluoride
Predominantly drinks fluoridated water/ beverages made from fluoridated water
Receives professionally applied fluoride
Uses over the counter fluoride mouth rinse (over age 6 years)
Uses at-home prescription fluoride products (over age 6 years)
RISK FACTORS
Consumes more than 3 sugary beverages or snacks between meals each day (or infants put to bed with a bottle containing beverage with sugar)
Physical or behavioral health issues that impede home care
Clinically, little saliva or dry mouth due to medical condition or medication
Recent caries experience (Past moderate or advanced lesion(s) since last assessment or in the last 3 years)
Parents or siblings have cavitated lesion(s) in the last year (consider for children under age 14 years)
Visible plaque
Un-coalesced and unsealed pits & fissures
Orthodontic or prosthodontic appliances that impede oral hygiene
DISEASE INDICATORS
Current Active initial lesion(s) (i.e., enamel lesions, white spots)
Current Active moderate or advanced lesion(s)

*Most of these "protective" factors can also be viewed as "risk factors" – i.e., lack of protective factors indicates greater risk for disease or presence of disease. Clinicians preferred them to be worded positively: i.e., use "Brushes with fluoridated toothpaste – Yes/No" rather than "Does not brush with fluoridated toothpaste – Yes/No".

Socioeconomic Status: In itself, socioeconomic status (SES) is an indicator for various exposures and behaviors that impact caries risk. SES as a factor in predicting caries risk was discussed at length. Significant evidence exists to support a strong correlation between SES and caries experience.[5-9] SES is often used as a risk indicator to target public health interventions (e.g., school based sealant programs).

When available, SES provides contextual information on population risk. However, there is insufficient evidence to determine whether SES is a risk factor outside of the other disease indicators/risk factors identified above. The panel also noted definitional constraints. Family level measures (e.g., income and parental education) may be more appropriate indicators of socioeconomic position for conducting person-level assessments. In many settings, income/parent education are not routinely or easily collected. Specifically "Medicaid Beneficiary" or "Belonging to a government program" may not be good definitions. Consequently, the use of SES may be included in determining an individual's risk status but should be assessed individually according to determinants such as life-time poverty, recent immigration, low health literacy; and not by population-based determinants such as "belonging to a government plan." Based on these considerations, the panel chose to provide the following guidance around SES: "Consider SES of the patient you are treating when such information can be acquired. SES (e.g., life-time poverty, recent immigrants, low health literacy) is strongly associated with caries incidence and is a risk factor. "Belonging to a government program" may not be reflective of caries risk for the individual."

Risk Prediction: Weighting of factors and risk classification

The panel considered the evidence basis for combining/weighting predictive factors to arrive at a risk designation. In general, the panel found limited evidence to guide weighting of the different factors to arrive at risk levels. Further, genome-level risk accounts for substantial variation in caries manifestation (lesion development) and will remain for the foreseeable future a "black box" of unknowable risk that will prevent accurate prediction using any model where genomic data are not included.[11-13] Further, the interaction of risk/protective factors is not well studied. For a person with a set of risk factors and no protective factors, the probability of caries occurrence may be quite different compared with someone with the same risk factors but many more caries protective factors. Any risk factor's predictive ability and thus the validity of any CRA tool will vary with the baseline prevalence of disease in the defined population in which it is being used.

In general, all five CRA tools evaluated in this review classify individuals as being at "low" risk for caries if they do not have any disease indicators or risk factors but have preventive factors. The combination and weighting of factors to arrive at elevated levels of risk (i.e., "moderate" or "high" or "extreme") and the number of levels of risk varies between the current tools. The panel emphasized the lack of evidence to determine which specific risk factors or their combinations lower a person's risk towards "moderate" or increase a person's risk towards "high" or "extreme".

Observations & Recommendations on Risk Assessment

FOR CRA TOOL DEVELOPERS:

- There is evidence that the 15 factors identified in this report may be used to assess caries risk. Many CRA tools evaluated in this report include most of these 15 factors (although variably defined).
- Within published studies, predictive strength of each risk factor is reported relative to the average risk of the population studied. Thus, even strong **single** risk factors may not have the desired predictive ability in the population in which the risk assessment is applied. [14] Thus it is important to (1) address risk based on combinations of different factors rather than single risk factors, and (2) assess any CRA tool in independent populations in order to determine its utility in assessing risk.
- In general weighting factors differentially to arrive at risk requires an algorithm based electronic tool rather than a paper CRA form. There is, however, limited evidence to identify the combination or weighting of risk factors to define distinct risk categories.

FOR PRACTITIONERS:

- Despite limited evidence on whether assessing caries risk by itself results in improved oral health, it is important to assess caries risk to educate patients and manage modifiable risk factors based on the best available evidence.
- Frequently used CRA tools include most of the 15 factors identified in this report.
- Current tools have derived various methods to categorize risk based on expert consensus. The categorization of risk differs between the tools. However, all tools appear to qualify "low risk" in a similar manner: lack of disease and presence of protective factors. Current CRA tools could be effectively used in identifying "low risk" patients.[15]
- Current or recent history of carious lesions is the most valid predictor of elevated caries risk.
- The most important use of a CRA is to measure the effectiveness of an intervention to reduce future caries risk and predict the occurance of new carious lesions.
- One or more carious lesions in younger children (3 years) or soon after tooth eruption is indicative of increased risk. [16]

FOR POLICY MAKERS (benefit design, quality measures, public health interventions):

- A large number of people at low risk may give rise to more cases of disease (i.e. number of people getting cavities) than a small number at high risk. [19] So when defining group benefit policies (e.g., coverage for fluorides or sealants for commercially insured populations who generally have lower caries incidence compared to those covered by public prorgrams) eliminating access to benefit for primary preventive services based on CRA may be detrimental.
- Within sub-populations with higher caries incidence (e.g., Medicaid), CRA may be used to identify priority populations as a means of sampling to measure improvement. However given the current state of science, CRA cannot be used to create valid population risk profiles based on aggregation of individual risk assessment data.
- Risk factors should not be construed as the "causes" of individual cases of disease;

i.e., eliminating risk factors will not eliminate the potential for disease occurrence because social, economic, genomic,and demographic factors outside the control or of the provider or patient contribute to an individual's risk. [17,18] Inclusion of SES on the CRA tool provides some socioeconomic context to understand the person's overall health risks.

- Assessing risk for a group of individuals that share a common social/economic context (i.e., population) to plan for group interventions (i.e., public health interventions) may not benefit from CRA tools intended for individuals. CRA tools included in this study are intended for person-centered individual risk assessment.

In the absence of objective caries risk assessment, the current subjective methods should not be discounted, but rather tested for their reliability and validity. Identified deficiencies in reliability and validity should then be addressed by refining the CRA tool. As more evidence emerges, electronic tools with evidence-based algorithms could provide more granular classification of risk rather than paper forms. Future research should begin by identifying gaps in the data and appropriately selecting where the lack of evidence presents an obstacle to patient-centered care. The science of caries risk assessment to date is mostly subjective and would benefit from increased objectivity, likely from a better understanding of microbiological endpoints, sialochemistry and genomics. Future research should also focus on establishing predictive ability of various risk factors across the life-span and better ways to determine how risk changes with age. Interaction of individual factors in modifying a patient's risk remains largely understudied and could be the focus of future efforts.

Endnotes

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Appendix 1: Caries Risk Assessment Expert Panel

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Ralph A. Cooley, DDS, (Chair, Expert Panel), Academy of General Dentistry and Dental Quality Alliance

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Rebecca Slayton, DDS, PhD, American Academy of Pediatric Dentistry

Norman Tinanoff, DDS, MS, American Academy of Pediatric Dentistry

Rober Weyant, MS, DMD, DrPH, ADA Council on Scientific Affairs

Joel White, DDS, MS, ADA Standards Committee on Dental Informatics

Appendix 2: Summary of Study Findings of Individual CRA Risk/Protective Factors

Summary of Study Results by Data Element: DISEASE INDICATORS

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Presence of any non-cavitated active enamel lesion(s) *(aka white spots, non-cavitated enamel defect, initial superficial, ADA CCS initial)*				
White spot lesions (sum of lesions on primary and permanent tooth surfaces) Note: Baseline caries experience: Mean dmfs, Grade 1, Aiken: 9.3, Portland: 2.9 Mean dmfs Grade 5, Aiken: 4.4, Portland: 2.4 Mean DMFS Grade 1, Aiken: 0.3, Portland: 0.2 Mean DMFS Grade 5, Aiken: 3.0, Portland: 1.7	1.23 (OR) Significant, 1 of 4 cohorts (one Grade 5) Note: Comparison to "any risk" in Beck et al. 1992 where "any risk" is a DMFS increment of 1 or more (Beck et al results below): 1.22-1.36 (OR) Significant, 2 of 4 cohorts (both Grade 5)	Two cohorts (Grade 1 and Grade 5) at two sites (Aiken, SC and Portland, ME) with 3-year follow-up (n=4158)	Backward stepwise logistic regression for outcome: high risk based on 3-year DMFS increment (final DMFS-baseline DMFS) where high risk definition varied by cohort	Disney JA, Graves RC, Stamm JW, Bohannan HM, Abernathy JR, Zack DD. The University of North Carolina Caries Risk Assessment study: further developments in caries risk prediction. Community Dent Oral Epidemiol 1992;20: 64–75.
Initial caries (loss of translucency and slight roughness on probing (chalky appearance)) **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years: 11% had initial or manifest caries; 7% had one or more manifest lesions. At 3.5 years: 37% initial/manifest; 29% manifest.	8.8 (OR, p<0.001) Univariate (manifest caries at 3.5 years) NA Multivariate (subjects with caries at 2.5 years were excluded from logistic regression analyses for caries outcome at 3.5 years)	Children 1 year at baseline with follow up at 2.5 and 3.5 years of age (n=692) [Stockholm, Sweden]	Univariate and logistic multivariate regression for association with outcomes: initial/manifest caries at 2.5 years of age and manifest caries at 3.5 years of age (versus not). Initial caries - loss of translucency and slight roughness on probing (chalky appearance); Manifest - minimal level verified as a cavity detectable by probing; and catch of probe under slight pressure for fissures.	Grindefjord M, Dahllöf G, Nilsson B, Modéer T. Stepwise prediction of dental caries in children up to 3.5 years of age. Caries Res 1996;30:256–66.
Level 2 - Enamel defects - opacity Level 2 - Enamel defects - hypoplasia **Note:** ECC prevalence at baseline (8 months) = 0; 14 months = 0; 20 months =1.6%; 26 months = 11.1%; 32 months=28.4%.	3.38 (IDR, p=0.31) Within level multivariable analysis NS Final model with all five levels, using sequential stepwise GEE 14.55 (IDR, p<0.001) Within level multivariable analysis 4.85 (IDR, p<0.001) Final model with all five levels, using sequential stepwise GEE IDR = Incidence density ratio = incidence density among those exposed and not exposed to independent variable.	Children 8 months of age with six month follow-ups through 32 months of age (2-year follow up) (n=255 at recruitment; 155 at last follow-up) [Guangzhou, China]	Generalized estimating equations used to assess relationship with outcome: incidence density of a tooth surface developing caries, which is the number of new caries-affected surfaces per surface time at risk. Incidence density ratio (IDR) = incidence density among those exposed and not exposed to independent variable. Sequential stepwise GEE using 5-level model (1=socioeconomic/demographic vars; 2=developmental characteristics; 3=nutritional upbringing including feeding/nutrition; 4=oral health behaviors; 5= S. mutans)	Zhou Y, Yang JY, Lo EC, Lin HC. The contribution of life course determinants to early childhood caries: a 2–year cohort study. Caries Res 2012;46:87–94.

NS=not significant
OR=Odds Ratio
RD=Risk Difference
RR=Risk Ratio
IRR=Incidence Rate Ratio
SN=Sensitivity
SP=Specificity
ROC=Receiver Operating Characteristic
AUC=Area under curve
PCC=Pearson Correlation Coefficient
SCC=Spearman Rank Correlation Coefficient

Data Element	Results (OR, RD, RR, Sn, Sp)	Population Note: *n* represents sample size at final follow-up	Relationship Examined	Study
Initial lesions present (vs absent) [Initial lesion defined as active carious lesion, which upon visual assessment, has intact surface with no clinically detectable dental tissue loss, with a whitish/yellowish area of increased opacity, roughness, and loss of luster. Also included localized surface defects (active microcavities)restricted to the enamel.]	NS Bivariate, 7-8 year olds, DMFT increment>0 1.80 (OR, p=0.045) Bivariate, 9-10 year olds, DMFT increment>0	7-10 years at baseline (n=765) with 2-yaer follow up [Piracicaba, SP, Brazil] Participants stratified into two age groups for analysis: 7-8 years old and 9-10 years old at baseline.	Bivariate associations with outcome: caries experience in the permanent teeth measured as DMFT increment>0 over the 2-year period.	Kassawara AB, Tagliaferro EP, Cortelazzi KL, Ambrosano GM, Assaf AV, Meneghim Mde C, et al. Epidemiological assessment of predictors of caries increment in 7-10- year-olds: a 2-year cohort study. J Appl Oral Sci 2010;18:116–20.
Presence of any cavitated lesion(s) *(aka ADA CCS moderate, ADA CCS Advanced, obvious caries)*				
Past caries experience baseline dmfs>0 (versus 0)	12.3 (OR, p<0.001), 0.78 (SN), 0.77 (SP) Baseline Significant (specific values not reported) Multivariate	Kindergarten children (mean age 5 y 8m) followed up after one year (n=302) [Montreal, Canada]	Bivariate association and multivariate logistic regression for outcome: at least one new carious surface in primary teeth at one-year follow-up	Demers M, Brodeur JM, Mouton C, Simard PL, Trahan L, Veilleux G. A multivariate model to predict caries increment in Montreal children aged 5 years. Community Dent Health 1992;9:273–81.
dmfs at baseline (7 years of age)	1.07 (OR, p<0.001) Follow-Up	7 years old at baseline (n=3,303) with at least one follow-up by age 10 years (n=3,002) [Flanders, Belgium]	1. Cross-sectional multiple logistic regression with outcome: dmfs (caries v. no caries) in **permanent first molars** (baseline) 2. Stepwise multiple logistic regression with outcome: net caries increment on **permanent first molars** (0/1 additional surface affected v. 2 or more additional surfaces affected) calculated by subtracting baseline DMFS6 score from last available DMFS6 score [follow-up]	Vanobbergen J, Martens L, Lesaffre E, Bogaerts K, Declerck D. 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 2001;35:442–50.
baseline dmfs	1.03 (OR) Significant, 1 of 4 cohorts (one Grade1) Note: Comparison to "any risk" in Beck et al. 1992 where "any risk" is a DMFS increment of 1 or more (Beck et al results below): 1.04 (OR) Significant, 1 of 4 cohorts (one Grade 1)	Two cohorts (Grade 1 and Grade 5) at two sites (Aiken, SC and Portland, ME) with 3-year follow-up (n=4158)	Backward stepwise logistic regression for outcome: high risk based on 3-year DMFS increment (final DMFS-baseline DMFS) where high risk definition varied by cohort	Disney JA, Graves RC, Stamm JW, Bohannan HM, Abernathy JR, Zack DD. The University of North Carolina Caries Risk Assessment study: further developments in caries risk prediction. Community Dent Oral Epidemiol 1992;20: 64–75.
baseline DMFS Note: Baseline caries experience: Mean dmfs, Grade 1, Aiken: 9.3, Portland: 2.9 Mean dmfs Grade 5, Aiken: 4.4, Portland: 2.4 Mean DMFS Grade 1, Aiken: 0.3, Portland: 0.2 Mean DMFS Grade 5, Aiken: 3.0, Portland: 1.7	1.16-1.20 (OR) Significant, 3 of 4 cohorts Note: Comparison to "any risk" in Beck et al. 1992 where "any risk" is a DMFS increment of 1 or more (Beck et al results below): 1.13-1.51 (OR) Significant, 3 of 4 cohorts	Two cohorts (Grade 1 and Grade 5) at two sites (Aiken, SC and Portland, ME) with 3-year follow-up (n=4158)	Backward stepwise logistic regression for outcome: high risk based on 3-year DMFS increment (final DMFS-baseline DMFS) where high risk definition varied by cohort	Disney JA, Graves RC, Stamm JW, Bohannan HM, Abernathy JR, Zack DD. The University of North Carolina Caries Risk Assessment study: further developments in caries risk prediction. Community Dent Oral Epidemiol 1992;20: 64–75.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Different cut-off-points of caries (d1-5fs), predictive power All primary molars >0 >1 >2 >3 >4 >5 Primary secondary molars >0 >1 >2 >3 >4 >5 **Note:** Baseline d1-5mft at 5 years old, mean=3.74. At 10 years, D1-5DMFT, mean=2.43.	0.76, AUC; ROC 0.93 (SN) 0.40 (SP) 0.87 (SN) 0.51 (SP) 0.84 (SN) 0.62 (SP) 0.78 (SN) 0.67 (SP) 0.64 (SN) 0.72 (SP) 0.56 (SN) 0.79 (SP) 0.75, AUC; ROC 0.93 (SN) 0.47 (SP) 0.87 (SN) 0.57 (SP) **0.76 (SN) 0.72 (SP) (highest sum)** 0.58 (SN) 0.75 (SP) 0.31 (SN) 0.84 (SP) 0.15 (SN) 0.89 (SP)	5 years of age at baseline; followed up at 10 years of age (n=186) [Bergen, Norway]	Bivariate association with assignment to "risk" group at 10 years based on caries status of permanent teeth. Risk group inclusion: (1) one or more dentin or filled lesions on the mesial surface of 6-year molars, and/or (2) same type of lesions on any incisor, and/or (3) total D1-5MFS more than 1 SD above the mean. [Erupted premolars and permanent 2nd molars were excluded.]	Skeie, Raadal, Strand & Espelid. The Relationship between Caries in the Primary Dentition at 5 Years of Age and Permanent Dentition at 10 Years of Age - A Longitudinal Study. Int J Paediatr Dent 2006;16:152–60.
Baseline caries - d1-3mfs **Notes:** degree 1 - opaque/discolored; degree 2 - early dentinal lesions no clinical cavity; degree 3- defect found on surface and restorative treatment necessary **Note:** Occurrence of children with cavitated caries or fillings (d3mfs>0) at 2 years of age was 3%. At age 5 years, 23% .	14.17 (OR, p<0.001) Univariate 7.33 (OR, p=0.003) Multivariate 0.29 (SN), 0.97(SP), 0.63 (AUC)	2 years at baseline; followed for 3 years (n=226) [Saarijarvi, Finland]	Bivariate and multivariate (using forward stepwise logistic regression) association with outcome: 3-year increment of cavitated carious lesions and/or fillings - measured as the increase of d3mfs from age of 2 years (degree 1 - opaque/discolored; degree 2 - early dentinal lesions no clinical cavity; degree 3- defect found on surface and restorative treatment necessary)	Pienihakkinen, Jokela & Alanen. Assessment of Caries Risk in Preschool Children. Caries Res 2004;38:156-162.
10% increase in proportion of new cavitated caries surfaces to surfaces at risk. **Note:** % with new non-cavitated caries at first exam, primary dentition: 21.15%; % with new cavitated caries at first exam, primary dentition: 26.28%	2.10 (IRR, p=0.004) New non-cavitated caries 3.53 (IRR, p=0.007) New cavitated caries	Children tracked from birth through 13 years old (n=156) [Iowa]	Multivariable model of association with: (1) new non-cavitated caries and (2) new cavitated caries (repeated measures analysis with measurements at 3-5 y, 6-8 y, and 11-13 y)	Chankanka et al. Longitudinal Associations between Children's Dental Caries and Risk Factors. J Public Health Dent 2011;71:289-300.
Baseline d16mfs - none as reference	1.6 (IRR, p<0.001) <7 new d16mfs 2.3 (IRR, p<0.001) >=7 3.7 (IRR, p<0.001) <7 new d36mfs 9.3 (IRR, p<0.001) >=7	Children 0-5 years at baseline followed for 2 years (n=788) [low-income African-American children in Detroit, Michigan]	Stepwise backward multiple regression, zero-inflated negative binomial models with outcomes: caries increment measured as (1) new d16mfs and (2) new d36mfs.	Ismail AI, Sohn W, Lim S, Willem JM. Predictors of dental caries progression in primary teeth. J Dent Res 2009;88: 270–5.
Baseline caries (dmft>0 versus =0) Note: At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	7.32 (OR, p<0.05) Prediction model w/o biological factors (change dmft>0) 3.95 (OR, p<0.05) Prediction model w/ biological factors (change dmft>0) Not included Risk model w/o biological factors (change dmft>0) Not included Risk model w/biological factors (change dmft>0) Not included Community high risk model; questionnaire (baseline dmft>0)	Children aged 3-6 years with one-year follow-up (n=1,576). [Singapore]	Multiple stepwise logistic regression for association with outcome: one-year caries increment measured as change in dmft. Data from 50% children used for model construction; remainder for model validation. Prediction (all potential factors) and risk models (subset of modifiable factors) with and without biological tests examined. Also, community screening model for identify "high risk" using a questionnaire - high risk = 25% of children with high caries burden (baseline dmft>2 for population studied). At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	Gao XL, Hsu CY, Xu Y, Hwarng HB, Loh T, Koh D. Building caries risk assessment models for children. J Dent Res 2010;89:637–43.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Number of decayed surfaces (baseline carious surfaces, continuous n) **Note:** Baseline carious surfaces (mean): 9.4 At 5-year following, net **increment** of carious surfaces (mean): 6.9	1.03 (RR, p<0.001) Multivariate, 5-year net increment carious TEETH 1.03 (RR, p<0.001) Multivariate, 5-year net increment carious SURFACES <u>Mean 5-year increment carious teeth</u> Baseline carious surfaces 2-3 surfaces: 3.6 mean increment 4-8: 4.0 8-14: 4.6 >=14 5.7 <u>Mean 5-year increment carious surfaces</u> Baseline carious surfaces 2-3 surfaces: 5.5 mean increment 4-8: 6.1 8-14: 7.1 >=14 8.8	6-10 years old at baseline followed for 5 years (n=429) [Boston, MA and Farmingham, ME] **Note:** Sample were high-risk children enrolled in the New England Children's Amalgam Trial - additional inclusion criteria were no prior amalgam restorations and having at least two decayed posterior occulsal surfaces All participants received restorations of baseline caries and sealants and comprehensive semiannual dental care.	Bivariate and multivariable associations with two outcomes: (1) 5-year increment of carious teeth and (2) 5-year increment of carious surfaces. Carious/filled surfaces measured from date of baseline visit through date of final study dental visit. Caries in both primary and permanent dentition were summed to obtain cumulative incident disease burden (net caries increment). Factors associated with caries increment at a level of p>0.15 entered into preliminary multivariate model; final multivariate model included variables significant at p<0.05 or changed coefficients of other variables more than 10%. Multivariate analyses conducted using negative binomial model.	Maserejian NN, Tavares MA, Hayes C, Soncini JA, Trachtenberg FL. Prospective study of 5-year caries incre-ment among children receiving comprehensive dental care in the New England children's amalgam trial. Community Dent Oral Epidemiol 009;37:9–18.
DMFT=0 and dmft>0 at baseline (vs. both=0) DMFT>0 and dfmt>0 at baseline (vs. both=0) Classification based on WHO recommendations; IL not included	NS Bivariate, 7-8 year olds, DMFT increment>0 NS Bivariate, 9-10 year olds, DMFT increment>0 9.87 (OR p<0.001) Bivariate, 7-8 year olds, DMFT increment>0 2.96 (OR p=0.002) Bivariate, 9-10 year olds, DMFT increment>0	7-10 years at baseline (n=765) with 2-yaer follow up [Piracicaba, SP, Brazil] Participants stratified into two age groups for analysis: 7-8 years old and 9-10 years old at baseline.	Bivariate associations with outcome: caries experience in the permanent teeth measured as DMFT increment>0 over the 2-year period.	Kassawara AB, Tagliaferro EP, Cortelazzi KL, Ambrosano GM, Assaf AV, Meneghim Mde C, et al. Epidemiological assessment of predictors of caries increment in 7-10- year-olds: a 2-year cohort study. J Appl Oral Sci 2010;18:116–20.
Primary dental caries at 6 yrs: DMFT 0 vs. >=1 •Not shown in multivariable regressions Primary dental caries at 6 yrs: DMFT 0; 1-3; 4-19 •Not shown in multivariable regressions Primary dental caries at 6 yrs: decayed teeth; 0; 1-3; 4-19 Primary dental caries at 6 yrs: missing teeth: >=1 vs. 0 Primary dental caries at 6 yrs: Filled teeth: >=1 vs. 0	<u>Initial Bivariate Tests</u> DMFT>=1, p<0.01 (chi-square/Fischer exact test) Bivariate mean DMFT, p<0.01 (Mann-Whitney u-test) Bivariate <u>Initial Bivariate Tests</u> DMFT>=1, p<0.01 (chi-square/Fischer exact test) Bivariate mean DMFT, p<0.01 (Mann-Whitney u-test) Bivariate <u>Initial Bivariate Tests</u> DMFT>=1, p<0.01 (chi-square/Fischer exact test) Bivariate mean DMFT, p<0.01 (Mann-Whitney u-test) Bivariate <u>Poisson Regressions</u> 2.16 (RR, p<0.001) Decayed teeth 1-3 (vs. 0) Univariate 2.89 (RR, p<0.001) Decayed teeth 4-19 (vs. 0) Univariate 2.01 (RR, p<0.001) Decayed teeth 1-3 (vs. 0) Multivariable 2.66 (RR, p<0.001) Decayed teeth 4-19 (vs. 0) Multivariable <u>Caries Prediction Logistic Regression</u> 2.76 (RR, p<0.01) Decayed teeth 1-3 (vs. 0) Multivariable 5.66 (RR, p<0.01) Decayed teeth 4-19 (vs. 0) Multivariable <u>Initial Bivariate Tests</u> NS but p<0.10 <u>Poisson Regressions</u> 1.65 (RR, p=0.009) Univariate NS Multivariable <u>Initial Bivariate Tests</u>	Study nested within a population based cohort with dental exams and interviews performed at 6 and 12 years of age (n=339) [Pelotas, Brazil]	Bivariate and multivariable associations with outcome: DMFT at 12 years old. Multivariate analyses were conducted using Poisson regression to generate relative risk ratio and logistic regression (backward stepwise) to predict dental caries at age 12 years. Variables grouped into hierarchical model with 6 levels: (1) socioeconomic/demographic, (2) nutritional/development characteristics, (3) OH behaviors and dental service use at age 6, (4) primary dental caries at 6 yrs, (5) family economic level at 12 yrs, (6) OH related behaviors and dental service use at 12 yrs. At each level, variables excluded if p>0.25. Final model variables retained if p<=0.05.	Peres MA, Barros AJ, Peres KG, Araujo CL, Menezes AM. Life course dental caries determinants and predictors in children aged 12 years: a population-based birth cohort. Community Dent Oral Epidemiol 2009;37:123–33.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Baseline caries experience (dmf+DMFS) **Note:** Baseline: 42% caries free; dmfs(mean) 5.5; DMFS(mean) 0.1 At 4 yrs: 29% caries free; dmfs(mean) 4.6; DMFS(mean) 0.6	p=0.0001 (Pearson chi-square/Fisher exact test) Bivariate 12.86 (OR, p=0.0001) Multivariable AUC/ROC: 0.79	6 years followed for 4 years (n=95) [Mexico City, Mexico]	Bivariate and multivariable (multiple logistic regression) associations with outcome: caries increment dichotomized as 0 newly affected vs. >=1 new surface affected. ROC/AUC calculated. Caries experience calculated as dmfs, DMFS and dfm+DMFS using WHO criteria. Two groups identified: caries-free and >=1 dmf+DMFS. Caries increment was most recent dmfs/DMFS score - baseline score.	Sanchez-Perez L, Golubov J, Irigoyen-Camacho ME, Moctezuma PA, Acosta-Gio E. Clinical, salivary, and bacterial markers for caries risk assessment in schoolchildren: a 4-year follow-up. Int J Paediatr Dent 2009;19:186–92.
Number decayed/filled permanent teeth (scored using WHO criteria) **Note:** Baseline: DF=0.054	Logistic Regression 1.12 (OR, p=0.002) Multivariate, all factors 1.12 (OR, p=0.001) Multivariate, stepwise NS Multivariate, most robust based on balancing technique Note: Overall study finding: decision analysis produced better prediction models than logistic regression or neural network approaches. Significant predictors in this approach were MS levels, LB, salivary pH, gender, and sweet beverages.	5-6 years at baseline, followed for 3 years (n=500) [Gifu Prefecture, Japan]	Outcome: new incident dental caries of the permanent teeth; 3 approaches: (1) conventional modeling, (2) neural network, C5.0 - tool for discovering patterns in databases and used to make predictions. Logistic regression analyses were conducted for a full model with all variables as well as using stepwise selection. Neural network model had 12 input layers, 3 hidden layers, and 1 output layer. C5.0 models work by sequenced sample splitting based on fields providing the maximum information gained. Balancing technique applied. Total of 10 balanced sample sets applied to the models. Model selection based on highest mean of sum of SN and SP.	Tamaki Y, Nomura Y, Katsumura S, Okada A, Yamada H, Tsuge S, et al. Construction of a dental caries prediction model by data mining. J Oral Sci 2009;51:61–8.
Baseline caries experience (with/without lesions) **Note:** Baseline caries prevalence: 32.7% Caries prevalence at 1-year follow-up: 56.4%	p<0.001, Mann-Whitney U Test, Caries incidence mean at follow up SN (1.0), SP (0.74), % correctly classified: 76%	12-30 months at baseline with one-year follow up (n=101) [Piracicaba, SP, Brazil]	Bivariate associations with outcomes: (1) caries incidence at follow up and (2) high caries incidence at follow up. Caries definitions •Initial caries lesion: demineralized surface having only loss of translucency •Manifest lesion: lesion with definite cavitation •Caries incidence: sum of new initial and manifest caries plus initial caries detected at baseline that progress to manifest caries during study •High caries incidence: development of 3 or more new manifest lesions during one-year follow-up	R.O. Mattos-Graner, D.J. Smith, W.F. King, M.P. Mayer, Water-insoluble glucan synthesis by mutans streptococcal strains correlates with caries incidence in 12- to 30-month-old children, J. Dent. Res. 79 (2000) 1371–1377.
Manifest caries (minimal level verified as a cavity detectable by probing) **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years: 11% had initial or manifest caries; 7% had one or more manifest lesions. At 3.5 years: 37% initial/manifest; 29% manifest.	13.5 (OR, p<0.001) Univariate (manifest caries at 3.5 years) NA Multivariate (subjects with caries at 2.5 years were excluded from logistic regression analyses for caries outcome at 3.5 years)	Children 1 year at baseline with follow up at 2.5 and 3.5 years of age (n=692) [Stockholm, Sweden]	Univariate and logistic multivariate regression for association with outcomes: initial/manifest caries at 2.5 years of age and manifest caries at 3.5 years of age (versus not). Initial caries - loss of translucency and slight roughness on probing (chalky appearance); Manifest - minimal level verified as a cavity detectable by probing; and catch of probe under slight pressure for fissures.	Grindefjord M, Dahllöf G, Nilsson B, Modéer T. Stepwise prediction of dental caries in children up to 3.5 years of age. Caries Res 1996;30:256–66.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
dmfs/DMFS at baseline measured as ICDAS>=3 (added last in models for use in non-dental settings; added first in models for use in dental setting) **Note:** Baseline mean age was 9.7 years Baseline mean ICDAS>=1: 15.7 Baseline mean ICDAS>=3: 8.2 12-month mean ICDAS>=1: 17.9 -89% of children 12-month mean ICDAS>=3: 8.4 -61% of children 24-month mean ICDAS>=1: 16.8 -91% of children 242-month mean ICDAS>=3: 8.4 -68% of children	<u>**Multivariate Caries Risk Models**</u> **Note:** Total of 12 Multivariate Caries Risk Models: 2 outcomes, 2 time periods, 3 ways of handling baseline dmfs/DMFS (not included, added last, added first) -Not included in 4 models where dmfs/DMFS not included at all -Significant in 7 of 8 remaining models **Reporting results for model with highest combined SN/SP in each of three model groups** 1. No dmfs/DMFS - N/A 2. dmfs/DMFS added last, 12 month follow-up, ICDAS>=3 (model SN=.81, SP=.58, AUC=0.77) 1.17 (OR, p=0.0065) 3. dmfs/DMFS added first, 12 month follow-up, ICDAS>=3 (model SN=.81, SP=.57, AUC=0.79) 1.14 (OR, p=0.0260) <u>**Multivariate Caries Risk Model for Identification of Number of Lesions Progressing**</u> Note: Total of 12 Multivariate Caries Risk Models: 2 outcomes, 2 time periods, 3 ways of handling baseline dmfs/DMFS -Not included in 4 models where dmfs/DMFS not included at all -Significant in 8 of 8 remaining models	5-13 years of age with 2-year follow-up (n=395) [Aguas Buenas, Puerto Rico]	Logistic regression for progression outcomes (see below) at 12/24 months; for each predictor individually; multiple regression developed using backward elimination retaining predictors p<0.05 with AUC/ROC calculated for final models at model level; Poisson regression for number of lesions with progression Two Outcomes: 1. Any progression (ICDAS>=1): at least one new lesion ICDAS>=1, one new filling, and/or progression of lesion from scores of 1-2 to 3 to higher or from 3-4 to 5 to higher between the two exams. 2. Progession toward cavitation (ICDAS>=3): at least one new lesion ICDAS>=3, one new filling, and/or progression of lesion from score of 1-2 to 3 or higher or from 3-4 to 5 or higher between the two exams. Models run for outcomes at 12 and 24 months; Models run without any baseline ICDAS; models run adding baseline ICDAS last; models run starting with baseline ICDAS score	Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.
dmft at baseline (1st grade) **Note:** Baseline caries experience in 1st grade (dmft>=1): cohort 1: 77.8%; cohort 2: 67.9%. Caries experience in 6th grade (DMFT>=1): cohort 1: 60%; cohort 2: 50.9%.: Baseline caries experience in 1st grade (dmft>=1): cohort 1: 77.8%; cohort 2: 67.9%. Caries experience in 6th grade (DMFT>=1): cohort 1: 60%; cohort 2: 50.9%.	<u>Spearman Rank Correlation Coefficient between dmft and DMFT</u> 0.441 (p=0.002), cohort 1 0.597 (p=0.001), cohort 2 <u>ROC Analysis (baseline dmft score screening criterion; change DMFT>0 validation criterion)</u> Area under curve: 0.717; optimal cut off: dmft>=4 with 0.74(SN) 0.72(SP), cohort 1 Area under curve: 0.768; optimal cut off: dmft>=5 with 0.52(SN) 0.92(SP), cohort 2 <u>Risk Ratios for change DMFT>0 for different cut-offs of baseline dmft</u> >=1 dmft NS, cohort 1; NS cohort 2 >=2 dmft 2.60, cohort 1; 2.68 cohort 2 >=3 dmft 2.20, cohort 1; 2.05 cohort 2 >=4 dmft 2.29, cohort 1; 2.40 cohort 2 >=5 dmft 1.94, cohort 1; 2.49 cohort 2 >=6 dmft 1.62, cohort 1; 2.23 cohort 2 >=7 dmft NS, cohort 1; 2.25 cohort 2 >=8 dmft NS, cohort 1; NA cohort 2	Two cohorts of Japanese girls born in 1982/82 (n=45) and 1989/1990 (n=53) with baseline examinations in 1st grade and follow-up in sixth grade. [Tokyo, Japan]	Association between caries experience in primary teeth and permanent teeth evaluated using correlation coefficient, ROC analysis, and risk ratios using different dmft score cutoff points. Caries recorded when lesion had unmistakable cavity. White, chalky, discolored spots with no visual cavity and stained/sticky pits/fissures without visual undermined enamel not recorded as caries.	Motohashi M, Yamada H, Genkai F, Kato H, Imai T, Sato S, et al. Employing dmft score as a risk predictor for caries development in the permanent teeth in Japanese primary school girls. J Oral Sci 2006;48:233–7.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
dmfs/DMFS at baseline measured as ICDAS>=3 (added last in models for use in non-dental settings; added first in models for use in dental setting) **Note:** Baseline mean age was 9.7 years Baseline mean ICDAS>=1: 15.7 Baseline mean ICDAS>=3: 8.2 12-month mean ICDAS>=1: 17.9 -89% of children 12-month mean ICDAS>=3: 8.4 -61% of children 24-month mean ICDAS>=1: 16.8 -91% of children 242-month mean ICDAS>=3: 8.4 -68% of children	<u>**Multivariate Caries Risk Models**</u> **Note:** Total of 12 Multivariate Caries Risk Models: 2 outcomes, 2 time periods, 3 ways of handling baseline dmfs/DMFS (not included, added last, added first) -Not included in 4 models where dmfs/DMFS not included at all -Significant in 7 of 8 remaining models **Reporting results for model with highest combined SN/SP in each of three model groups** 1. No dmfs/DMFS - N/A 2. dmfs/DMFS added last, 12 month follow-up, ICDAS>=3 (model SN=.81, SP=.58, AUC=0.77) 1.17 (OR, p=0.0065) 3. dmfs/DMFS added first, 12 month follow-up, ICDAS>=3 (model SN=.81, SP=.57, AUC=0.79) 1.14 (OR, p=0.0260) <u>**Multivariate Caries Risk Model for Identification of Number of Lesions Progressing**</u> Note: Total of 12 Multivariate Caries Risk Models: 2 outcomes, 2 time periods, 3 ways of handling baseline dmfs/DMFS -Not included in 4 models where dmfs/DMFS not included at all -Significant in 8 of 8 remaining models	5-13 years of age with 2-year follow-up (n=395) [Aguas Buenas, Puerto Rico]	Logistic regression for progression outcomes (see below) at 12/24 months; for each predictor individually; multiple regression developed using backward elimination retaining predictors p<0.05 with AUC/ROC calculated for final models at model level; Poisson regression for number of lesions with progression Two Outcomes: 1. Any progression (ICDAS>=1): at least one new lesion ICDAS>=1, one new filling, and/or progression of lesion from scores of 1-2 to 3 to higher or from 3-4 to 5 to higher between the two exams. 2. Progession toward cavitation (ICDAS>=3): at least one new lesion ICDAS>=3, one new filling, and/or progression of lesion from score of 1-2 to 3 or higher or from 3-4 to 5 or higher between the two exams. Models run for outcomes at 12 and 24 months; Models run without any baseline ICDAS; models run adding baseline ICDAS last; models run starting with baseline ICDAS score	Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.
dmft at baseline (1st grade) **Note:** Baseline caries experience in 1st grade (dmft>=1): cohort 1: 77.8%; cohort 2: 67.9%. Caries experience in 6th grade (DMFT>=1): cohort 1: 60%; cohort 2: 50.9%.: Baseline caries experience in 1st grade (dmft>=1): cohort 1: 77.8%; cohort 2: 67.9%. Caries experience in 6th grade (DMFT>=1): cohort 1: 60%; cohort 2: 50.9%.	<u>Spearman Rank Correlation Coefficient between dmft and DMFT</u> 0.441 (p=0.002), cohort 1 0.597 (p=0.001), cohort 2 <u>ROC Analysis (baseline dmft score screening criterion; change DMFT>0 validation criterion)</u> Area under curve: 0.717; optimal cut off: dmft>=4 with 0.74(SN) 0.72(SP), cohort 1 Area under curve: 0.768; optimal cut off: dmft>=5 with 0.52(SN) 0.92(SP), cohort 2 <u>Risk Ratios for change DMFT>0 for different cut-offs of baseline dmft</u> >=1 dmft NS, cohort 1; NS cohort 2 >=2 dmft 2.60, cohort 1; 2.68 cohort 2 >=3 dmft 2.20, cohort 1; 2.05 cohort 2 >=4 dmft 2.29, cohort 1; 2.40 cohort 2 >=5 dmft 1.94, cohort 1; 2.49 cohort 2 >=6 dmft 1.62, cohort 1; 2.23 cohort 2 >=7 dmft NS, cohort 1; 2.25 cohort 2 >=8 dmft NS, cohort 1; NA cohort 2	Two cohorts of Japanese girls born in 1982/82 (n=45) and 1989/1990 (n=53) with baseline examinations in 1st grade and follow-up in sixth grade. [Tokyo, Japan]	Association between caries experience in primary teeth and permanent teeth evaluated using correlation coefficient, ROC analysis, and risk ratios using different dmft score cutoff points. Caries recorded when lesion had unmistakable cavity. White, chalky, discolored spots with no visual cavity and stained/sticky pits/fissures without visual undermined enamel not recorded as caries.	Motohashi M, Yamada H, Genkai F, Kato H, Imai T, Sato S, et al. Employing dmft score as a risk predictor for caries development in the permanent teeth in Japanese primary school girls. J Oral Sci 2006;48:233–7.
Baseline dft 0 1 2 >=3 **Note:** At baseline, mean decayed and filled deciduous teeth and surfaces were 2.21 and 4.04.	Caries risk proportions (p=0.013) 0.744 0.700 0.818 0.968 AUC (ROC): 0.674	Children 6-7 years old followed for 24 months at 6-month intervals (n=95) [Granada, Spain]	Bivariate association with outcome: caries risk defined as at least one new caries in permanent or deciduous dentition during the 2-year period, detected in any one of the 6-month visits. Also calculated area under ROC curve. Used WHO caries criteria.	Baca P, Parejo E, Bravo M, Castillo A, Liebana J. Discriminant ability for caries risk of modified colorimetric tests. Med Oral Patol Oral Cir Bucal 2011;16:e978–83.

<table>
<tr><th>Data Element</th><th>Results (OR, RD, RR, Sn, Sp)</th><th>Population
Note: n represents sample size at final follow-up</th><th>Relationship Examined</th><th>Study</th></tr>
<tr>
<td>Baseline (1st grade) dmfs+DMFS
Note:
Baseline caries experience in first permanent molars in 1st grade: 11.3%

Follow-up caries experience in 1st permanent molars in 4th grade: 24.5%</td>
<td><u>AUC/ROC</u>
Child-level analysis: AUC/ROC for 1st grade dmfs+DMFS=0.65
Molar-level analysis: AUC/ROC for 1st grade dmfs+DMFS=0.69

<u>Child-level logistic regression for predictor dmfs+DMFS>0 (vs. 0)</u>
2.72 (OR, p=0.012) Univariate
2.76 (OR, p-0.012) Multivariate

Table pasted from article below:

TABLE 1A
Relationship between thresholds of dmfs + DMFS in 1st grade and carious lesion experience in the 1st permanent molars in 4th grade
<table>
<tr><th>Threshold*</th><th>Sensitivity (%)</th><th>Specificity (%)</th></tr>
<tr><td>dmfs+DMFS>0</td><td>69.4</td><td>54.5</td></tr>
<tr><td>dmfs+DMFS>1</td><td>50.0</td><td>64.8</td></tr>
<tr><td>dmfs+DMFS>2</td><td>47.2</td><td>73.1</td></tr>
<tr><td>dmfs+DMFS>3</td><td>38.9</td><td>80.7</td></tr>
<tr><td>dmfs+DMFS>4</td><td>36.1</td><td>82.1</td></tr>
<tr><td>dmfs+DMFS>5</td><td>30.6</td><td>88.3</td></tr>
<tr><td>dmfs+DMFS>6</td><td>22.2</td><td>90.3</td></tr>
<tr><td>dmfs+DMFS>7</td><td>19.4</td><td>93.1</td></tr>
<tr><td>dmfs+DMFS>8</td><td>13.9</td><td>94.5</td></tr>
<tr><td>dmfs+DMFS>9</td><td>13.9</td><td>95.2</td></tr>
</table>
*Threshold number of dmfs + DMFS</td>
<td>1st grade at baseline, followed up at 4th grade (n=204) [Cambridge, MA]

Child-level analyses: excluded children who had carious lesions in first permanent molar by 1st grade

Molar-level analyses: excluded decayed/filled molars by 1st grade</td>
<td>Bivariate and multivariate (logistic regression) association of dmfs+DMFS at 1st grade with outcome: carious lesion experience (D or F) in permanent first molars in 4th grade.

SN/SP calculated; best performance identified as test with highest sensitivity and negative predictive value.

Caries classification used definitions used in NHANES. dmfs/DMFS indices</td>
<td>R.L. Badovinac, K.E. Morgan, J. Lefevre, S. Wadhawan, L. Mucci, L. Schoeff, et al., Risk assessment criteria applied to a screening exam: implications for improving the efficiency of a sealant program, J. Public Health Dent. 65 (2005) 203–208.</td>
</tr>
<tr>
<td>Approximal Caries Lesions at Baseline
0
1
2
3
4-8
>8

Note:
Baseline: 4.9% of all approximal surfaces were in a caries state or restored.</td>
<td>
Reference cat
1.61 (RR, p<0.05) Individual based caries rate; 1.49 (RR, p<0.05) surface-based caries rate
2.06 (RR, p<0.05) Individual based caries rate; 1.55 (RR, p<0.05) surface-based caries rate
3.55 (RR, p<0.05) Individual based caries rate; 1.87 (RR, p<0.05) surface-based caries rate
3.62 (RR, p<0.05) Individual based caries rate; 2.29 (RR, p<0.05) surface-based caries rate
4.85 (RR, p<0.05) Individual based caries rate; 3.18 (RR, p<0.05) surface-based caries rate</td>
<td>11-13 years at baseline, followed to 21-22 years of age (n=534) [Stockholm, Sweden]</td>
<td>Bivariate analysis of association of baseline approximal caries with future approximal caries, examining 2 outcomes: (1) individual-based incidence of first new approximal caries lesion and (2) surface-based incidence of approximal lesions.

Time to first approximal lesion assessed and individual based caries rate calculated. Surface-based caries rate based on total number of approximal surfaces that progressed to a caries state per 100 tooth surface-years. Poisson regression with over-dispersion used to calculate relative risk of developing new approximal lesions related to approximal caries.</td>
<td>Stenlund H, Mejàre I, Källestal C. Caries rates related to approximal caries at ages 11-13: a 10-year follow-up study in Sweden. J Dent Res 2002;81:455–8.</td>
</tr>
</table>

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
NON-CLINICAL: Caregiver Report CG report: child had tooth extracted **Note:** Baseline mean age was 9.7 years Baseline mean ICDAS>=1: 15.7 Baseline mean ICDAS>=3: 8.2 12-month mean ICDAS>=1: 17.9 -89% of children 12-month mean ICDAS>=3: 8.4 -61% of children 24-month mean ICDAS>=1: 16.8 -91% of children 242-month mean ICDAS>=3: 8.4 -68% of children	**Bivariate association with Caries Progression (significant or NS using logistic regression - specific values not reported)** New ICDAS>=1 at 24 months: Significant New ICDAS>=3 at 24 months: Significant **Multivariate Caries Risk Models** **Note:** Total of 12 Multivariate Caries Risk Models: 2 outcomes, 2 time periods, 3 ways of handling baseline dmfs/DMFS (not included, added last, added first) -Significant in 6 of 12 models (all 12-month follow up models) -Not included in the 24-month follow-up models **Reporting results for best model for "any progression" and "progression to cavitation"** 1. dmfs/DMFS excluded, 24-month follow-up, ICDAS>=1 (model SN=.82, SP=.59, AUC=0.75) NS (not included in final model) 2. dmfs/DMFS added last, 12 month follow-up, ICDAS>=3 (model SN=.81, SP=.58, AUC=0.77) 1.97 (OR, p=0.0111) 3. dmfs/DMFS added first, 12 month follow-up, ICDAS>=3 (model SN=.81, SP=.57, AUC=0.79)	5-13 years of age with 2-year follow-up (n=395) [Aguas Buenas, Puerto Rico]	Logistic regression for progression outcomes (see below) at 12/24 months; for each predictor individually; multiple regression developed using backward elimination retaining predictors p<0.05 with AUC/ROC calculated for final models at model level; Poisson regression for number of lesions with progression Two Outcomes: 1. Any progression (ICDAS>=1): at least one new lesion ICDAS>=1, one new filling, and/or progression of lesion from scores of 1-2 to 3 to higher or from 3-4 to 5 to higher between the two exams. 2. Progession toward cavitation (ICDAS>=3): at least one new lesion ICDAS>=3, one new filling, and/or progression of lesion from score of 1-2 to 3 or higher or from 3-4 to 5 or higher between the two exams. Models run for outcomes at 12 and 24 months; Models run without any baseline ICDAS; models run adding baseline ICDAS last; models run starting with baseline ICDAS score	Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.
NON-CLINICAL: Caregiver Report CG report: child had tooth restored **Note:** Baseline mean age was 9.7 years Baseline mean ICDAS>=1: 15.7 Baseline mean ICDAS>=3: 8.2 12-month mean ICDAS>=1: 17.9 -89% of children 12-month mean ICDAS>=3: 8.4 -61% of children 24-month mean ICDAS>=1: 16.8 -91% of children 242-month mean ICDAS>=3: 8.4 -68% of children	**Bivariate association with Caries Progression (significant or NS using logistic regression - specific values not reported)** New ICDAS>=1 at 24 months: Significant New ICDAS>=3 at 24 months: Significant **Multivariate Caries Risk Models** **Note:** Total of 12 Multivariate Caries Risk Models: 2 outcomes, 2 time periods, 3 ways of handling baseline dmfs/DMFS (not included, added last, added first) -Significant in 7 of 12 models (all 12-month follow up models) **Reporting results for best model for "any progression" and "progression to cavitation"** 1. dmfs/DMFS excluded, 24-month follow-up, ICDAS>=1 (model SN=.82, SP=.59, AUC=0.75) 2.31 (OR, p=0.0321) 2. dmfs/DMFS added last, 12 month follow-up, ICDAS>=3 (model SN=.81, SP=.58, AUC=0.77) 1.74 (OR, p=0.0323) 3. dmfs/DMFS added first, 12 month follow-up, ICDAS>=3 (model SN=.81, SP=.57, AUC=0.79)	5-13 years of age with 2-year follow-up (n=395) [Aguas Buenas, Puerto Rico]	Logistic regression for progression outcomes (see below) at 12/24 months; for each predictor individually; multiple regression developed using backward elimination retaining predictors p<0.05 with AUC/ROC calculated for final models at model level; Poisson regression for number of lesions with progression Two Outcomes: 1. Any progression (ICDAS>=1): at least one new lesion ICDAS>=1, one new filling, and/or progression of lesion from scores of 1-2 to 3 to higher or from 3-4 to 5 to higher between the two exams. 2. Progession toward cavitation (ICDAS>=3): at least one new lesion ICDAS>=3, one new filling, and/or progression of lesion from score of 1-2 to 3 or higher or from 3-4 to 5 or higher between the two exams. Models run for outcomes at 12 and 24 months; Models run without any baseline ICDAS; models run adding baseline ICDAS last; models run starting with baseline ICDAS score	Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.
NON-CLINICAL: Parent estimation of number of decayed teeth Note: At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	NS Prediction model w/o biological factors (change dmft>0) NS Prediction model w/ biological factors (change dmft>0) NS Risk model w/o biological factors (change dmft>0) NS Risk model w/biological factors (change dmft>0)	Children aged 3-6 years with one-year follow-up (n=1,576). [Singapore]	Multiple stepwise logistic regression for association with outcome: one-year caries increment measured as change in dmft. Data from 50% children used for model construction; remainder for model validation. Prediction (all potential factors) and risk models (subset of modifiable factors) with and without biological tests examined. Also, community screening model for identify "high risk" using a questionnaire - high risk = 25% of children with high caries burden (baseline dmft>2 for population studied). At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	Gao XL, Hsu CY, Xu Y, Hwarng HB, Loh T, Koh D. Building caries risk assessment models for children. J Dent Res 2010;89:637–43.
Any cavitated lesion in last 3 years for new patient or since last caries risk assessment for existing patients				

Summary of Study Results by Data Element: PROTECTIVE FACTORS

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Brushes twice a day with fluoridated toothpaste				
Brushes less than once a day (versus at least once a day)	1.26 (OR, p=0.03) Baseline 2.24 (OR <0.0001) Follow-Up	7 years old at baseline (n=3,303) with at least one follow-up by age 10 years (n=3,002) [Flanders, Belgium]	1. Cross-sectional multiple logistic regression with outcome: dmfs (caries v. no caries) in **permanent first molars** (baseline) 2. Stepwise multiple logistic regression with outcome: net caries increment on **permanent first molars** (0/1 additional surface affected v. 2 or more additional surfaces affected) calculated by subtracting baseline DMFS6 score from last available DMFS6 score [follow-up]	Vanobbergen J, Martens L, Lesaffre E, Bogaerts K,Declerck D. 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 2001;35:442–50.
Toothbrushing frequency with fluoride toothpaste (each one per day increase in frequency) Note: % with new non-cavitated caries at first exam, primary dentition: 21.15%; % with new cavitated caries at first exam, primary dentition: 26.28%	0.67 (IRR, p=0.044) New non-cavitated caries NS New cavitated caries	Children tracked from birth through 13 years old (n=156) [Iowa]	Multivariable model of association with: (1) new non-cavitated caries and (2) new cavitated caries (repeated measures analysis with measurements at 3-5 y, 6-8 y, and 11-13 y)	Chankanka et al. Longitudinal Associations between Children's Dental Caries and Risk Factors. J Public Health Dent 2011;71:289-300.
Brushing teeth with fluoride toothpaste Once/day (versus <1/day) Twice/day (Versus <1/day) **Note:** Baseline mean DMFS experimental group: 2.1 control group: 2.3 Mean DMFS after 4 years: experimental: 4.7 control: 6.9	change DMFS>=1: 0.31 (OR, p=0.026) Bivariate change DMFS>=3: NS Bivariate change DMFS>=5: NS Bivariate **Note: Table indicated 0.31. But authors stated in text that OR was 3.2. change DMFS>=1: NS Bivariate change DMFS>=3: NS Bivariate change DMFS>=5: NS Bivariate	11-12 year olds with 4-year follow-up (n=497) [Pori, Finland]	Randomized clinical trial. Intervention/experimental group: received individually, designed patient-centered regimen for caries control. Control: standard dental care Outcome: DMFS increment defined as difference in scores between baseline and 4-year follow-up. Three definitions of failure considered: (1) increment>=1; (2) increment >=3; (3) increment >=5. Compared outcome between experimental and control group. Bivariate association between oral health behaviors at baseline and outcome using logistic regression for experimental group. Caries status used criteria in Nyvad et al. DMFS score included surfaces with active or inactive caries lesions with cavitation (scores 5 and 6), those with a filling, those extracted due to caries, and those with caries extending to inner or middle third of dentin or the pulp in radiographs.	Hietasalo P, Tolvanen M, Seppa L, Lahti S, Poutanen R, Niinimaa A, et al. Oral health-related behaviors predictive of failures in caries control among 11-12-yr-old Finnish schoolchildren. Eur J Oral Sci 2008;116:267–71.
Brushing frequency at 6 yrs (<1/day, 1-2/day, >2/day) **Note:** The following variables were not significant in initial bivariate tests. However, 95% of children brushed at least once a day and used toothpaste. The authors referenced fluoridated toothpaste although it is not clear if this was explicit in the questionnaire or inferred. •Use of toothpaste at 6 yrs (yes vs. no) •Use of toothpaste at 12 yrs (yes vs. no) •Brushing frequency at 12 yrs (>=2/day vs. <2/day) **Note:** Baseline primary dental caries at 6 yrs (DMFT>0): 63%	Initial Bivariate Tests DMFT>=1, p<0.01 (chi-square/Fischer exact test) Bivariate mean DMFT, NS (Mann-Whitney u-test) Bivariate Poisson Regressions NS Univariate and Multivariate	Study nested within a population based cohort with dental exams and interviews performed at 6 and 12 years of age (n=339) [Pelotas, Brazil]	Bivariate and multivariable associations with outcome: DMFT at 12 years old. Multivariate analyses were conducted using Poisson regression to generate relative risk ratio and logistic regression (backward stepwise) to predict dental caries at age 12 years. Variables grouped into hierarchical model with 6 levels: (1) socioeconomic/demographic, (2) nutritional/development characteristics, (3) OH behaviors and dental service use at age 6, (4) primary dental caries at 6 yrs, (5) family economic level at 12 yrs, (6) OH related behaviors and dental service use at 12 yrs. At each level, variables excluded if p>0.25. Final model variables retained if p<=0.05.	Peres MA, Barros AJ, Peres KG, Araujo CL, Menezes AM. Life course dental caries determinants and predictors in children aged 12 years: a population-based birth cohort. Community Dent Oral Epidemiol 2009;37:123–33.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Daily use of fluoride toothpaste (yes/no) **Note:** Baseline: DF=0.054	Logistic Regression NS, Multivariate, all factors Not included, Multivariate, stepwise Not included, Multivariate, most robust based on balancing technique Note: Overall study finding: decision analysis produced better prediction models than logistic regression or neural network approaches. Significant predictors in this approach were MS levels, LB, salivary pH, gender, and sweet beverages.	5-6 years at baseline, followed for 3 years (n=500) [Gifu Prefecture, Japan]	Outcome: new incident dental caries of the permanent teeth; 3 approaches: (1) conventional modeling, (2) neural network, C5.0 - tool for discovering patterns in databases and used to make predictions. Logistic regression analyses were conducted for a full model with all variables as well as using stepwise selection. Neural network model had 12 input layers, 3 hidden layers, and 1 output layer. C5.0 models work by sequenced sample splitting based on fields providing the maximum information gained. Balancing technique applied. Total of 10 balanced sample sets applied to the models. Model selection based on highest mean of sum of SN and SP.	Tamaki Y, Nomura Y, Katsumura S, Okada A, Yamada H, Tsuge S, et al. Construction of a dental caries prediction model by data mining. J Oral Sci 2009;51:61–8.
Tooth-brushing **fluoride not specified but authors noted that almost all toothpastes in Sweden contain fluoride so it was implied** Reporting >=2x/day at 2 of the 3 exams at which questionnaires were administered (vs reporting >=2x/day at all 3 exams) Reporting >=2x/day at 1 of the 3 exams (vs >=2x/day at all 3) Reporting <2x/day at all 3 exams (vs >=2x/day at all 3)	1.06 (RR, p<0.05) Univariate, increment DMFS, total study group 1.05 (RR, p<0.05) Multivariable, increment DMFS, total study group 1.11 (RR, p<0.05) Univariate, increment DeMFS, total study group 1.15 (RR, p<0.05) Multivariable, increment DeMFS, total study group 1.08 (RR, p<0.05) Univariate, increment DMFS, high risk group 1.08(RR, p<0.05) Multivariable, increment DMFS, high risk group 1.16 (RR, p<0.05) Univariate, increment DeMFS, high risk group 1.15 (RR, p<0.05) Multivariable, increment DeMFS, high risk group 1.11 (RR, p<0.05) Univariate, increment DMFS, total study group 1.09 (RR, p<0.05) Multivariable, increment DMFS, total study group 1.19 (RR, p<0.05) Univariate, increment DeMFS, total study group 1.17 (RR, p<0.05) Multivariable, increment DeMFS, total study group 1.14 (RR, p<0.05) Univariate, increment DMFS, high risk group 1.14 (RR, p<0.05) Multivariable, increment DMFS, high risk group 1.22 (RR, p<0.05) Univariate, increment DeMFS, high risk group 1.17 (RR, p<0.05) Multivariable, increment DeMFS, high risk group 1.06 (RR, p<0.05) Univariate, increment DMFS, total study group NS Multivariable, increment DMFS, total study group 1.09 (RR, p<0.05) Univariate, increment DeMFS, total study group NS (RR, p<0.05) Multivariable, increment DeMFS, total study group NS for any of the high risk group models	12 years old at baseline followed for 4 years (n=3,373) [Sweden]	Bivariate and multivariable associations with two outcomes: (1) DMFS increment and (2) DeMFS increment -enamel caries on proximal surfaces included in index. Poisson regression with over-dispersion used to analyze incidence rate. Evaluated for total population and "high risk." High risk identified as -having >1 decayed proximal surface, enamel or dentine caries, filled proximal surface or missing tooth because of caries, or -dentist found patient had high risk due to mental/physical disability or chronic disease, or -CFU>10(5) - lactobacillus test Children randomly assigned to one of our preventive programs: (1) tooth-brushing, (2) fluoride lozenges prescription, (3) fluoride varnish, (4) individual program - counseling dental hygiene and nutrition; professional cleaning and FV.	Källestal C, Fjelddahl A. A four-year cohort study of caries and its risk factors in adolescents with high and low risk at baseline. Swed Dent J 2007;31:11–25.
Toothbrushing<1/day **Fluoride not specified - separate question about fluoride toothpaste that was NS** Comparing three groups of children: (A) caries free at baseline and follow-up, (B) caries free at baseline with caries at follow-up, (C) caries at baseline and follow-up. Two comparisons among the three groups: (A) and (B) compared; (B) and (C) compared. **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years (baseline for this study): 11% had initial or manifest caries. At 3.5 years: 37% initial/manifest.	1.8 (OR, p<0.01) Univariate Group B v. Group A NS Group C v. Group B	Children 2.5 years at baseline with 1-year follow-up (n=692) [Stockholm, Sweden]	Univariate analysis of each variable comparing children (A) caries free at baseline and follow-up, (B) caries free at baseline with caries at follow-up, (C) caries at baseline and follow-up - (A) and (B) compared; (B) and (C) compared.	Grindefjord M, Dahllöf G, Modéer T. Caries development in children from 2.5 to 3.5 years of age: a longitudinal study. Caries Res 1995;29:449–54.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Toothbrushing<1/day **Fluoride not specified - separate question about fluoride toothpaste** **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years: 11% had initial or manifest caries; 7% had one or more manifest lesions. At 3.5 years: 37% initial/manifest; 29% manifest.	2.7 (OR, p<0.001) Univariate (manifest caries at 3.5 years) NS Multivariate (initial/manifest at 2.5 y) NS Multivariate (manifest at 3.5 y)	Children 1 year at baseline with follow up at 2.5 and 3.5 years of age (n=692) [Stockholm, Sweden]	Univariate and logistic multivariate regression for association with outcomes: initial/manifest caries at 2.5 years of age and manifest caries at 3.5 years of age (versus not). Initial caries - loss of translucency and slight roughness on probing (chalky appearance); Manifest - minimal level verified as a cavity detectable by probing; and catch of probe under slight pressure for fissures.	Grindefjord M, Dahllöf G, Nilsson B, Modéer T. Stepwise prediction of dental caries in children up to 3.5 years of age. Caries Res 1996;30:256–66.
No fluoride toothpaste (separate question from toothbrushing) **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years: 11% had initial or manifest caries; 7% had one or more manifest lesions. At 3.5 years: 37% initial/manifest; 29% manifest.	1.5 (OR, p<0.05) Univariate (manifest caries at 3.5 years) NS Multivariate (initial/manifest at 2.5 y) NS Multivariate (manifest at 3.5 y)	Children 1 year at baseline with follow up at 2.5 and 3.5 years of age (n=692) [Stockholm, Sweden]	Univariate and logistic multivariate regression for association with outcomes: initial/manifest caries at 2.5 years of age and manifest caries at 3.5 years of age (versus not). Initial caries - loss of translucency and slight roughness on probing (chalky appearance); Manifest - minimal level verified as a cavity detectable by probing.	Grindefjord M, Dahllöf G, Nilsson B, Modéer T. Stepwise prediction of dental caries in children up to 3.5 years of age. Caries Res 1996;30:256–66.
Toothbrushing frequency (separate variables for at least once daily and at least twice daily); **fluoride not specified** Note: Baseline caries experience: Mean dmfs, Grade 1, Aiken: 9.3, Portland: 2.9 Mean dmfs Grade 5, Aiken: 4.4, Portland: 2.4 Mean DMFS Grade 1, Aiken: 0.3, Portland: 0.2 Mean DMFS Grade 5, Aiken: 3.0, Portland: 1.7	NS <u>Note: Comparison to "any risk" in Beck et al. 1992 where "any risk" is a DMFS increment of 1 or more:</u> 0.93 - 2.03 (OR) Significant in 2 of 4 cohorts, but opposite signs	Two cohorts (Grade 1 and Grade 5) at two sites (Aiken, SC and Portland, ME) with 3-year follow-up (n=4158)	Backward stepwise logistic regression for outcome: high risk based on 3-year DMFS increment (final DMFS-baseline DMFS) where high risk definition varied by cohort	Disney JA, Graves RC, Stamm JW, Bohannan HM, Abernathy JR, Zack DD. The University of North Carolina Caries Risk Assessment study: further developments in caries risk prediction. Community Dent Oral Epidemiol 1992;20: 64–75.
Note: Dependent variable is *no* carious lesions at 3 yrs Baseline toothbrushing frequency (>=1/day) Toothbrushing frequency at 2 years of age	<u>Stepwise Multivariate Logistic Regression Results</u> NS 2.86 (OR, p=0.002)	1 year at baseline, followed for 2 years (n=289) [Jonkoping, Sweden]	Bivariate and multivariate (stepwise logistic regression) association with outcome: absence of carious lesions (manifest or initial) at 3 years of age.	Wendt LK, Hallonsten AL, Koch G, Birkhed D. Analysis of caries-related factors in infants and toddlers living in Sweden. Acta Odontol Scand 1996;54:131–7.
Tooth brushing frequency (<1/day, 1/day, 2+/day) **Fluoride not specified.** <1/day (vs. 2+/day) 1/day (vs. 2+day) **Note:** Baseline carious surfaces (mean): 9.4 At 5-year following, net **increment** of carious surfaces (mean): 6.9	1.37 (RR, p=0.04) Multivariate, 5-year net increment carious TEETH 1.45 (RR, p=0.04) Multivariate, 5-year net increment carious SURFACES NS Multivariate, 5-year net increment carious TEETH NS Multivariate, 5-year net increment carious SURFACES <u>Mean 5-year increment carious teeth</u> Toothbrushing frequency <1/day: 5.6 mean increment 1/day: 4.5 2+/day: 4.2 <u>Mean 5-year increment carious surfaces</u> Toothbrushing frequency <1/day: 9.0 mean increment 1/day: 7.2 2+/day: 6.3	6-10 years old at baseline followed for 5 years (n=429) [Boston, MA and Farmingham, ME] **Note:** Sample were high-risk children enrolled in the New England Children's Amalgam Trial - additional inclusion criteria were no prior amalgam restorations and having at least two decayed posterior occulsal surfaces All participants received restorations of baseline caries and sealants and comprehensive semiannual dental care.	Bivariate and multivariable associations with two outcomes: (1) 5-year increment of carious teeth and (2) 5-year increment of carious surfaces. Carious/filled surfaces measured from date of baseline visit through date of final study dental visit. Caries in both primary and permanent dentition were summed to obtain cumulative incident disease burden (net caries increment). Factors associated with caries increment at a level of p>0.15 entered into preliminary multivariate model; final multivariate model included variables significant at p<0.05 or changed coefficients of other variables more than 10%. Multivariate analyses conducted using negative binomial model.	Maserejian NN, Tavares MA, Hayes C, Soncini JA, Trachtenberg FL. Prospective study of 5-year caries incre-ment among children receiving comprehensive dental care in the New England children's amalgam trial. Community Dent Oral Epidemiol 009;37:9–18.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Child brushes less than twice a day **fluoride not specified** **Note:** Baseline mean age was 9.7 years Baseline mean ICDAS>=1: 15.7 Baseline mean ICDAS>=3: 8.2 12-month mean ICDAS>=1: 17.9 -89% of children 12-month mean ICDAS>=3: 8.4 -61% of children 24-month mean ICDAS>=1: 16.8 -91% of children 242-month mean ICDAS>=3: 8.4 -68% of children	**Bivariate association with Caries Progression (significant or NS using logistic regression - specific values not reported)** New ICDAS>=1 at 24 months: NS New ICDAS>=3 at 24 months: NS **Multivariate Caries Risk Models** NS - Not included in any of the final models	5-13 years of age with 2-year follow-up (n=395) [Aguas Buenas, Puerto Rico]	Logistic regression for progression outcomes (see below) at 12/24 months; for each predictor individually; multiple regression developed using backward elimination retaining predictors p<0.05 with AUC/ROC calculated for final models at model level; Poisson regression for number of lesions with progression Two Outcomes: 1. Any progression (ICDAS>=1): at least one new lesion ICDAS>=1, one new filling, and/or progression of lesion from scores of 1-2 to 3 to higher or from 3-4 to 5 to higher between the two exams. 2. Progession toward cavitation (ICDAS>=3): at least one new lesion ICDAS>=3, one new filling, and/or progression of lesion from score of 1-2 to 3 or higher or from 3-4 to 5 or higher between the two exams. Models run for outcomes at 12 and 24 months; Models run without any baseline ICDAS; models run adding baseline ICDAS last; models run starting with baseline ICDAS score	Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.
Toothbrushing frequency during preceding week (<7 days or >=7 days); **NOTE: could be with or without toothpaste**	NS	Children 0-5 years at baseline followed for 2 years (n=788) [low-income African-American children in Detroit, Michigan]	Stepwise backward multiple regression, zero-inflated negative binomial models with outcomes: caries increment measured as (1) new d16mfs and (2) new d36mfs.	Ismail AI, Lim S, Sohn W, Willem JM. Determinants of early childhood caries in low-income African American young children. Pediatr Dent 2008;30:289–96.
Toothbrushing of child by mother (never or sometimes versus everyday) **fluoride not specified** **Note:** Baseline caries experience among 3 year olds was 41% with mean dmft of 1.70.	NS	646 mother-child pairs; children aged 1.5 and 3 years during examinations conducted between 1992 to 2005. [Ishii town, Tokushima Prefecture, Japan]	Multiple logistic regression of factors associated with outcome: presence of dental caries at age 3 years. Caries was based on WHO methodology; recorded as present when lesion in pit/fissure, or on a smooth tooth surface, has detectably softened floor, undermined enamel, or softened wall; dmft recorded.	Niji R, Arita K, Abe Y, Lucas ME, Nishino M, Mitome M. Maternal age at birth and other risk factors in early childhood caries. Pediatr Dent 2010;32:493–8.
Supervised brushing=brushed at least twice a day (vs less frequently) **fluoride not specified** **Note:** Baseline caries prevalence among 3 year olds was 20.1% d1-5 mfs and 6.6% d3-5 mfs. Caries prevalence at 5 years was 48.0% d15mfs and 19.1% d3-5mfs.	2.5 (0R, p<0.05) Bivariate NS Multivariate	Children 3 years of age followed up at age 5 years (n=304) [Oslo, Norway]	Bivariate and multiple logistic regression of factors associated with outcome: positive severe caries increment (change in d3-5mfs). 5 grade caries diagnostic system: grades 1-2=enamel lesions; 3-5 dentine lesions. Caries increment=change d1-5mfs Severe caries increment=change d3-5mfs Molar-approximal caries excluded from caries increment calculations.	Skeie MS, Espelid I, Riordan PJ, Klock KS. Caries increment in children aged 3-5 years in relation to parents' dental attitudes: Oslo, Norway 2002 to 2004. Community Dent Oral Epidemiol 2008;36:441–50.
Level 4 - Frequency of tooth brushing >=1 time per day (vs. less) **fluoride not specified** **Note:** ECC prevalence at baseline (8 months) = 0; 14 months = 0; 20 months =1.6%; 26 months = 11.1%; 32 months=28.4%.	NS Within level multivariable analysis Not included Final model with all five levels, using sequential stepwise GEE IDR = Incidence density ratio = incidence density among those exposed and not exposed to independent variable.	Children 8 months of age with six month follow-ups through 32 months of age (2-year follow up) (n=255 at recruitment; 155 at last follow-up) [Guangzhou, China]	Generalized estimating equations used to assess relationship with outcome: incidence density of a tooth surface developing caries, which is the number of new caries-affected surfaces per surface time at risk. Incidence density ratio = incidence density among those exposed and not exposed to independent variable. Sequential stepwise GEE using 5-level model (1=socioeconomic/demographic vars; 2=developmental characteristics; 3=nutritional upbringing including feeding/nutrition; 4=oral health behaviors; 5= S. mutans)	Zhou Y, Yang JY, Lo EC, Lin HC. The contribution of life course determinants to early childhood caries: a 2–year cohort study. Caries Res 2012;46:87–94.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Fluoride "regular" uses (not well defined) **Note:** Occurrence of children with cavitated caries or fillings (d3mfs>0) at 2 years of age was 3%. At age 5 years, 23% .	NS Univariate 0.53 (SN), 0.59 (SP), 0.56 (AUC)	2 years at baseline; followed for 3 years (n=226) [Saarijarvi, Finland]	Bivariate and multivariate (using forward stepwise logistic regression) association with outcome: 3-year increment of cavitated carious lesions and/or fillings - measured as the increase of d3mfs from age of 2 years	Pienihakkinen, Jokela & Alanen. Assessment of Caries Risk in Preschool Children. Caries Res 2004;38:156-162.
Drinks fluoridated water				
Composite water fluoride levels based on main sources of water Note: % with new non-cavitated caries at first exam, primary dentition: 21.15%; % with new cavitated caries at first exam, primary dentition: 26.28%	NS New non-cavitated caries NS New cavitated caries	Children tracked from birth through 13 years old (n=156) [Iowa]	Multivariable model (GLMM based on negative binomial distribution) of association with: (1) new non-cavitated caries and (2) new cavitated caries (repeated measures analysis with measurements at 3-5 y, 6-8 y, and 11-13 y)	Chankanka et al. Longitudinal Associations between Children's Dental Caries and Risk Factors. J Public Health Dent 2011;71:289-300.
Never lived in non-fluoridated community Note: At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	NS Prediction model w/o biological factors (change dmft>0) NS Prediction model w/ biological factors (change dmft>0) 0.68 (OR, p<0.05) Risk model w/o biological factors (change dmft>0) NS Risk model w/biological factors (change dmft>0) NS Community high risk model; questionnaire (baseline dmft>0)	Children aged 3-6 years with one-year follow-up (n=1,576). [Singapore]	Multiple stepwise logistic regression for association with outcome: one-year caries increment measured as change in dmft. Data from 50% children used for model construction; remainder for model validation. Prediction (all potential factors) and risk models (subset of modifiable factors) with and without biological tests examined. Also, community screening model for identify "high risk" using a questionnaire - high risk = 25% of children with high caries burden (baseline dmft>2 for population studied).	Gao XL, Hsu CY, Xu Y, Hwarng HB, Loh T, Koh D. Building caries risk assessment models for children. J Dent Res 2010;89:637–43.
Fluoride in drinking level (based on clinic nurse report) <1.0 ppm vs. >=1.0 ppm **Note:** Baseline total population % with DMFS=0: 47% Baseline high risk % with DMFS=0: 28% Baseline DMFS, total population, 12 yrs old (mean)=1.67 Baseline DMFS, high risk, 12 yrs old (mean)=2.87 Baseline DeMFS, total population, 12 years old (mean)=2.40 Baseline DeMFS, high risk, 12 yrs old (mean)=4.67 DMFS, total population, 16 yrs old (mean)=3.69 DMFS, high risk, 16 yrs old (mean)=5.95 DeMFS, total population, 16 years old (mean)=6.42 DeMFS, high risk, 16 yrs old (mean)=10.03	1.05 (RR, p<0.05) Univariate, increment DMFS, total study group 1.05 (RR, p<0.05) Multivariable, increment DMFS, total study group 1.10 (RR, p<0.05) Univariate, increment DeMFS, total study group NS Multivariable, increment DeMFS, total study group NS in any of the high risk group models.	12 years old at baseline followed for 4 years (n=3,373) [Sweden]	Bivariate and multivariable associations with two outcomes: (1) DMFS increment and (2) DeMFS increment -enamel caries on proximal surfaces included in index. Poisson regression with over-dispersion used to analyze incidence rate. Evaluated for total population and "high risk." High risk identified as -having >1 decayed proximal surface, enamel or dentine caries, filled proximal surface or missing tooth because of caries, or -dentist found patient had high risk due to mental/physical disability or chronic disease, or -CFU>10(5) - lactobacillus test Children randomly assigned to one of our preventive programs: (1) tooth-brushing, (2) fluoride lozenges prescription, (3) fluoride varnish, (4) individual program - counseling dental hygiene and nutrition; professional cleaning and FV.	Källestal C, Fjelddahl A. A four-year cohort study of caries and its risk factors in adolescents with high and low risk at baseline. Swed Dent J 2007;31:11–25.
Drinking water type (bottled vs tap) Water source (well vs municipal supply) **Note:** Baseline carious surfaces (mean): 9.4 At 5-year following, net **increment** of carious surfaces (mean): 6.9	Neither of these variables were significantly associated with 5-year increment in bivariate/multivariate models.	6-10 years old at baseline followed for 5 years (n=429) [Boston, MA and Farmingham, ME] **Note:** Sample were high-risk children enrolled in the New England Children's Amalgam Trial - additional inclusion criteria were no prior amalgam restorations and having at least two decayed posterior occulsal surfaces All participants received restorations of baseline caries and sealants and comprehensive semiannual dental care.	Bivariate and multivariable associations with two outcomes: (1) 5-year increment of carious teeth and (2) 5-year increment of carious surfaces. Carious/filled surfaces measured from date of baseline visit through date of final study dental visit. Caries in both primary and permanent dentition were summed to obtain cumulative incident disease burden (net caries increment). Factors associated with caries increment at a level of p>0.15 entered into preliminary multivariate model; final multivariate model included variables significant at p<0.05 or changed coefficients of other variables more than 10%. Multivariate analyses conducted using negative binomial model.	Maserejian NN, Tavares MA, Hayes C, Soncini JA, Trachtenberg FL. Prospective study of 5-year caries incre-ment among children receiving comprehensive dental care in the New England children's amalgam trial. Community Dent Oral Epidemiol 009;37:9–18.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population Note: *n* represents sample size at final follow-up	Relationship Examined	Study
Type of water child drinks (well, bottled, tap) **Note:** Baseline mean age was 9.7 years Baseline mean ICDAS>=1: 15.7 Baseline mean ICDAS>=3: 8.2 12-month mean ICDAS>=1: 17.9 -89% of children 12-month mean ICDAS>=3: 8.4 -61% of children 24-month mean ICDAS>=1: 16.8 -91% of children 242-month mean ICDAS>=3: 8.4 -68% of children	**Bivariate association with Caries Progression (significant or NS using logistic regression - specific values not reported)** New ICDAS>=1 at 24 months: NS New ICDAS>=3 at 24 months: NS **Multivariate Caries Risk Models** NS - Not included in any of the final models	5-13 years of age with 2-year follow-up (n=395) [Aguas Buenas, Puerto Rico]	Logistic regression for progression outcomes (see below) at 12/24 months; for each predictor individually; multiple regression developed using backward elimination retaining predictors p<0.05 with AUC/ROC calculated for final models at model level; Poisson regression for number of lesions with progression Two Outcomes: 1. Any progression (ICDAS>=1): at least one new lesion ICDAS>=1, one new filling, and/or progression of lesion from scores of 1-2 to 3 to higher or from 3-4 to 5 to higher between the two exams. 2. Progession toward cavitation (ICDAS>=3): at least one new lesion ICDAS>=3, one new filling, and/or progression of lesion from score of 1-2 to 3 or higher or from 3-4 to 5 or higher between the two exams. Models run for outcomes at 12 and 24 months; Models run without any baseline ICDAS; models run adding baseline ICDAS last; models run starting with baseline ICDAS score	Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.
Piped water supply (yes vs. no) **Note:** Baseline primary dental caries at 6 yrs (DMFT>0): 63%	NS in initial bivariate tests	Study nested within a population based cohort with dental exams and interviews performed at 6 and 12 years of age (n=339) [Pelotas, Brazil]	Bivariate and multivariable associations with outcome: DMFT at 12 years old. Multivariate analyses were conducted using Poisson regression to generate relative risk ratio and logistic regression (backward stepwise) to predict dental caries at age 12 years. Variables grouped into hierarchical model with 6 levels: (1) socioeconomic/demographic, (2) nutritional/development characteristics, (3) OH behaviors and dental service use at age 6, (4) primary dental caries at 6 yrs, (5) family economic level at 12 yrs, (6) OH related behaviors and dental service use at 12 yrs. At each level, variables excluded if p>0.25. Final model variables retained if p<=0.05.	Peres MA, Barros AJ, Peres KG, Araujo CL, Menezes AM. Life course dental caries determinants and predictors in children aged 12 years: a population-based birth cohort. Community Dent Oral Epidemiol 2009;37:123–33.
Prescription home-use products (e.g. high concentration fluoride toothpastes)				
Assigned preventive program: prescription fluoride lozenges (vs. tooth-brushing) **Note:** Baseline total population % with DMFS=0: 47% Baseline high risk % with DMFS=0: 28% Baseline DMFS, total population, 12 yrs old (mean)=1.67 Baseline DMFS, high risk, 12 yrs old (mean)=2.87 Baseline DeMFS, total population, 12 years old (mean)=2.40 Baseline DeMFS, high risk, 12 yrs old (mean)=4.67 DMFS, total population, 16 yrs old (mean)=3.69 DMFS, high risk, 16 yrs old (mean)=5.95 DeMFS, total population, 16 years old (mean)=6.42 DeMFS, high risk, 16 yrs old (mean)=10.03	NS Univariate, increment DeMFS, total study group NS Multivariable, increment DeMFS, total study group NS (RR, p<0.05) Univariate, increment DeMFS, high risk group NS (RR, p<0.05) Multivariable, increment DeMFS, high risk group	12 years old at baseline followed for 4 years (n=3,373) [Sweden]	Bivariate and multivariable associations with two outcomes: (1) DMFS increment and (2) DeMFS increment -enamel caries on proximal surfaces included in index. Poisson regression with over-dispersion used to analyze incidence rate. Evaluated for total population and "high risk." High risk identified as -having >1 decayed proximal surface, enamel or dentine caries, filled proximal surface or missing tooth because of caries, or -dentist found patient had high risk due to mental/physical disability or chronic disease, or -CFU>10(5) - lactobacillus test Children randomly assigned to one of our preventive programs: (1) tooth-brushing, (2) fluoride lozenges prescription, (3) fluoride varnish, (4) individual program - counseling dental hygiene and nutrition; professional cleaning and FV.	Källestal C, Fjelddahl A. A four-year cohort study of caries and its risk factors in adolescents with high and low risk at baseline. Swed Dent J 2007;31:11–25.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
In-office applied fluoride products (e.g. fluoride varnish)				
Professional fluoride (Regularly, Occasionally, No) **Note:** Baseline mean age was 9.7 years Baseline mean ICDAS>=1: 15.7 Baseline mean ICDAS>=3: 8.2 12-month mean ICDAS>=1: 17.9 -89% of children 12-month mean ICDAS>=3: 8.4 -61% of children 24-month mean ICDAS>=1: 16.8 -91% of children 242-month mean ICDAS>=3: 8.4 -68% of children	**Bivariate association with Caries Progression (significant or NS using logistic regression - specific values not reported)** New ICDAS>=1 at 24 months: NS New ICDAS>=3 at 24 months: NS **Multivariate Caries Risk Models** NS - not included in any of the final models.	5-13 years of age with 2-year follow-up (n=395) [Aguas Buenas, Puerto Rico]	Logistic regression for progression outcomes (see below) at 12/24 months; for each predictor individually; multiple regression developed using backward elimination retaining predictors p<0.05 with AUC/ROC calculated for final models at model level; Poisson regression for number of lesions with progression Two Outcomes: 1. Any progression (ICDAS>=1): at least one new lesion ICDAS>=1, one new filling, and/or progression of lesion from scores of 1-2 to 3 to higher or from 3-4 to 5 to higher between the two exams. 2. Progession toward cavitation (ICDAS>=3): at least one new lesion ICDAS>=3, one new filling, and/or progression of lesion from score of 1-2 to 3 or higher or from 3-4 to 5 or higher between the two exams. Models run for outcomes at 12 and 24 months; Models run without any baseline ICDAS; models run adding baseline ICDAS last; models run starting with baseline ICDAS score	Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.
Assigned preventive program: fluoride varnish (vs. tooth-brushing) **Note:** Baseline total population % with DMFS=0: 47% Baseline high risk % with DMFS=0: 28% Baseline DMFS, total population, 12 yrs old (mean)=1.67 Baseline DMFS, high risk, 12 yrs old (mean)=2.87 Baseline DeMFS, total population, 12 years old (mean)=2.40 Baseline DeMFS, high risk, 12 yrs old (mean)=4.67 DMFS, total population, 16 yrs old (mean)=3.69 DMFS, high risk, 16 yrs old (mean)=5.95 DeMFS, total population, 16 years old (mean)=6.42 DeMFS, high risk, 16 yrs old (mean)=10.03	0.93 (RR, p<0.05) Univariate, increment DeMFS, total study group 0.90 (RR, p<0.05) Multivariable, increment DeMFS, total study group 0.93 (RR, p<0.05) Univariate, increment DeMFS, high risk group 0.90 (RR, p<0.05) Multivariable, increment DeMFS, high risk group	12 years old at baseline followed for 4 years (n=3,373) [Sweden]	Bivariate and multivariable associations with two outcomes: (1) DMFS increment and (2) DeMFS increment -enamel caries on proximal surfaces included in index. Poisson regression with over-dispersion used to analyze incidence rate. Evaluated for total population and "high risk." High risk identified as -having >1 decayed proximal surface, enamel or dentine caries, filled proximal surface or missing tooth because of caries, or -dentist found patient had high risk due to mental/physical disability or chronic disease, or -CFU>10(5) - lactobacillus test Children randomly assigned to one of our preventive programs: (1) tooth-brushing, (2) fluoride lozenges prescription, (3) fluoride varnish, (4) individual program - counseling dental hygiene and nutrition; professional cleaning and FV.	Källestal C, Fjelddahl A. A four-year cohort study of caries and its risk factors in adolescents with high and low risk at baseline. Swed Dent J 2007;31:11–25.
Professional topical fluoride (yes/no) **Note:** Baseline: DF=0.054	Logistic Regression NS, Multivariate, all factors Not included, Multivariate, stepwise Not included, Multivariate, most robust based on balancing technique Note: Overall study finding: decision analysis produced better prediction models than logistic regression or neural network approaches. Significant predictors in this approach were MS levels, LB, salivary pH, gender, and sweet beverages.	5-6 years at baseline, followed for 3 years (n=500) [Gifu Prefecture, Japan]	Outcome: new incident dental caries of the permanent teeth; 3 approaches: (1) conventional modeling, (2) neural network, C5.0 - tool for discovering patterns in databases and used to make predictions. Logistic regression analyses were conducted for a full model with all variables as well as using stepwise selection. Neural network model had 12 input layers, 3 hidden layers, and 1 output layer. C5.0 models work by sequenced sample splitting based on fields providing the maximum information gained. Balancing technique applied. Total of 10 balanced sample sets applied to the models. Model selection based on highest mean of sum of SN and SP.	Tamaki Y, Nomura Y, Katsumura S, Okada A, Yamada H, Tsuge S, et al. Construction of a dental caries prediction model by data mining. J Oral Sci 2009;51:61–8.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Over the counter fluoride products (e.g. mouth rinses)				
Fluoride mouthrinse (ever versus never used) Note: Baseline caries experience: Mean dmfs, Grade 1, Aiken: 9.3, Portland: 2.9 Mean dmfs Grade 5, Aiken: 4.4, Portland: 2.4 Mean DMFS Grade 1, Aiken: 0.3, Portland: 0.2 Mean DMFS Grade 5, Aiken: 3.0, Portland: 1.7	NS Note: Comparison to "any risk" in Beck et al. 1992 where "any risk" is a DMFS increment of 1 or more: NS	Two cohorts (Grade 1 and Grade 5) at two sites (Aiken, SC and Portland, ME) with 3-year follow-up (n=4158)	Backward stepwise logistic regression for outcome: high risk based on 3-year DMFS increment (final DMFS-baseline DMFS) where high risk definition varied by cohort	Disney JA, Graves RC, Stamm JW, Bohannan HM, Abernathy JR, Zack DD. The University of North Carolina Caries Risk Assessment study: further developments in caries risk prediction. Community Dent Oral Epidemiol 1992;20:64–75.
Fluoride mouthwash daily use (yes/no) **Note:** Baseline: DF=0.054	Logistic Regression NS, Multivariate, all factors Not included, Multivariate, stepwise 0.45 (OR, p=0.03), Multivariate, most robust based on balancing technique Note: Overall study finding: decision analysis produced better prediction models than logistic regression or neural network approaches. Significant predictors in this approach were MS levels, LB, salivary pH, gender, and sweet beverages.	5-6 years at baseline, followed for 3 years (n=500) [Gifu Prefecture, Japan]	Outcome: new incident dental caries of the permanent teeth; 3 approaches: (1) conventional modeling, (2) neural network, C5.0 - tool for discovering patterns in databases and used to make predictions. Logistic regression analyses were conducted for a full model with all variables as well as using stepwise selection. Neural network model had 12 input layers, 3 hidden layers, and 1 output layer. C5.0 models work by sequenced sample splitting based on fields providing the maximum information gained. Balancing technique applied. Total of 10 balanced sample sets applied to the models. Model selection based on highest mean of sum of SN and SP.	Tamaki Y, Nomura Y, Katsumura S, Okada A, Yamada H, Tsuge S, et al. Construction of a dental caries prediction model by data mining. J Oral Sci 2009;51:61–8.
Regular use of systemic fluoride supplements	1.54 (OR, p<0.001) Baseline NS Follow-Up	7 years old at baseline (n=3,303) with at least one follow-up by age 10 years (n=3,002) [Flanders, Belgium]	1. Cross-sectional multiple logistic regression with outcome: dmfs (caries v. no caries) in **permanent first molars** (baseline) 2. Stepwise multiple logistic regression with outcome: net caries increment on **permanent first molars** (0/1 additional surface affected v. 2 or more additional surfaces affected) calculated by subtracting baseline DMFS6 score from last available DMFS6 score [follow-up]	Vanobbergen J, Martens L, Lesaffre E, Bogaerts K, Declerck D. 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 2001;35:442–50.
Use of fluoride drops, tablets, or vitamins (yes 0/no 1) Note: Baseline caries experience: Mean dmfs, Grade 1, Aiken: 9.3, Portland: 2.9 Mean dmfs Grade 5, Aiken: 4.4, Portland: 2.4 Mean DMFS Grade 1, Aiken: 0.3, Portland: 0.2 Mean DMFS Grade 5, Aiken: 3.0, Portland: 1.7	NS Note: Comparison to "any risk" in Beck et al. 1992 where "any risk" is a DMFS increment of 1 or more: 1.55 (OR) Significant in 1 of 4 cohorts (One Grade 1)	Two cohorts (Grade 1 and Grade 5) at two sites (Aiken, SC and Portland, ME) with 3-year follow-up (n=4158)	Backward stepwise logistic regression for outcome: high risk based on 3-year DMFS increment (final DMFS-baseline DMFS) where high risk definition varied by cohort	Disney JA, Graves RC, Stamm JW, Bohannan HM, Abernathy JR, Zack DD. The University of North Carolina Caries Risk Assessment study: further developments in caries risk prediction. Community Dent Oral Epidemiol 1992;20: 64–75.
Previous use of fluoride supplements (versus not)	2.1 (OR, p=0.002), 0.55 (SN), 0.63 (SP) Baseline NS Multivariate	Kindergarten children (mean age 5 y 8m) followed up after one year (n=302) [Montreal, Canada]	Bivariate association and multivariate logistic regression for outcome: at least one new carious surface in primary teeth at one-year follow-up	Demers M, Brodeur JM, Mouton C, Simard PL, Trahan L, Veilleux G. A multivariate model to predict caries increment in Montreal children aged 5 years. Community Dent Health 1992;9:273–81.
No fluoride tablets Comparing three groups of children: (A) caries free at baseline and follow-up, (B) caries free at baseline with caries at follow-up, (C) caries at baseline and follow-up. Two comparisons among the three groups: (A) and (B) compared; (B) and (C) compared. **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years (baseline for this study): 11% had initial or manifest caries. At 3.5 years: 37% initial/manifest.	2.0 (OR, p<0.05) Univariate Group B v. Group A NS Group C v. Group B	Children 2.5 years at baseline with 1-year follow-up (n=692) [Stockholm, Sweden]	Univariate analysis of each variable comparing children (A) caries free at baseline and follow-up, (B) caries free at baseline with caries at follow-up, (C) caries at baseline and follow-up - (A) and (B) compared; (B) and (C) compared.	Grindefjord M, Dahllöf G, Modéer T. Caries development in children from 2.5 to 3.5 years of age: a longitudinal study. Caries Res 1995;29:449–54.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Use of fluorides other than fluoride toothpaste Note: At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	NS Prediction model w/o biological factors (change dmft>0) 0.42 (OR, p<0.05) Prediction model w/ biological factors (change dmft>0) NS Risk model w/o biological factors (change dmft>0) NS Risk model w/biological factors (change dmft>0) 2.63 (OR, p<0.05) Community high risk model; questionnaire (baseline dmft>0)	Children aged 3-6 years with one-year follow-up (n=1,576). [Singapore]	Multiple stepwise logistic regression for association with outcome: one-year caries increment measured as change in dmft. Data from 50% children used for model construction; remainder for model validation. Prediction (all potential factors) and risk models (subset of modifiable factors) with and without biological tests examined. Also, community screening model for identify "high risk" using a questionnaire - high risk = 25% of children with high caries burden (baseline dmft>2 for population studied). At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	Gao XL, Hsu CY, Xu Y, Hwarng HB, Loh T, Koh D. Building caries risk assessment models for children. J Dent Res 2010;89:637–43.
Child uses additional fluoride products at home (yes no) **Note:** Baseline mean age was 9.7 years Baseline mean ICDAS>=1: 15.7 Baseline mean ICDAS>=3: 8.2 12-month mean ICDAS>=1: 17.9 -89% of children 12-month mean ICDAS>=3: 8.4 -61% of children 24-month mean ICDAS>=1: 16.8 -91% of children 242-month mean ICDAS>=3: 8.4 -68% of children	**Bivariate association with Caries Progression (significant or NS using logistic regression - specific values not reported)** New ICDAS>=1 at 24 months: NS New ICDAS>=3 at 24 months: NS **Multivariate Caries Risk Models** **Note:** Total of 12 Multivariate Caries Risk Models: 2 outcomes, 2 time periods, 3 ways of handling baseline dmfs/DMFS (not included, added last, added first) NS- Not included in any of these models. **Multivariate Caries Risk Model for Identification of Number of Lesions Progressing** Note: Total of 12 Multivariate Caries Risk Models: 2 outcomes, 2 time periods, 3 ways of handling baseline dmfs/DMFS -Significant in 4 of 12 models	5-13 years of age with 2-year follow-up (n=395) [Aguas Buenas, Puerto Rico]	Logistic regression for progression outcomes (see below) at 12/24 months; for each predictor individually; multiple regression developed using backward elimination retaining predictors p<0.05 with AUC/ROC calculated for final models at model level; Poisson regression for number of lesions with progression Two Outcomes: 1. Any progression (ICDAS>=1): at least one new lesion ICDAS>=1, one new filling, and/or progression of lesion from scores of 1-2 to 3 to higher or from 3-4 to 5 to higher between the two exams. 2. Progession toward cavitation (ICDAS>=3): at least one new lesion ICDAS>=3, one new filling, and/or progression of lesion from score of 1-2 to 3 or higher or from 3-4 to 5 or higher between the two exams. Models run for outcomes at 12 and 24 months; Models run without any baseline ICDAS; models run adding baseline ICDAS last; models run starting with baseline ICDAS score	Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.
Self-administered fluoride (e.g., fluoride rinses, gums or lozenges) none vs. any kind **Note:** Baseline total population % with DMFS=0: 47% Baseline high risk % with DMFS=0: 28% Baseline DMFS, total population, 12 yrs old (mean)=1.67 Baseline DMFS, high risk, 12 yrs old (mean)=2.87 Baseline DeMFS, total population, 12 years old (mean)=2.40 Baseline DeMFS, high risk, 12 yrs old (mean)=4.67 DMFS, total population, 16 yrs old (mean)=3.69 DMFS, high risk, 16 yrs old (mean)=5.95 DeMFS, total population, 16 years old (mean)=6.42 DeMFS, high risk, 16 yrs old (mean)=10.03	NS in any of the models.	12 years old at baseline followed for 4 years (n=3,373) [Sweden]	Bivariate and multivariable associations with two outcomes: (1) DMFS increment and (2) DeMFS increment -enamel caries on proximal surfaces included in index. Poisson regression with over-dispersion used to analyze incidence rate. Evaluated for total population and "high risk." High risk identified as -having >1 decayed proximal surface, enamel or dentine caries, filled proximal surface or missing tooth because of caries, or -dentist found patient had high risk due to mental/physical disability or chronic disease, or -CFU>10(5) - lactobacillus test Children randomly assigned to one of our preventive programs: (1) tooth-brushing, (2) fluoride lozenges prescription, (3) fluoride varnish, (4) individual program - counseling dental hygiene and nutrition; professional cleaning and FV.	Källestal C, Fjelddahl A. A four-year cohort study of caries and its risk factors in adolescents with high and low risk at baseline. Swed Dent J 2007;31:11–25.

Summary of Study Results by Data Element: RISK FACTORS

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Deep pits and fissures				
Pit and fissure morphology score (shallow, moderate or deep) Note: Baseline caries experience: Mean dmfs, Grade 1, Aiken: 9.3, Portland: 2.9 Mean dmfs Grade 5, Aiken: 4.4, Portland: 2.4 Mean DMFS Grade 1, Aiken: 0.3, Portland: 0.2 Mean DMFS Grade 5, Aiken: 3.0, Portland: 1.7	1.08-1.10 (OR) Significant, 3 of 4 cohorts Note: Comparison to "any risk" in Beck et al. 1992 where "any risk" is a DMFS increment of 1 or more (Beck et al results below): 1.06-1.14 (OR) Significant, 2 of 4 cohorts	Two cohorts (Grade 1 and Grade 5) at two sites (Aiken, SC and Portland, ME) with 3-year follow-up (n=4158)	Backward stepwise logistic regression for outcome: high risk based on 3-year DMFS increment (final DMFS-baseline DMFS) where high risk definition varied by cohort	Disney JA, Graves RC, Stamm JW, Bohannan HM, Abernathy JR, Zack DD. The University of North Carolina Caries Risk Assessment study: further developments in caries risk prediction. Community Dent Oral Epidemiol 1992;20:64–75.
Fissure morphology **Note:** Fissure morphology determined based on degree of penetration of the periodontal probe-tine in both permanent first lower molars scored as: no penetration, minimal, and deep. **Note:** Baseline: 42% caries free; dmfs(mean) 5.5; DMFS(mean) 0.1 At 4 yrs: 29% caries free; dmfs(mean) 4.6; DMFS(mean) 0.6	p=0.011 (Pearson chi-square/Fisher exact test) Bivariate 19.10 (OR, p=0.024) Multivariable AUC/ROC: 0.57	6 years followed for 4 years (n=95) [Mexico City, Mexico]	Bivariate and multivariable (multiple logistic regression) associations with outcome: caries increment dichotomized as 0 newly affected vs. >=1 new surface affected. ROC/AUC calculated. Caries experience calculated as dmfs, DMFS and dfm+DMFS using WHO criteria. Two groups identified: caries-free and >=1 dmf+DMFS. Caries increment was most recent dmfs/DMFS score - baseline score.	Sanchez-Perez L, Golubov J, Irigoyen-Camacho ME, Moctezuma PA, Acosta-Gio E. Clinical, salivary, and bacterial markers for caries risk assessment in schoolchildren: a 4-year follow-up. Int J Paediatr Dent 2009;19:186–92.
Visible plaque on teeth				
Visible plaque **Note:** Occurrence of children with cavitated caries or fillings (d3mfs>0) at 2 years of age was 3%. At age 5 years, 23% .	2.52 (OR, p=0.02) Univariate NS Multivariate # sextants with visible plaque (012 versus 34+): 0.23 (SN), 0.95 (SP), 0.58 (AUC)	2 years at baseline; followed for 3 years (n=226) [Saarijarvi, Finland]	Bivariate and multivariate (using forward stepwise logistic regression) association with outcome: 3-year increment of cavitated carious lesions and/or fillings - measured as the increase of d3mfs from age of 2 years (degree 1 - opaque/discolored; degree 2 - early dentinal lesions no clinical cavity; degree 3- defect found on surface and restorative treatment necessary)	Pienihakkinen, Jokela & Alanen. Assessment of Caries Risk in Preschool Children. Caries Res 2004;38:156-162.
Plaque index (average Plaque Index, continuous) Note: At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	5.05 (OR, p<0.05) Prediction model w/o biological factors (change dmft>0) 8.90 (OR, p<0.05) Prediction model w/ biological factors (change dmft>0) 9.06 (OR, p<0.05) Risk model w/o biological factors (change dmft>0) 7.37 (OR, p<0.05) Risk model w/biological factors (change dmft>0) Not included Community high risk model; questionnaire (baseline dmft>0)	Children aged 3-6 years with one-year follow-up (n=1,576). [Singapore]	Multiple stepwise logistic regression for association with outcome: one-year caries increment measured as change in dmft. Data from 50% children used for model construction; remainder for model validation. Prediction (all potential factors) and risk models (subset of modifiable factors) with and without biological tests examined. Also, community screening model for identify "high risk" using a questionnaire - high risk = 25% of children with high caries burden (baseline dmft>2 for population studied). At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	Gao XL, Hsu CY, Xu Y, Hwarng HB, Loh T, Koh D. Building caries risk assessment models for children. J Dent Res 2010;89:637–43.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Visible plaque at 3 years of age "No visible plaque" = no or minor amount of loose plaque "Visible plaque" = firmly attached plaque found on some or all teeth Note: At 3 years of age (baseline): 16% (n=21) had caries experience including enamel lesions. At 6 years of age, this increased to 40% (n=54).	NS Association with caries experience at age 6.	Children 3 years at baseline with follow up at 6 years of age (n=135) [Turku, Finland]	Bivariate association between factors (sweet intake and visible plaque) and outcome: caries experience by age 6. Caries experience is total experience and not increment. Caries experience includes enamel lesions as well as dentin lesions/fillings.	Karjalainen S, Söderling E, Sewon L, Lapinleimu H, Simell O. A prospective study on sucrose consumption, visible plaque and caries in children from 3 to 6 years of age. Community Dent Oral Epidemiol 01;29:136–42.
Level 4 - Visible plaque proportion >=20% (vs. 0) Level 4 - Visible plaque proportion <20% (vs. 0) Used visible plaque index. **Note:** ECC prevalence at baseline (8 months) = 0; 14 months = 0; 20 months =1.6%; 26 months = 11.1%; 32 months=28.4%.	1.67 (IDR, p=0.007 Within level multivariable analysis Not included Final model with all five levels, using sequential stepwise GEE 9.11 (IDR, p=0.10) Within level multivariable analysis NS Final model with all five levels, using sequential stepwise GEE	Children 8 months of age with six month follow-ups through 32 months of age (2-year follow up) (n=255 at recruitment; 155 at last follow-up) [Guangzhou, China]	Generalized estimating equations used to assess relationship with outcome: incidence density of a tooth surface developing caries, which is the number of new caries-affected surfaces per surface time at risk. Incidence density ratio = incidence density among those exposed and not exposed to independent variable. Sequential stepwise GEE using 5-level model (1=socioeconomic/demographic vars; 2=developmental characteristics; 3=nutritional upbringing including feeding/nutrition; 4=oral health behaviors; 5= S. mutans)	Zhou Y, Yang JY, Lo EC, Lin HC. The contribution of life course determinants to early childhood caries: a 2–year cohort study. Caries Res 2012;46:87–94.
Note: Dependent variable is *no* carious lesions at 3 yrs No visible plaque at baseline No visible plaque at 2 yrs of age *Plaque noted when visible on buccal surfaces of maxillary incisors	<u>Stepwise Multivariate Logistic Regression Results</u> 4.50 (OR, p=0.005 3.55 (OR, p=0.003)	1 year at baseline, followed for 2 years (n=289) [Jonkoping, Sweden]	Bivariate and multivariate (stepwise logistic regression) association with outcome: absence of carious lesions (manifest or initial) at 3 years of age.	Wendt LK, Hallonsten AL, Koch G, Birkhed D. Analysis of caries-related factors in infants and toddlers living in Sweden. Acta Odontol Scand 1996;54:131–7.
Baseline visible plaque on labial surfaces of upper incisors **Note:** Baseline caries prevalence: 32.7% Caries prevalence at 1-year follow-up: 56.4%	NS, Bivariate, Caries incidence mean at follow up NS, Bivariate, High caries incidence at follow up (vs. low caries incidence) SN (0.78), SP (0.58), % correctly classified: 59%	12-30 months at baseline with one-year follow up (n=101) [Piracicaba, SP, Brazil]	Bivariate associations with outcomes: (1) caries incidence at follow up and (2) high caries incidence at follow up. Caries definitions •Initial caries lesion: demineralized surface having only loss of translucency •Manifest lesion: lesion with definite cavitation •Caries incidence: sum of new initial and manifest caries plus initial caries detected at baseline that progress to manifest caries during study •High caries incidence: development of 3 or more new manifest lesions during one-year follow-up	R.O. Mattos-Graner, D.J. Smith, W.F. King, M.P. Mayer, Water-insoluble glucan synthesis by mutans streptococcal strains correlates with caries incidence in 12- to 30-month-old children, J. Dent. Res. 79 (2000) 1371–1377.
Difficulty with home care due to physical or behavioral reasons				

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Frequent sugar consumption (e.g. sugary drinks, snacks rich in fermentable carbohydrates)				
Snacking between meals (sugar/chips/cereal versus all other) Note: Baseline caries experience: Mean dmfs, Grade 1, Aiken: 9.3, Portland: 2.9 Mean dmfs Grade 5, Aiken: 4.4, Portland: 2.4 Mean DMFS Grade 1, Aiken: 0.3, Portland: 0.2 Mean DMFS Grade 5, Aiken: 3.0, Portland: 1.7	NS Note: Comparison to "any risk" in Beck et al. 1992 where "any risk" is a DMFS increment of 1 or more (Beck et al results below): NS	Two cohorts (Grade 1 and Grade 5) at two sites (Aiken, SC and Portland, ME) with 3-year follow-up (n=4158)	Backward stepwise logistic regression for outcome: high risk based on 3-year DMFS increment (final DMFS-baseline DMFS) where high risk definition varied by cohort	Disney JA, Graves RC, Stamm JW, Bohannan HM, Abernathy JR, Zack DD. The University of North Carolina Caries Risk Assessment study: further developments in caries risk prediction. Community Dent Oral Epidemiol 1992;20: 64–75.
Note: Dependent variable is *no* carious lesions at 3 yrs No intake sugar-containing liquid in bottle at baseline No intake sugar-containing liquid in bottle at 2 yrs old No intake sugar-containing liquid when thirsty at baseline No intake sugar-containing liquid when thirsty at 2 yrs old No intake sugar-containing liquid during the night at baseline No intake sugar-containing liquid during the night at 2 yrs old Softdrinks at baseline Soft drinks less than 2/week at 2 yrs old Ice cream at baseline Ice cream at 2 yrs old Sweets at baseline Sweets at 2 years old	Stepwise Multivariate Logistic Regression Results NS NS 2.26 (OR, p=0.002) NS NS 23.66 (OR, p=0.010) NS 2.42 (OR, p=0.021) NS NS NS NS	1 year at baseline, followed for 2 years (n=289) [Jonkoping, Sweden]	Bivariate and multivariate (stepwise logistic regression) association with outcome: absence of carious lesions (manifest or initial) at 3 years of age.	Wendt LK, Hallonsten AL, Koch G, Birkhed D. Analysis of caries-related factors in infants and toddlers living in Sweden. Acta Odontol Scand 1996;54:131–7.
Level 4 - Frequency of eating sweets >=1 time per day (vs. less) **Note:** ECC prevalence at baseline (8 months) = 0; 14 months = 0; 20 months =1.6%; 26 months = 11.1%; 32 months=28.4%.	1.35 (IDR, p=0.098) Within level multivariable analysis *Although p<0.05, retained all variables p<0.25 in stepwise regression 2.25 (IDR,p=0.13) Final model with all five levels, using sequential stepwise GEE	Children 8 months of age with six month follow-ups through 32 months of age (2-year follow up) (n=255 at recruitment; 155 at last follow-up) [Guangzhou, China]	Generalized estimating equations used to assess relationship with outcome: incidence density of a tooth surface developing caries, which is the number of new caries-affected surfaces per surface time at risk. Incidence density ratio = incidence density among those exposed and not exposed to independent variable. Sequential stepwise GEE using 5-level model (1=socioeconomic/demographic vars; 2=developmental characteristics; 3=nutritional upbringing including feeding/nutrition; 4=oral health behaviors; 5= S. mutans)	Zhou Y, Yang JY, Lo EC, Lin HC. The contribution of life course determinants to early childhood caries: a 2–year cohort study. Caries Res 2012;46:87–94.
Frequent sugar = high sugar related intake (eating/drinking) every day **Note:** Baseline caries prevalence among 3 year olds was 20.1% d1-5 mfs and 6.6% d3-5 mfs. Caries prevalence at 5 years was 48.0% d15mfs and 19.1% d3-5mfs.	2.5 (OR, p<0.05) Bivariate NS Multivariate	Children 3 years of age followed up at age 5 years (n=304) [Oslo, Norway]	Bivariate and multiple logistic regression of factors associated with outcome: positive severe caries increment (change in d3-5mfs). 5 grade caries diagnostic system: grades 1-2=enamel lesions; 3-5 dentine lesions. Caries increment=change d1-5mfs Severe caries increment=change d3-5mfs Molar-approximal caries excluded from caries increment calculations.	Skeie MS, Espelid I, Riordan PJ, Klock KS. Caries increment in children aged 3-5 years in relation to parents' dental attitudes: Oslo, Norway 2002 to 2004. Community Dent Oral Epidemiol 2008;36:441–50.

Sweet consumption at 6 yrs (<1/day vs. >=1/day) **Note:** Baseline primary dental caries at 6 yrs (DMFT>0): 63%	NS in initial bivariate tests.	Study nested within a population based cohort with dental exams and interviews performed at 6 and 12 years of age (n=339) [Pelotas, Brazil]	Bivariate and multivariable associations with outcome: DMFT at 12 years old. Multivariate analyses were conducted using Poisson regression to generate relative risk ratio and logistic regression (backward stepwise) to predict dental caries at age 12 years. Variables grouped into hierarchical model with 6 levels: (1) socioeconomic/demographic, (2) nutritional/development characteristics, (3) OH behaviors and dental service use at age 6, (4) primary dental caries at 6 yrs, (5) family economic level at 12 yrs, (6) OH related behaviors and dental service use at 12 yrs. At each level, variables excluded if p>0.25. Final model variables retained if p<=0.05.	Peres MA, Barros AJ, Peres KG, Araujo CL, Menezes AM. Life course dental caries determinants and predictors in children aged 12 years: a population-based birth cohort. Community Dent Oral Epidemiol 2009;37:123–33.
Candies daily (vs. several times a week/once a week or less) **Note**: Occurrence of children with cavitated caries or fillings (d3mfs>0) at 2 years of age was 3%. At age 5 years, 23% .	6.22 (OR, p<0.001) Univariate 3.64 (OR, p=0.004) Multivariate 0.84 (SN), 0.55 (SP) - comparison is 1/week or less versus several times/wk or daily 0.70 (AUC)	2 years at baseline; followed for 3 years (n=226) [Saarijarvi, Finland]	Bivariate and multivariate (using forward stepwise logistic regression) association with outcome: 3-year increment of cavitated carious lesions and/or fillings - measured as the increase of d3mfs from age of 2 years	Pienihakkinen, Jokela & Alanen. Assessment of Caries Risk in Preschool Children. Caries Res 2004;38:156-162.
Candy >=1/v Comparing three groups of children: (A) caries free at baseline and follow-up, (B) caries free at baseline with caries at follow-up, (C) caries at baseline and follow-up. Two comparisons among the three groups: (A) and (B) compared; (B) and (C) compared. **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years (baseline for this study): 11% had initial or manifest caries. At 3.5 years: 37% initial/manifest.	2.7 (OR, p<0.001) Univariate Group B v. Group A NS Group C v. Group B	Children 2.5 years at baseline with 1-year follow-up (n=692) [Stockholm, Sweden]	Univariate analysis of each variable comparing children (A) caries free at baseline and follow-up, (B) caries free at baseline with caries at follow-up, (C) caries at baseline and follow-up - (A) and (B) compared; (B) and (C) compared.	Grindefjord M, Dahllöf G, Modéer T. Caries development in children from 2.5 to 3.5 years of age: a longitudinal study. Caries Res 1995;29:449–54.
Candy >=1/week **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years: 11% had initial or manifest caries; 7% had one or more manifest lesions. At 3.5 years: 37% initial/manifest; 29% manifest.	2.9 (OR, p<0.001) Univariate (manifest caries at 3.5 years) 2.28 (OR, p=0.005) Multivariate (initial/manifest at 2.5 y) [standardized beta coefficient: 0.823] 1.63 (OR, p=0.032) Multivariate (manifest at 3.5 y) [standardized beta coefficient: 0.489] Note: Logistic regression ORs are standardized for each factor.	Children 1 year at baseline with follow up at 2.5 and 3.5 years of age (n=692) [Stockholm, Sweden]	Univariate and logistic multivariate regression for association with outcomes: initial/manifest caries at 2.5 years of age and manifest caries at 3.5 years of age (versus not). Initial caries - loss of translucency and slight roughness on probing (chalky appearance); Manifest - minimal level verified as a cavity detectable by probing; and catch of probe under slight pressure for fissures.	Grindefjord M, Dahllöf G, Nilsson B, Modéer T. Stepwise prediction of dental caries in children up to 3.5 years of age. Caries Res 1996;30:256–66.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Snacking on treats >=1/day (Treats included items containing fermentable carbs; does not include snacks consumed as planned meals) **Note:** Baseline mean DMFS experimental group: 2.1 control group: 2.3 Mean DMFS after 4 years: experimental: 4.7 control: 6.9	change DMFS>=1: NS Bivariate change DMFS>=3: NS Bivariate change DMFS>=5: NS Bivariate	11-12 year olds with 4-year follow-up (n=497) [Pori, Finland]	Randomized clinical trial. Intervention/experimental group: received individually, designed patient-centered regimen for caries control. Control: standard dental care Outcome: DMFS increment defined as difference in scores between baseline and 4-year followup. Three definitions of failure considered: (1) increment>=1; (2) increment >=3; (3) increment >=5. Compared outcome between experimental and control group. Bivariate association between oral health behaviors at baseline and outcome using logistic regression for experimental group. Caries status used criteria in Nyvad et al. DMFS score included surfaces with active or inactive caries lesions with cavitation (scores 5 and 6), those with a filling, those extracted due to caries, and those with caries extending to inner or middle third of dentin or the pulp in radiographs.	Hietasalo P, Tolvanen M, Seppa L, Lahti S, Poutanen R, Niinimaa A, et al. Oral health-related behaviors predictive of failures in caries control among 11-12-yr-old Finnish schoolchildren. Eur J Oral Sci 2008;116:267–71.
Eating candy >=1/day **Note:** Baseline mean DMFS experimental group: 2.1 control group: 2.3 Mean DMFS after 4 years: experimental: 4.7 control: 6.9	change DMFS>=1: NS Bivariate change DMFS>=3: 2.31 (OR, p=0.008) Bivariate change DMFS>=5: 2.72 (OR, p=0.008) Bivariate	11-12 year olds with 4-year follow-up (n=497) [Pori, Finland]	Randomized clinical trial. Intervention/experimental group: received individually, designed patient-centered regimen for caries control. Control: standard dental care Outcome: DMFS increment defined as difference in scores between baseline and 4-year followup. Three definitions of failure considered: (1) increment>=1; (2) increment >=3; (3) increment >=5. Compared outcome between experimental and control group. Bivariate association between oral health behaviors at baseline and outcome using logistic regression for experimental group. Caries status used criteria in Nyvad et al. DMFS score included surfaces with active or inactive caries lesions with cavitation (scores 5 and 6), those with a filling, those extracted due to caries, and those with caries extending to inner or middle third of dentin or the pulp in radiographs.	Hietasalo P, Tolvanen M, Seppa L, Lahti S, Poutanen R, Niinimaa A, et al. Oral health-related behaviors predictive of failures in caries control among 11-12-yr-old Finnish schoolchildren. Eur J Oral Sci 2008;116:267–71.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Candy (self-reported frequency) daily or more frequent reported at 1 of 3 exams where questionnaire administered (vs. less frequent) daily or more frequent reported at 2-3 of 3 exams (vs. less frequent) Questionnaires administered at exams at 12 yrs, 14 yrs, and 16 yrs **Note:** Baseline total population % with DMFS=0: 47% Baseline high risk % with DMFS=0: 28% Baseline DMFS, total population, 12 yrs old (mean)=1.67	 NS Univariate, increment DMFS, total study group NS Multivariable, increment DMFS, total study group NS Univariate, increment DeMFS, total study group NS Multivariable, increment DeMFS, total study group NS Univariate, increment DMFS, high risk group NS Multivariable, increment DMFS, high risk group NS Univariate, increment DeMFS, high risk group NS Multivariable, increment DeMFS, high risk group 1.04 (RR, $p<0.05$) Univariate, increment DMFS, total study group NS Multivariable, increment DMFS, total study group 1.05 (RR, $p<0.05$) Univariate, increment DeMFS, total study group 1.09 (RR, $p<0.05$) Multivariable, increment DeMFS, total study group NS Univariate, increment DMFS, high risk group NS Multivariable, increment DMFS, high risk group 1.08 (RR, $p<0.05$) Univariate, increment DeMFS, high risk group 1.09 (RR, $p<0.05$) Multivariable, increment DeMFS, high risk group	12 years old at baseline followed for 4 years (n=3,373) [Sweden]	Bivariate and multivariable associations with two outcomes: (1) DMFS increment and (2) DeMFS increment -enamel caries on proximal surfaces included in index. Poisson regression with over-dispersion used to analyze incidence rate. Evaluated for total population and "high risk." High risk identified as -having >1 decayed proximal surface, enamel or dentine caries, filled proximal surface or missing tooth because of caries, or -dentist found patient had high risk due to mental/physical disability or chronic disease, or -CFU>10(5) - lactobacillus test Children randomly assigned to one of our preventive programs: (1) tooth-brushing, (2) fluoride lozenges prescription, (3) fluoride varnish, (4) individual program - counseling dental hygiene and nutrition; professional cleaning and FV.	Källestal C, Fjelddahl A. A four-year cohort study of caries and its risk factors in adolescents with high and low risk at baseline. Swed Dent J 2007;31:11–25.
Sweet intake at 3 years of age (>1/week) Note: At 3 years of age (baseline): 16% (n=21) had caries experience including enamel lesions. At 6 years of age, this increased to 40% (n=54).	NS Association with caries experience at age 6. 0.61 (SN), 0.54 (SP) Note: Authors did find a statistically significant greater consumption of sucrose among children with caries experience compared with children without caries experience at both 3 and 6 years of age. But consumption at age 3 was not significantly associated with caries experience at age 6.	Children 3 years at baseline with follow up at 6 years of age (n=135) [Turku, Finland]	Bivariate association between factors (sweet intake and visible plaque) and outcome: caries experience by age 6. Caries experience is total experience and not increment. Caries experience includes enamel lesions as well as dentin lesions/fillings.	Karjalainen S, Söderling E, Sewon L, Lapinleimu H, Simell O. A prospective study on sucrose consumption, visible plaque and caries in children from 3 to 6 years of age. Community Dent Oral Epidemiol 01;29:136–42.
Frequency of between-meal sweets per day (Categories: none, once, 2-3 times, 4-5 times, >5 times) Note: At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	1.37 (OR, $p<0.05$) Prediction model w/o biological factors (change dmft>0) NS Prediction model w/ biological factors (change dmft>0) 1.34 (OR, $p<0.05$) Risk model w/o biological factors (change dmft>0) NS Risk model w/biological factors (change dmft>0) NS Community high risk model; questionnaire (baseline dmft>0)	Children aged 3-6 years with one-year follow-up (n=1,576). [Singapore]	Multiple stepwise logistic regression for association with outcome: one-year caries increment measured as change in dmft. Data from 50% children used for model construction; remainder for model validation. Prediction (all potential factors) and risk models (subset of modifiable factors) with and without biological tests examined. Also, community screening model for identify "high risk" using a questionnaire - high risk = 25% of children with high caries burden (baseline dmft>2 for population studied). At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	Gao XL, Hsu CY, Xu Y, Hwarng HB, Loh T, Koh D. Building caries risk assessment models for children. J Dent Res 2010;89:637–43.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Relative risk of caries increment by highest quartile of total daily sugar consumption (daily mean=175 g) compared with lowest quartile (daily mean=109 g) Relative risk of caries increment by highest quartile of between-meal sugar consumption (daily mean=175 g) compared with lowest quartile (daily mean=109 g) **Note:** Baseline mean DMFS boys: 4.1 girls: 4.5 Mean DMFS after 3 years: boys: 6.8 girls: 7.7	1.22 (RR, p<0.05) any DMFS increment 1.80 (RR, p<0.05) any proximal increment NS any pit and fissure increment NS any DMFS increment 1.65 (RR, borderline) any proximal increment NS any pit and fissure increment **Note:** Reported using multiple linear regression to examine sugar consumption and fluoride use on caries incidence controlling for gender and age. Found "in a few models consumption of sugars was weakly associated with caries incidence, but when baseline caries was added to the model these associations became small and non-significant. Baseline caries prevalence was the strongest predictor of caries incidence in most of the equations." Authors concluded that the study "results . . . make it hard to argue that intake of sugars is directly relate to caries incidence in this population . . . ."[No model results presented in paper.]	10-15 year olds with 3-year follow-up (n=499) [Coldwater, Quincy & Union City, Michigan]	Calculated relative risk of caries increment among participants by highest quartile of sugar consumption compared to lowest quartile. Outcomes: Any DMFS increment; any proximal increment; any pit and fissure increment.	Burt BA, Szpunar SM. The Michigan study: the relationship between sugars intake and dental caries over three years. Int Dent J 1994;44:230–40.
Sweet snacks (1/day, 2/day, 3/day, 4+day in questionnaire; unclear how defined in model) **Note:** Baseline: DF=0.054	Logistic Regression NS, Multivariate, all factors Not included, Multivariate, stepwise Not included, Multivariate, most robust based on balancing technique Note: Overall study finding: decision analysis produced better prediction models than logistic regression or neural network approaches. Significant predictors in this approach were MS levels, LB, salivary pH, gender, and sweet beverages.	5-6 years at baseline, followed for 3 years (n=500) [Gifu Prefecture, Japan]	Outcome: new incident dental caries of the permanent teeth; 3 approaches: (1) conventional modeling, (2) neural network, C5.0 - tool for discovering patterns in databases and used to make predictions. Logistic regression analyses were conducted for a full model with all variables as well as using stepwise selection. Neural network model had 12 input layers, 3 hidden layers, and 1 output layer. C5.0 models work by sequenced sample splitting based on fields providing the maximum information gained. Balancing technique applied. Total of 10 balanced sample sets applied to the models. Model selection based on highest mean of sum of SN and SP.	Tamaki Y, Nomura Y, Katsumura S, Okada A, Yamada H, Tsuge S, et al. Construction of a dental caries prediction model by data mining. J Oral Sci 2009;51:61–8.
Child chews sugar-containing gum (yes no) **Note:** Baseline mean age was 9.7 years Baseline mean ICDAS>=1: 15.7 Baseline mean ICDAS>=3: 8.2 12-month mean ICDAS>=1: 17.9 -89% of children 12-month mean ICDAS>=3: 8.4 -61% of children 24-month mean ICDAS>=1: 16.8 -91% of children 242-month mean ICDAS>=3: 8.4 -68% of children	**Bivariate association with Caries Progression (significant or NS using logistic regression - specific values not reported)** New ICDAS>=1 at 24 months: NS New ICDAS>=3 at 24 months: NS **Multivariate Caries Risk Models** NS - Not included in any final models.	5-13 years of age with 2-year follow-up (n=395) [Aguas Buenas, Puerto Rico]	Logistic regression for progression outcomes (see below) at 12/24 months; for each predictor individually; multiple regression developed using backward elimination retaining predictors p<0.05 with AUC/ROC calculated for final models at model level; Poisson regression for number of lesions with progression Two Outcomes: 1. Any progression (ICDAS>=1): at least one new lesion ICDAS>=1, one new filling, and/or progression of lesion from scores of 1-2 to 3 to higher or from 3-4 to 5 to higher between the two exams. 2. Progression toward cavitation (ICDAS>=3): at least one new lesion ICDAS>=3, one new filling, and/or progression of lesion from score of 1-2 to 3 or higher or from 3-4 to 5 or higher between the two exams. Models run for outcomes at 12 and 24 months; Models run without any baseline ICDAS; models run adding baseline ICDAS last; models run starting with baseline ICDAS score	Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Bedtime sweets (Categories: never, occasionally, frequently, almost every night) Note: At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	NS Prediction model w/o biological factors (change dmft>0) NS Prediction model w/ biological factors (change dmft>0) 1.33 (OR, p<0.05) Risk model w/o biological factors (change dmft>0) NS Risk model w/biological factors (change dmft>0) NS Community high risk model; questionnaire (baseline dmft>0)	Children aged 3-6 years with one-year follow-up (n=1,576). [Singapore]	Multiple stepwise logistic regression for association with outcome: one-year caries increment measured as change in dmft. Data from 50% children used for model construction; remainder for model validation. Prediction (all potential factors) and risk models (subset of modifiable factors) with and without biological tests examined. Also, community screening model for identify "high risk" using a questionnaire - high risk = 25% of children with high caries burden (baseline dmft>2 for population studied). At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	Gao XL, Hsu CY, Xu Y, Hwarng HB, Loh T, Koh D. Building caries risk assessment models for children. J Dent Res 2010;89:637–43.
Bedtime feeding at 1 year old (breast milk/formula/juice/sweets versus nothing/water/pacifier) Note: At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	NS Prediction model w/o biological factors (change dmft>0) NS Prediction model w/ biological factors (change dmft>0) 1.48 (OR, p<0.05) Risk model w/o biological factors (change dmft>0) NS Risk model w/biological factors (change dmft>0) NS Community high risk model; questionnaire (baseline dmft>0)	Children aged 3-6 years with one-year follow-up (n=1,576). [Singapore]	Multiple stepwise logistic regression for association with outcome: one-year caries increment measured as change in dmft. Data from 50% children used for model construction; remainder for model validation. Prediction (all potential factors) and risk models (subset of modifiable factors) with and without biological tests examined. Also, community screening model for identify "high risk" using a questionnaire - high risk = 25% of children with high caries burden (baseline dmft>2 for population studied). At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	Gao XL, Hsu CY, Xu Y, Hwarng HB, Loh T, Koh D. Building caries risk assessment models for children. J Dent Res 2010;89:637–43.
Consumption sugar-containing beverages at night Comparing three groups of children: (A) caries free at baseline and follow-up, (B) caries free at baseline with caries at follow-up, (C) caries at baseline and follow-up. Two comparisons among the three groups: (A) and (B) compared; (B) and (C) compared. **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years (baseline for this study): 11% had initial or manifest caries. At 3.5 years: 37% initial/manifest.	1.2 (OR, p<0.001) Univariate Group B v. Group A NS Group C v. Group B	Children 2.5 years at baseline with 1-year follow-up (n=692) [Stockholm, Sweden]	Univariate analysis of each variable comparing children (A) caries free at baseline and follow-up, (B) caries free at baseline with caries at follow-up, (C) caries at baseline and follow-up - (A) and (B) compared; (B) and (C) compared.	Grindefjord M, Dahllöf G, Modéer T. Caries development in children from 2.5 to 3.5 years of age: a longitudinal study. Caries Res 1995;29:449–54.
Consumption sugar-containing beverages at night **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years: 11% had initial or manifest caries; 7% had one or more manifest lesions. At 3.5 years: 37% initial/manifest; 29% manifest.	2.2 (OR, p<0.001) Univariate (manifest caries at 3.5 years) NS Multivariate (initial/manifest at 2.5 y) NS Multivariate (manifest at 3.5 y)	Children 1 year at baseline with follow up at 2.5 and 3.5 years of age (n=692) [Stockholm, Sweden]	Univariate and logistic multivariate regression for association with outcomes: initial/manifest caries at 2.5 years of age and manifest caries at 3.5 years of age (versus not). Initial caries - loss of translucency and slight roughness on probing (chalky appearance); Manifest - minimal level verified as a cavity detectable by probing; and catch of probe under slight pressure for fissures.	Grindefjord M, Dahllöf G, Nilsson B, Modéer T. Stepwise prediction of dental caries in children up to 3.5 years of age. Caries Res 1996;30:256–66.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Sugary drink at bedtime at 3 years of age (yes vs no) **Note:** Baseline caries prevalence among 3 year olds was 20.1% d1-5 mfs and 6.6% d3-5 mfs. Caries prevalence at 5 years was 48.0% d15mfs and 19.1% d3-5mfs.	3.9 (OR, p<0.05) Bivariate NS Multivariate	Children 3 years of age followed up at age 5 years (n=304) [Oslo, Norway]	Bivariate and multiple logistic regression of factors associated with outcome: positive severe caries increment (change in d3-5mfs). 5 grade caries diagnostic system: grades 1-2=enamel lesions; 3-5 dentine lesions. Caries increment=change d1-5mfs Severe caries increment=change d3-5mfs Molar-approximal caries excluded from caries increment calculations.	Skeie MS, Espelid I, Riordan PJ, Klock KS. Caries increment in children aged 3-5 years in relation to parents' dental attitudes: Oslo, Norway 2002 to 2004. Community Dent Oral Epidemiol 2008;36:441–50.
Daily use of sugar containing drinks between meals (yes versus no)	1.37 (OR, p<0.001) Baseline 1.25 (OR, p=0.049) Follow-Up	7 years old at baseline (n=3,303) with at least one follow-up by age 10 years (n=3,002) [Flanders, Belgium]	1. Cross-sectional multiple logistic regression with outcome: dmfs (caries v. no caries) in **permanent first molars** (baseline) 2. Stepwise multiple logistic regression with outcome: net caries increment on **permanent first molars** (0/1 additional surface affected v. 2 or more additional surfaces affected) calculated by subtracting baseline DMFS6 score from last available DMFS6 score [follow-up]	Vanobbergen J, Martens L, Lesaffre E, Bogaerts K, Declerck D. 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 2001;35:442–50.
Consumption sugar-containing beverages >=2 per day Comparing three groups of children: (A) caries free at baseline and follow-up, (B) caries free at baseline with caries at follow-up, (C) caries at baseline and follow-up. Two comparisons among the three groups: (A) and (B) compared; (B) and (C) compared. **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years (baseline for this study): 11% had initial or manifest caries. At 3.5 years: 37% initial/manifest.	2.1 (OR, p<0.01) Univariate Group B v. Group A NS Group C v. Group B	Children 2.5 years at baseline with 1-year follow-up (n=692)	Univariate analysis of each variable comparing children (A) caries free at baseline and follow-up, (B) caries free at baseline with caries at follow-up, (C) caries at baseline and follow-up - (A) and (B) compared; (B) and (C) compared.	Grindefjord M, Dahllöf G, Modéer T. Caries development in children from 2.5 to 3.5 years of age: a longitudinal study. Caries Res 1995;29:449–54.
Consumption sugar-containing beverages >2 per day **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years: 11% had initial or manifest caries; 7% had one or more manifest lesions. At 3.5 years: 37% initial/manifest; 29% manifest.	2.6 (OR, p<0.001) Univariate (manifest caries at 3.5 years) NS Multivariate (initial/manifest at 2.5 y) 0.58 (OR, p=0.045) Multivariate (manifest at 3.5 y) [standardized beta coefficient: 0.580] Note: Logistic regression ORs are standardized for each factor.	Children 1 year at baseline with follow up at 2.5 and 3.5 years of age (n=692) [Stockholm, Sweden]	Univariate and logistic multivariate regression for association with outcomes: initial/manifest caries at 2.5 years of age and manifest caries at 3.5 years of age (versus not). Initial caries - loss of translucency and slight roughness on probing (chalky appearance); Manifest - minimal level verified as a cavity detectable by probing; and catch of probe under slight pressure for fissures.	Grindefjord M, Dahllöf G, Nilsson B, Modéer T. Stepwise prediction of dental caries in children up to 3.5 years of age. Caries Res 1996;30:256–66.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Child drinks soda between meals yes no **Note:** Baseline mean age was 9.7 years Baseline mean ICDAS>=1: 15.7 Baseline mean ICDAS>=3: 8.2 12-month mean ICDAS>=1: 17.9 -89% of children 12-month mean ICDAS>=3: 8.4 -61% of children 24-month mean ICDAS>=1: 16.8 -91% of children 242-month mean ICDAS>=3: 8.4 -68% of children	**Bivariate association with Caries Progression (significant or NS using logistic regression - specific values not reported)** New ICDAS>=1 at 24 months: NS New ICDAS>=3 at 24 months: NS **Multivariate Caries Risk Models** **Note:** Total of 12 Multivariate Caries Risk Models: 2 outcomes, 2 time periods, 3 ways of handling baseline dmfs/DMFS (not included, added last, added first) -Significant in 1 of 12 models (not included in the other 11 final models) **Reporting results for best model for "any progression" and "progression to cavitation"** 1. dmfs/DMFS excluded, 24-month follow-up, ICDAS>=1 (model SN=.82, SP=.59, AUC=0.75) NS-Not included 2. dmfs/DMFS added last, 12 month follow-up, ICDAS>=3 (model SN=.81, SP=.58, AUC=0.77) NS-Not included 3. dmfs/DMFS added first, 12 month follow-up, ICDAS>=3 (model SN=.81, SP=.57, AUC=0.79) 1.75 (OR, p=0.0496)	5-13 years of age with 2-year follow-up (n=395) [Aguas Buenas, Puerto Rico]	Logistic regression for progression outcomes (see below) at 12/24 months; for each predictor individually; multiple regression developed using backward elimination retaining predictors p<0.05 with AUC/ROC calculated for final models at model level; Poisson regression for number of lesions with progression Two Outcomes: 1. Any progression (ICDAS>=1): at least one new lesion ICDAS>=1, one new filling, and/or progression of lesion from scores of 1-2 to 3 to higher or from 3-4 to 5 to higher between the two exams. 2. Progression toward cavitation (ICDAS>=3): at least one new lesion ICDAS>=3, one new filling, and/or progression of lesion from score of 1-2 to 3 or higher or from 3-4 to 5 or higher between the two exams. Models run for outcomes at 12 and 24 months; Models run without any baseline ICDAS; models run adding baseline ICDAS last; models run starting with baseline ICDAS score	Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.
Child drinks juices between meals (yes no) **Note:** Baseline mean age was 9.7 years Baseline mean ICDAS>=1: 15.7 Baseline mean ICDAS>=3: 8.2 12-month mean ICDAS>=1: 17.9 -89% of children 12-month mean ICDAS>=3: 8.4 -61% of children 24-month mean ICDAS>=1: 16.8 -91% of children 242-month mean ICDAS>=3: 8.4 -68% of children	**Bivariate association with Caries Progression (significant or NS using logistic regression - specific values not reported)** New ICDAS>=1 at 24 months: NS New ICDAS>=3 at 24 months: NS **Multivariate Caries Risk Models** NS - Not included in any final models	5-13 years of age with 2-year follow-up (n=395) [Aguas Buenas, Puerto Rico]	Logistic regression for progression outcomes (see below) at 12/24 months; for each predictor individually; multiple regression developed using backward elimination retaining predictors p<0.05 with AUC/ROC calculated for final models at model level; Poisson regression for number of lesions with progression Two Outcomes: 1. Any progression (ICDAS>=1): at least one new lesion ICDAS>=1, one new filling, and/or progression of lesion from scores of 1-2 to 3 to higher or from 3-4 to 5 to higher between the two exams. 2. Progression toward cavitation (ICDAS>=3): at least one new lesion ICDAS>=3, one new filling, and/or progression of lesion from score of 1-2 to 3 or higher or from 3-4 to 5 or higher between the two exams. Models run for outcomes at 12 and 24 months; Models run without any baseline ICDAS; models run adding baseline ICDAS last; models run starting with baseline ICDAS score	Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.
Child has sweet drinks between meals (never, 1x/day, 2x/day, >2x /day) **Note:** Baseline mean age was 9.7 years Baseline mean ICDAS>=1: 15.7 Baseline mean ICDAS>=3: 8.2 12-month mean ICDAS>=1: 17.9 -89% of children 12-month mean ICDAS>=3: 8.4 -61% of children 24-month mean ICDAS>=1: 16.8 -91% of children 242-month mean ICDAS>=3: 8.4 -68% of children	**Bivariate association with Caries Progression (significant or NS using logistic regression - specific values not reported)** New ICDAS>=1 at 24 months: NS New ICDAS>=3 at 24 months: NS **Multivariate Caries Risk Models** NS - Not included in any final models.	5-13 years of age with 2-year follow-up (n=395) [Aguas Buenas, Puerto Rico]	Logistic regression for progression outcomes (see below) at 12/24 months; for each predictor individually; multiple regression developed using backward elimination retaining predictors p<0.05 with AUC/ROC calculated for final models at model level; Poisson regression for number of lesions with progression Two Outcomes: 1. Any progression (ICDAS>=1): at least one new lesion ICDAS>=1, one new filling, and/or progression of lesion from scores of 1-2 to 3 to higher or from 3-4 to 5 to higher between the two exams. 2. Progression toward cavitation (ICDAS>=3): at least one new lesion ICDAS>=3, one new filling, and/or progression of lesion from score of 1-2 to 3 or higher or from 3-4 to 5 or higher between the two exams. Models run for outcomes at 12 and 24 months; Models run without any baseline ICDAS; models run adding baseline ICDAS last; models run starting with baseline ICDAS score	Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Soda consumption, 4 categories (none; 1 day/week; 2-6 days; every day)	1.5 (IRR, p<0.001) 2-6 days new d16mfs 1.9 (IRR, p<0.001) 2-6 days new d36mfs Note: 1 day and every day per week NS.	Children 0-5 years at baseline followed for 2 years (n=788) [low-income African-American children in Detroit, Michigan]	Stepwise backward multiple regression, zero-inflated negative binomial models with outcomes: caries increment measured as (1) new d16mfs and (2) new d36mfs.	Ismail AI, Sohn W, Lim S, Willem JM. Predictors of dental caries progression in primary teeth. J Dent Res 2009;88: 270–5.
Drinking soft drinks >=1/day **Note:** Baseline mean DMFS experimental group: 2.1 control group: 2.3 Mean DMFS after 4 years: experimental: 4.7 control: 6.9	change DMFS>=1: NS Bivariate change DMFS>=3: NS Bivariate change DMFS>=5: NS Bivariate	11-12 year olds with 4-year follow-up (n=497) [Pori, Finland]	Randomized clinical trial. Intervention/experimental group: received individually, designed patient-centered regimen for caries control. Control: standard dental care Outcome: DMFS increment defined as difference in scores between baseline and 4-year followup. Three definitions of failure considered: (1) increment>=1; (2) increment >=3; (3) increment >=5. Compared outcome between experimental and control group. Bivariate association between oral health behaviors at baseline and outcome using logistic regression for experimental group. Caries status used criteria in Nyvad et al. DMFS score included surfaces with active or inactive caries lesions with cavitation (scores 5 and 6), those with a filling, those extracted due to caries, and those with caries extending to inner or middle third of dentin or the pulp in radiographs.	Hietasalo P, Tolvanen M, Seppa L, Lahti S, Poutanen R, Niinimaa A, et al. Oral health-related behaviors predictive of failures in caries control among 11-12-yr-old Finnish schoolchildren. Eur J Oral Sci 2008;116:267–71.
100% juice exposure - high (versus low); other beverage exposure examined not significant Note: % with new non-cavitated caries at first exam, primary dentition: 21.15%; % with new cavitated caries at first exam, primary dentition: 26.28%	0.50 (IRR, p=0.02) New non-cavitated caries 0.52 (IRR, p=0.03) New cavitated caries	Children tracked from birth through 13 years old (n=156) [Iowa]	Multivariable model (GLMM based on negative binomial distribution) of association with: (1) new non-cavitated caries and (2) new cavitated caries (repeated measures analysis with measurements at 3-5 y, 6-8 y, and 11-13 y)	Chankanka et al. Longitudinal Associations between Children's Dental Caries and Risk Factors. J Public Health Dent 2011;71:289-300.
Soft drinks (self-reported frequency) more than once a week (vs less frequent) Questionnaires administered at exams at 12 yrs, 14 yrs, and 16 yrs **Note:** Baseline total population % with DMFS=0: 47% Baseline high risk % with DMFS=0: 28% Baseline DMFS, total population, 12 yrs old (mean)=1.67 Baseline DMFS, high risk, 12 yrs old (mean)=2.87 Baseline DeMFS, total population, 12 years old (mean)=2.40 Baseline DeMFS, high risk, 12 yrs old (mean)=4.67 DMFS, total population, 16 yrs old (mean)=3.69 DMFS, high risk, 16 yrs old (mean)=5.95	NS in any of the models	12 years old at baseline followed for 4 years (n=3,373) [Sweden]	Bivariate and multivariable associations with two outcomes: (1) DMFS increment and (2) DeMFS increment -enamel caries on proximal surfaces included in index. Poisson regression with over-dispersion used to analyze incidence rate. Evaluated for total population and "high risk." High risk identified as -having >1 decayed proximal surface, enamel or dentine caries, filled proximal surface or missing tooth because of caries, or -dentist found patient had high risk due to mental/physical disability or chronic disease, or -CFU>10(5) - lactobacillus test Children randomly assigned to one of our preventive programs: (1) tooth-brushing, (2) fluoride lozenges prescription, (3) fluoride varnish, (4) individual program - counseling dental hygiene and nutrition; professional cleaning and FV.	Källestal C, Fjelddahl A. A four-year cohort study of caries and its risk factors in adolescents with high and low risk at baseline. Swed Dent J 2007;31:11–25.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Sweet beverages (1/day, 2/day, 3/day, 4+day in questionnaire; unclear how defined in model) **Note:** Baseline: DF=0.054	Logistic Regression NS, Multivariate, all factors Not included, Multivariate, stepwise NS, Multivariate, most robust based on balancing technique Note: Overall study finding: decision analysis produced better prediction models than logistic regression or neural network approaches. Significant predictors in this approach were MS levels, LB, salivary pH, gender, and sweet beverages.	5-6 years at baseline, followed for 3 years (n=500) [Gifu Prefecture, Japan]	Outcome: new incident dental caries of the permanent teeth; 3 approaches: (1) conventional modeling, (2) neural network, C5.0 - tool for discovering patterns in databases and used to make predictions. Logistic regression analyses were conducted for a full model with all variables as well as using stepwise selection. Neural network model had 12 input layers, 3 hidden layers, and 1 output layer. C5.0 models work by sequenced sample splitting based on fields providing the maximum information gained. Balancing technique applied. Total of 10 balanced sample sets applied to the models. Model selection based on highest mean of sum of SN and SP.	Tamaki Y, Nomura Y, Katsumura S, Okada A, Yamada H, Tsuge S, et al. Construction of a dental caries prediction model by data mining. J Oral Sci 2009;51:61–8.
Level 3 - Bottle feeding (yes vs. no) **Note:** ECC prevalence at baseline (8 months) = 0; 14 months = 0; 20 months =1.6%; 26 months = 11.1%; 32 months=28.4%.	1.35 (IDR, p=0.098) Within level multivariable analysis *Although p<0.05, retained all variables p<0.25 in stepwise regression 2.25 (IDR,p=0.13) Final model with all five levels, using sequential stepwise GEE	Children 8 months of age with six month follow-ups through 32 months of age (2-year follow up) (n=255 at recruitment; 155 at last follow-up) [Guangzhou, China]	Generalized estimating equations used to assess relationship with outcome: incidence density of a tooth surface developing caries, which is the number of new caries-affected surfaces per surface time at risk. Incidence density ratio = incidence density among those exposed and not exposed to independent variable. Sequential stepwise GEE using 5-level model (1=socioeconomic/demographic vars; 2=developmental characteristics; 3=nutritional upbringing including feeding/nutrition; 4=oral health behaviors; 5= S. mutans)	Zhou Y, Yang JY, Lo EC, Lin HC. The contribution of life course determinants to early childhood caries: a 2–year cohort study. Caries Res 2012;46:87–94.
Regularity of between meal snacks (irregular versus regular) **Note:** Baseline caries experience among 3 year olds was 41% with mean dmft of 1.70.	NS	646 mother-child pairs; children aged 1.5 and 3 years during examinations conducted between 1992 to 2005. [Ishii town, Tokushima Prefecture, Japan]	Multiple logistic regression of factors associated with outcome: presence of dental caries at age 3 years. Caries was based on WHO methodology; recorded as present when lesion in pit/fissure, or on a smooth tooth surface, has detectably softened floor, undermined enamel, or softened wall; dmft recorded.	Niji R, Arita K, Abe Y, Lucas ME, Nishino M, Mitome M. Maternal age at birth and other risk factors in early childhood caries. Pediatr Dent 2010;32:493–8.
Frequency of between-meal snacks **Note:** Baseline caries experience among 3 year olds was 41% with mean dmft of 1.70.	2/day (versus 0-1) NS 3/day (versus 0-1) NS >=4/day (versus 0-1) 2.53 (OR, p=0.03)	646 mother-child pairs; children aged 1.5 and 3 years during examinations conducted between 1992 to 2005. [Ishii town, Tokushima Prefecture, Japan]	Multiple logistic regression of factors associated with outcome: presence of dental caries at age 3 years. Caries was based on WHO methodology; recorded as present when lesion in pit/fissure, or on a smooth tooth surface, has detectably softened floor, undermined enamel, or softened wall; dmft recorded.	Niji R, Arita K, Abe Y, Lucas ME, Nishino M, Mitome M. Maternal age at birth and other risk factors in early childhood caries. Pediatr Dent 2010;32:493–8.
Meals >7/day **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years: 11% had initial or manifest caries; 7% had one or more manifest lesions. At 3.5 years: 37% initial/manifest; 29% manifest.	1.8 (OR, p<0.05) Univariate (manifest caries at 3.5 years) NS Multivariate (initial/manifest at 2.5 y) NS Multivariate (manifest at 3.5 y)	Children 1 year at baseline with follow up at 2.5 and 3.5 years of age (n=692) [Stockholm, Sweden]	Univariate and logistic multivariate regression for association with outcomes: initial/manifest caries at 2.5 years of age and manifest caries at 3.5 years of age (versus not). Initial caries - loss of translucency and slight roughness on probing (chalky appearance); Manifest - minimal level verified as a cavity detectable by probing; and catch of probe under slight pressure for fissures.	Grindefjord M, Dahllöf G, Nilsson B, Modéer T. Stepwise prediction of dental caries in children up to 3.5 years of age. Caries Res 1996;30:256–66.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Meals >7/day Comparing three groups of children: (A) caries free at baseline and follow-up, (B) caries free at baseline with caries at follow-up, (C) caries at baseline and follow-up. Two comparisons among the three groups: (A) and (B) compared; (B) and (C) compared. **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years (baseline for this study): 11% had initial or manifest caries. At 3.5 years: 37% initial/manifest.	NS	Children 2.5 years at baseline with 1-year follow-up (n=692) [Stockholm, Sweden]	Univariate analysis of each variable comparing children (A) caries free at baseline and follow-up, (B) caries free at baseline with caries at follow-up, (C) caries at baseline and follow-up - (A) and (B) compared; (B) and (C) compared.	Grindefjord M, Dahllöf G, Modéer T. Caries development in children from 2.5 to 3.5 years of age: a longitudinal study. Caries Res 1995;29:449–54.
Child snacks between meals (never, 1x/day, 2x/day, >2x /day) **Note:** Baseline mean age was 9.7 years Baseline mean ICDAS>=1: 15.7 Baseline mean ICDAS>=3: 8.2 12-month mean ICDAS>=1: 17.9 -89% of children 12-month mean ICDAS>=3: 8.4 -61% of children 24-month mean ICDAS>=1: 16.8 -91% of children 242-month mean ICDAS>=3: 8.4 -68% of children	**Bivariate association with Caries Progression (significant or NS using logistic regression - specific values not reported)** New ICDAS>=1 at 24 months: NS New ICDAS>=3 at 24 months: NS **Multivariate Caries Risk Models** NS - Not included in any final models	5-13 years of age with 2-year follow-up (n=395) [Aguas Buenas, Puerto Rico]	Logistic regression for progression outcomes (see below) at 12/24 months; for each predictor individually; multiple regression developed using backward elimination retaining predictors p<0.05 with AUC/ROC calculated for final models at model level; Poisson regression for number of lesions with progression Two Outcomes: 1. Any progression (ICDAS>=1): at least one new lesion ICDAS>=1, one new filling, and/or progression of lesion from scores of 1-2 to 3 to higher or from 3-4 to 5 to higher between the two exams. 2. Progression toward cavitation (ICDAS>=3): at least one new lesion ICDAS>=3, one new filling, and/or progression of lesion from score of 1-2 to 3 or higher or from 3-4 to 5 or higher between the two exams. Models run for outcomes at 12 and 24 months; Models run without any baseline ICDAS; models run adding baseline ICDAS last; models run starting with baseline ICDAS score	Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.
Snacking frequency (>2 times per day between meals versus 2 times or less)	1.24 (OR, p=0.006) Baseline NS Follow-Up	7 years old at baseline (n=3,303) with at least one follow-up by age 10 years (n=3,002) [Flanders, Belgium]	1. Cross-sectional multiple logistic regression with outcome: dmfs (caries v. no caries) in **permanent first molars** (baseline) 2. Stepwise multiple logistic regression with outcome: net caries increment on **permanent first molars** (0/1 additional surface affected v. 2 or more additional surfaces affected) calculated by subtracting baseline DMFS6 score from last available DMFS6 score [follow-up]	Vanobbergen J, Martens L, Lesaffre E, Bogaerts K, Declerck D. 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 2001;35:442–50.
Dry mouth (due to medication, radiation, chemotherapy, drug use)				
Orthodontic or prosthodontic appliances.				

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Recent caries experience in parents or siblings				
Caregiver baseline dmfs (4 categories: cat 1=0-27, ref; cat2=28-40; cat3=41-59; cat 4=60-182)	1.3 (IRR, p=0.03) cat 3 new d16mfs 1.4 (IRR, p=0.03) cat 4 Note: cat 2 NS	Children 0-5 years at baseline followed for 2 years (n=788) [low-income African-American children in Detroit, Michigan]	Stepwise backward multiple regression, zero-inflated negative binomial models with outcomes: caries increment measured as (1) new d16mfs and (2) new d36mfs.	Ismail AI, Sohn W, Lim S, Willem JM. Predictors of dental caries progression in primary teeth. J Dent Res 2009;88: 270–5.
Caregiver has current caries (Self report) **Note:** Baseline mean age was 9.7 years Baseline mean ICDAS>=1: 15.7 Baseline mean ICDAS>=3: 8.2 12-month mean ICDAS>=1: 17.9 -89% of children 12-month mean ICDAS>=3: 8.4 -61% of children 24-month mean ICDAS>=1: 16.8 -91% of children 242-month mean ICDAS>=3: 8.4 -68% of children	**Bivariate association with Caries Progression (significant or NS using logistic regression - specific values not reported)** New ICDAS>=1 at 24 months: Significant New ICDAS>=3 at 24 months: Significant **Multivariate Caries Risk Models** **Note:** Total of 12 Multivariate Caries Risk Models: 2 outcomes, 2 time periods, 3 ways of handling baseline dmfs/DMFS (not included, added last, added first) -Significant in 3 of 12 models (all 12-month follow up models) **Reporting results for best model for "any progression" and "progression to cavitation"** 1. dmfs/DMFS excluded, 24-month follow-up, ICDAS>=1 (model SN=.82, SP=.59, AUC=0.75) 2.62 (OR, p=0.0160) 2. dmfs/DMFS added last, 12 month follow-up, ICDAS>=3 (model SN=.81, SP=.58, AUC=0.77) NS (Not included in final model) 3. dmfs/DMFS added first, 12 month follow-up, ICDAS>=3 (model SN=.81, SP=.57, AUC=0.79)	5-13 years of age with 2-year follow-up (n=395) [Aguas Buenas, Puerto Rico]	Logistic regression for progression outcomes (see below) at 12/24 months; for each predictor individually; multiple regression developed using backward elimination retaining predictors p<0.05 with AUC/ROC calculated for final models at model level; Poisson regression for number of lesions with progression Two Outcomes: 1. Any progression (ICDAS>=1): at least one new lesion ICDAS>=1, one new filling, and/or progression of lesion from scores of 1-2 to 3 to higher or from 3-4 to 5 to higher between the two exams. 2. Progression toward cavitation (ICDAS>=3): at least one new lesion ICDAS>=3, one new filling, and/or progression of lesion from score of 1-2 to 3 or higher or from 3-4 to 5 or higher between the two exams. Models run for outcomes at 12 and 24 months; Models run without any baseline ICDAS; models run adding baseline ICDAS last; models run starting with baseline ICDAS score	Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.
Special healthcare needs				
No "health problems" Note: At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	2.87 (OR, p<0.05) Prediction model w/o biological factors (change dmft>0) 2.67 (OR, p<0.05) Prediction model w/ biological factors (change dmft>0) NS Risk model w/o biological factors (change dmft>0) NS Risk model w/biological factors (change dmft>0) NS Community high risk model; questionnaire (baseline dmft>0)	Children aged 3-6 years with one-year follow-up (n=1,576). [Singapore]	Multiple stepwise logistic regression for association with outcome: one-year caries increment measured as change in dmft. Data from 50% children used for model construction; remainder for model validation. Prediction (all potential factors) and risk models (subset of modifiable factors) with and without biological tests examined. Also, community screening model for identify "high risk" using a questionnaire - high risk = 25% of children with high caries burden (baseline dmft>2 for population studied).	Gao XL, Hsu CY, Xu Y, Hwarng HB, Loh T, Koh D. Building caries risk assessment models for children. J Dent Res 2010;89:637–43.
Low SES				
High SES (vs. low SES) Note: % with new non-cavitated caries at first exam, primary dentition: 21.15%; % with new cavitated caries at first exam, primary dentition: 26.28%	0.58 (IRR, p=0.02) New non-cavitated caries NS New cavitated caries	Children tracked from birth through 13 years old (n=156) [Iowa]	Multivariable model (GLMM based on negative binomial distribution) of association with: (1) new non-cavitated caries and (2) new cavitated caries (repeated measures analysis with measurements at 3-5 y, 6-8 y, and 11-13 y)	Chankanka et al. Longitudinal Associations between Children's Dental Caries and Risk Factors. J Public Health Dent 2011;71:289-300.
Household income (<$10K or >= $10K)	NS	Children 0-5 years at baseline followed for 2 years (n=788) [low-income African-American children in Detroit, Michigan]	Stepwise backward multiple regression, zero-inflated negative binomial models with outcomes: caries increment measured as (1) new d16mfs and (2) new d36mfs.	Ismail AI, Sohn W, Lim S, Willem JM. Predictors of dental caries progression in primary teeth. J Dent Res 2009;88: 270–5.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Level 1 - Family monthly income >=$450 US (vs less) **Note:** ECC prevalence at baseline (8 months) = 0; 14 months = 0; 20 months =1.6%; 26 months = 11.1%; 32 months=28.4%.	2.40 (IDR, p=0.010) Within level multivariable analysis 3.05 (IDR,p=0.003) Final model with all five levels, using sequential stepwise GEE	Children 8 months of age with six month follow-ups through 32 months of age (2-year follow up) (n=255 at recruitment; 155 at last follow-up) [Guangzhou, China]	Generalized estimating equations used to assess relationship with outcome: incidence density of a tooth surface developing caries, which is the number of new caries-affected surfaces per surface time at risk. Incidence density ratio = incidence density among those exposed and not exposed to independent variable. Sequential stepwise GEE using 5-level model (1=socioeconomic/demographic vars; 2=developmental characteristics; 3=nutritional upbringing including feeding/nutrition; 4=oral health behaviors; 5= S. mutans)	Zhou Y, Yang JY, Lo EC, Lin HC. The contribution of life course determinants to early childhood caries: a 2–year cohort study. Caries Res 2012;46:87–94.
Maternal social welfare allowance - yes (vs no) **Note:** Baseline DMFT at 13 yrs (mean)=1.28 Baseline DMFSA at 13 yrs (mean)=0.31 DMFT at 19 yrs (mean): 3.39 DMFSa at 19 yrs (mean): 1.60	1.71 (OR, p<0.001) Bivariate Note: Variable included in multivariable regression as control; OR and significance in these models were not reported.	13 years of age followed 6 years (n=15,538) [Stockholm, Sweden]	Bivariate and multivariable logistic regression with outcome: approximal caries increment (DMFSa) between 13 and 19 years of age.	Julihn A, Ekbom A, Modéer T. Maternal overweight and smoking: prenatal risk factors for caries development in offspring during the teenage period. Eur J Epidemiol 2009;24: 753–62.
Caregiver education (<h.s., h.s., >h.s.) Caregiver employment status Household income (<$20,000; $20,001-$40,000;>=$40,000) Welfare use Medicaid/Medicare use Meeting FPL **Note:** Baseline carious surfaces (mean): 9.4 At 5-year following, net **increment** of carious surfaces (mean): 6.9	None of these 6 variables had a significant association with 5-year increment in bivariate/multivariate models.	6-10 years old at baseline followed for 5 years (n=429) [Boston, MA and Farmingham, ME] **Note:** Sample were high-risk children enrolled in the New England Children's Amalgam Trial - additional inclusion criteria were no prior amalgam restorations and having at least two decayed posterior occlusal surfaces All participants received restorations of baseline caries and sealants and comprehensive semiannual dental care.	Bivariate and multivariable associations with two outcomes: (1) 5-year increment of carious teeth and (2) 5-year increment of carious surfaces. Carious/filled surfaces measured from date of baseline visit through date of final study dental visit. Caries in both primary and permanent dentition were summed to obtain cumulative incident disease burden (net caries increment). Factors associated with caries increment at a level of p>0.15 entered into preliminary multivariate model; final multivariate model included variables significant at p<0.05 or changed coefficients of other variables more than 10%. Multivariate analyses conducted using negative binomial model.	Maserejian NN, Tavares MA, Hayes C, Soncini JA, Trachtenberg FL. Prospective study of 5-year caries incre-ment among children receiving comprehensive dental care in the New England children's amalgam trial. Community Dent Oral Epidemiol 009;37:9–18.
WIC participation (yes/no)	NS	Children 0-5 years at baseline followed for 2 years (n=788) [low-income African-American children in Detroit, Michigan]	Stepwise backward multiple regression, zero-inflated negative binomial models with outcomes: caries increment measured as (1) new d16mfs and (2) new d36mfs.	Ismail AI, Sohn W, Lim S, Willem JM. Predictors of dental caries progression in primary teeth. J Dent Res 2009;88: 270–5.
Head Start participation (yes versus no)	NS new d16mfs 0.6 (IRR, p=0.02) new d36mfs	Children 0-5 years at baseline followed for 2 years (n=788) [low-income African-American children in Detroit, Michigan]	Stepwise backward multiple regression, zero-inflated negative binomial models with outcomes: caries increment measured as (1) new d16mfs and (2) new d36mfs.	Ismail AI, Sohn W, Lim S, Willem JM. Predictors of dental caries progression in primary teeth. J Dent Res 2009;88: 270–5.
Full time employment (yes/no)	NS	Children 0-5 years at baseline followed for 2 years (n=788) [low-income African-American children in Detroit, Michigan]	Stepwise backward multiple regression, zero-inflated negative binomial models with outcomes: caries increment measured as (1) new d16mfs and (2) new d36mfs.	Ismail AI, Sohn W, Lim S, Willem JM. Predictors of dental caries progression in primary teeth. J Dent Res 2009;88: 270–5.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Parent education <13 years (versus >=13 years)	2.9 (OR, p<0.001), 0.69 (SN), 0.57 (SP) Baseline Significant (specific values not reported) Multivariate	Kindergarten children (mean age 5 y 8m) followed up after one year (n=302) [Montreal, Canada]	Bivariate association and multivariate logistic regression for outcome: at least one new carious surface in primary teeth at one-year follow-up	Demers M, Brodeur JM, Mouton C, Simard PL, Trahan L, Veilleux G. A multivariate model to predict caries increment in Montreal children aged 5 years. Community Dent Health 1992;9:273–81.
Education, household head, # of years Note: Baseline caries experience: Mean dmfs, Grade 1, Aiken: 9.3, Portland: 2.9 Mean dmfs Grade 5, Aiken: 4.4, Portland: 2.4 Mean DMFS Grade 1, Aiken: 0.3, Portland: 0.2 Mean DMFS Grade 5, Aiken: 3.0, Portland: 1.7	NS <u>Note: Comparison to "any risk" in Beck et al. 1992 where "any risk" is a DMFS increment of 1 or more (Beck et al. results below):</u> 0.87-0.98 (OR) Significant in 2 of 4 cohorts	Two cohorts (Grade 1 and Grade 5) at two sites (Aiken, SC and Portland, ME) with 3-year follow-up (n=4158)	Backward stepwise logistic regression for outcome: high risk based on 3-year DMFS increment (final DMFS-baseline DMFS) where high risk definition varied by cohort	Disney JA, Graves RC, Stamm JW, Bohannan HM, Abernathy JR, Zack DD. The University of North Carolina Caries Risk Assessment study: further developments in caries risk prediction. Community Dent Oral Epidemiol 1992;20: 64–75.
Mother's education <=9 years Comparing three groups of children: (A) caries free at baseline and follow-up, (B) caries free at baseline with caries at follow-up, (C) caries at baseline and follow-up. Two comparisons among the three groups: (A) and (B) compared; (B) and (C) compared. **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years (baseline for this study): 11% had initial or manifest caries. At 3.5 years: 37% initial/manifest.	3.4 (OR, p<0.001) Univariate Group B v. Group A NS Group C v. Group B	Children 2.5 years at baseline with 1-year follow-up (n=692) [Stockholm, Sweden]	Univariate analysis of each variable comparing children (A) caries free at baseline and follow-up, (B) caries free at baseline with caries at follow-up, (C) caries at baseline and follow-up - (A) and (B) compared; (B) and (C) compared.	Grindefjord M, Dahllöf G, Modéer T. Caries development in children from 2.5 to 3.5 years of age: a longitudinal study. Caries Res 1995;29:449–54.
Mother's education <=9 years **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years: 11% had initial or manifest caries; 7% had one or more manifest lesions. At 3.5 years: 37% initial/manifest; 29% manifest.	3.6 (OR, p<0.001) Univariate (manifest caries at 3.5 years) NS Multivariate (initial/manifest at 2.5 y) 2.58 (OR, p=0.002) Multivariate (manifest at 3.5 y) [standardized beta coefficient: 0.947] Note: Logistic regression ORs are standardized for each factor.	Children 1 year at baseline with follow up at 2.5 and 3.5 years of age (n=692) [Stockholm, Sweden]	Univariate and logistic multivariate regression for association with outcomes: initial/manifest caries at 2.5 years of age and manifest caries at 3.5 years of age (versus not). Initial caries - loss of translucency and slight roughness on probing (chalky appearance); Manifest - minimal level verified as a cavity detectable by probing; and catch of probe under slight pressure for fissures.	Grindefjord M, Dahllöf G, Nilsson B, Modéer T. Stepwise prediction of dental caries in children up to 3.5 years of age. Caries Res 1996;30:256–66.
Parent education (<h.s. or >=h.s.)	NS	Children 0-5 years at baseline followed for 2 years (n=788) [low-income African-American children in Detroit, Michigan]	Stepwise backward multiple regression, zero-inflated negative binomial models with outcomes: caries increment measured as (1) new d16mfs and (2) new d36mfs.	Ismail AI, Sohn W, Lim S, Willem JM. Predictors of dental caries progression in primary teeth. J Dent Res 2009;88: 270–5.
Mother educational level <=9 years (vs. >9 years) Father educational level <=9 years (vs. >9 years) +B165 **Note:** Baseline DMFT at 13 yrs (mean)=1.28 Baseline DMFSA at 13 yrs (mean)=0.31 DMFT at 19 yrs (mean): 3.39 DMFSa at 19 yrs (mean): 1.60	1.39 (OR, p<0.001) Bivariate 1.13 (OR, p=0.005) Note: Variables were included in multivariable regression as controls; OR and significance in these models were not reported.	13 years of age followed 6 years (n=15,538) [Stockholm, Sweden]	Bivariate and multivariable logistic regression with outcome: approximal caries increment (DMFSa) between 13 and 19 years of age.	Julihn A, Ekbom A, Modéer T. Maternal overweight and smoking: prenatal risk factors for caries development in offspring during the teenage period. Eur J Epidemiol 2009;24: 753–62.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Level 1 - Mother's schooling at birth >=12 years (vs less) **Note:** ECC prevalence at baseline (8 months) = 0; 14 months = 0; 20 months =1.6%; 26 months = 11.1%; 32 months=28.4%.	0.28 (IDR, p=0.003) Within level multivariable analysis 0.35 (IDR,p=0.017) Final model with all five levels, using sequential stepwise GEE	Children 8 months of age with six month follow-ups through 32 months of age (2-year follow up) (n=255 at recruitment; 155 at last follow-up) [Guangzhou, China]	Generalized estimating equations used to assess relationship with outcome: incidence density of a tooth surface developing caries, which is the number of new caries-affected surfaces per surface time at risk. Incidence density ratio = incidence density among those exposed and not exposed to independent variable. Sequential stepwise GEE using 5-level model (1=socioeconomic/demographic vars; 2=developmental characteristics; 3=nutritional upbringing including feeding/nutrition; 4=oral health behaviors; 5= S. mutans)	Zhou Y, Yang JY, Lo EC, Lin HC. The contribution of life course determinants to early childhood caries: a 2–year cohort study. Caries Res 2012;46:87–94.
Father's education level (categories - none, primary, secondary) Note: At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	0.65 (OR, p<0.05) Prediction model w/o biological factors (change dmft>0) 0.61 (OR, p<0.05) Prediction model w/ biological factors (change dmft>0) Not included Risk model w/o biological factors (change dmft>0) Not included Risk model w/biological factors (change dmft>0) NS Community high risk model; questionnaire (baseline dmft>0)	Children aged 3-6 years with one-year follow-up (n=1,576). [Singapore]	Multiple stepwise logistic regression for association with outcome: one-year caries increment measured as change in dmft. Data from 50% children used for model construction; remainder for model validation. Prediction (all potential factors) and risk models (subset of modifiable factors) with and without biological tests examined. Also, community screening model for identify "high risk" using a questionnaire - high risk = 25% of children with high caries burden (baseline dmft>2 for population studied). At baseline, 40.3% of children were affected by caries (mean dmft was 1.57). In 1 year, 43.7% of children had dmft increment. Mean increase of dmft in 1 year was 0.93.	Gao XL, Hsu CY, Xu Y, Hwarng HB, Loh T, Koh D. Building caries risk assessment models for children. J Dent Res 2010;89:637–43.
Mother's education (>=8 yrs vs. < 8 yrs) **Note:** The following variables did not have statistically significant association with caries at 12 yrs in initial bivariate tests: •Father's education (>=8 yrs vs. < 8 yrs) •Social class (employer/professional; skilled worker; unskilled worker) •Family income (quartiles) •Family economic status at 12 yrs (A+B, C, D+E) **Note:** Baseline caries: 63%	Initial Bivariate Tests DMFT>=1 at 12 yrs, p=0.03 (chi-square/Fischer exact test) Bivariate meant DMFT at 12 yrs, p=0.05 (Mann-Whitney u-test) Bivariate Poisson Regressions NS Univariate and Multivariate (p=0.07)	Study nested within a population based cohort with dental exams and interviews performed at 6 and 12 years of age (n=339) [Pelotas, Brazil]	Bivariate and multivariable associations with outcome: DMFT at 12 years old. Multivariate analyses were conducted using Poisson regression to generate relative risk ratio and logistic regression (backward stepwise) to predict dental caries at age 12 years. Variables grouped into hierarchical model with 6 levels: (1) socioeconomic/demographic, (2) nutritional/development characteristics, (3) OH behaviors and dental service use at age 6, (4) primary dental caries at 6 yrs, (5) family economic level at 12 yrs, (6) OH related behaviors and dental service use at 12 yrs. At each level, variables excluded if p>0.25. Final model variables retained if p<=0.05.	Peres MA, Barros AJ, Peres KG, Araujo CL, Menezes AM. Life course dental caries determinants and predictors in children aged 12 years: a population-based birth cohort. Community Dent Oral Epidemiol 2009;37:123–33.
High social status/parent education - both parents attained university level education (versus not) **Note:** Baseline caries prevalence among 3 year olds was 20.1% d1-5 mfs and 6.6% d3-5 mfs. Caries prevalence at 5 years was 48.0% d15mfs and 19.1% d3-5mfs.	2.6 (OR, p<0.05) Bivariate NS Multivariate	Children 3 years of age followed up at age 5 years (n=304) [Oslo, Norway]	Bivariate and multiple logistic regression of factors associated with outcome: positive severe caries increment (change in d3-5mfs). 5 grade caries diagnostic system: grades 1-2=enamel lesions; 3-5 dentine lesions. Caries increment=change d1-5mfs Severe caries increment=change d3-5mfs Molar-approximal caries excluded from caries increment calculations.	Skeie MS, Espelid I, Riordan PJ, Klock KS. Caries increment in children aged 3-5 years in relation to parents' dental attitudes: Oslo, Norway 2002 to 2004. Community Dent Oral Epidemiol 2008;36:441–50.

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Caregiver education (high school, post-high school, college degree) **Note:** Baseline mean age was 9.7 years Baseline mean ICDAS>=1: 15.7 Baseline mean ICDAS>=3: 8.2 12-month mean ICDAS>=1: 17.9 -89% of children 12-month mean ICDAS>=3: 8.4 -61% of children 24-month mean ICDAS>=1: 16.8 -91% of children 242-month mean ICDAS>=3: 8.4 -68% of children	**Bivariate association with Caries Progression (significant or NS using logistic regression - specific values not reported)** New ICDAS>=1 at 24 months: NS New ICDAS>=3 at 24 months: NS **Multivariate Caries Risk Models** NS - Not included in any of the multivariate models.	5-13 years of age with 2-year follow-up (n=395) [Aguas Buenas, Puerto Rico]	Logistic regression for progression outcomes (see below) at 12/24 months; for each predictor individually; multiple regression developed using backward elimination retaining predictors p<0.05 with AUC/ROC calculated for final models at model level; Poisson regression for number of lesions with progression Two Outcomes: 1. Any progression (ICDAS>=1): at least one new lesion ICDAS>=1, one new filling, and/or progression of lesion from scores of 1-2 to 3 to higher or from 3-4 to 5 to higher between the two exams. 2. Progression toward cavitation (ICDAS>=3): at least one new lesion ICDAS>=3, one new filling, and/or progression of lesion from score of 1-2 to 3 or higher or from 3-4 to 5 or higher between the two exams. Models run for outcomes at 12 and 24 months; Models run without any baseline ICDAS; models run adding baseline ICDAS last; models run starting with baseline ICDAS score	Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.
Lower Socioeconomic Level (classified using parent occupation reported by adolescent): workers vs. civil servant **Note:** Baseline total population % with DMFS=0: 47% Baseline high risk % with DMFS=0: 28% Baseline DMFS, total population, 12 yrs old (mean)=1.67 Baseline DMFS, high risk, 12 yrs old (mean)=2.87 Baseline DeMFS, total population, 12 years old (mean)=2.40 Baseline DeMFS, high risk, 12 yrs old (mean)=4.67 DMFS, total population, 16 yrs old (mean)=3.69 DMFS, high risk, 16 yrs old (mean)=5.95 DeMFS, total population, 16 years old (mean)=6.42 DeMFS, high risk, 16 yrs old (mean)=10.03	1.05 (RR, p<0.05) Univariate, increment DMFS, total study group 1.04 (RR, p<0.05) Multivariable, increment DMFS, total study group 1.05 (RR, p<0.05) Univariate, increment DeMFS, total study group 1.06 (RR, p<0.05) Multivariable, increment DeMFS, total study group 1.08 (RR, p<0.05) Univariate, increment DMFS, high risk group 1.06 (RR, p<0.05) Multivariable, increment DMFS, high risk group 1.07 (RR, p<0.05) Univariate, increment DeMFS, high risk group 1.06 (RR, p<0.05) Multivariable, increment DeMFS, high risk group	12 years old at baseline followed for 4 years (n=3,373) [Sweden]	Bivariate and multivariable associations with two outcomes: (1) DMFS increment and (2) DeMFS increment -enamel caries on proximal surfaces included in index. Poisson regression with over-dispersion used to analyze incidence rate. Evaluated for total population and "high risk." High risk identified as -having >1 decayed proximal surface, enamel or dentine caries, filled proximal surface or missing tooth because of caries, or -dentist found patient had high risk due to mental/physical disability or chronic disease, or -CFU>10(5) - lactobacillus test Children randomly assigned to one of our preventive programs: (1) tooth-brushing, (2) fluoride lozenges prescription, (3) fluoride varnish, (4) individual program - counseling dental hygiene and nutrition; professional cleaning and FV.	Källestal C, Fjelddahl A. A four-year cohort study of caries and its risk factors in adolescents with high and low risk at baseline. Swed Dent J 2007;31:11–25.
Social class	NS	Children 2.5 years at baseline with 1-year follow-up (n=692) [Stockholm, Sweden]	Univariate analysis of each variable comparing children (A) caries free at baseline and follow-up, (B) caries free at baseline with caries at follow-up, (C) caries at baseline and follow-up - (A) and (B) compared; (B) and (C) compared.	Grindefjord M, Dahllöf G, Modéer T. Caries development in children from 2.5 to 3.5 years of age: a longitudinal study. Caries Res 1995;29:449–54.
Social class (based on father occupation, unemployed/workers social class3) **Note:** Clinical examinations conducted at 2.5 and 3.5 years of age. At 2.5 years: 11% had initial or manifest caries; 7% had one or more manifest lesions. At 3.5 years: 37% initial/manifest; 29% manifest.	1.8 (OR, p<0.01) Univariate (manifest caries at 3.5 years) NS Multivariate (initial/manifest at 2.5 y) NS Multivariate (manifest at 3.5 y)	Children 1 year at baseline with follow up at 2.5 and 3.5 years of age (n=692) [Stockholm, Sweden]	Univariate and logistic multivariate regression for association with outcomes: initial/manifest caries at 2.5 years of age and manifest caries at 3.5 years of age (versus not). Initial caries - loss of translucency and slight roughness on probing (chalky appearance); Manifest - minimal level verified as a cavity detectable by probing; and catch of probe under slight pressure for fissures.	Grindefjord M, Dahllöf G, Nilsson B, Modéer T. Stepwise prediction of dental caries in children up to 3.5 years of age. Caries Res 1996;30:256–66.
Neighborhood disadvantage (1=most disadvantaged; 4 = least disadvantaged)	0.7 (IRR, p=0.03) category 3 new d16mfs Note: Categories 2, 4 NS for new d16mfs. NS overall for new d36mfs.	Children 0-5 years at baseline followed for 2 years (n=788) [low-income African-American children in Detroit, Michigan]	Stepwise backward multiple regression, zero-inflated negative binomial models with outcomes: caries increment measured as (1) new d16mfs and (2) new d36mfs.	Ismail AI, Sohn W, Lim S, Willem JM. Predictors of dental caries progression in primary teeth. J Dent Res 2009;88: 270–5.

Included Studies

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Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk factors of caries progression in a Hispanic school-aged population. J Dent Res 2011;90:1189–96.

Gao XL, Hsu CY, Xu Y, Hwarng HB, Loh T, Koh D. Building caries risk assessment models for children. J Dent Res 2010;89:637–43.

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Appendix 3: Summary of Additonal Studies Identified by Panel members Factors

Summary of Study Results by Data Element: DISEASE INDICATORS

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Presence of any non-cavitated active enamel lesion(s) *(aka white spots, non-cavitated enamel defect, initial superficial, ADA CCS initial)*				
Approximal enamel lesions on xrays	8.21 (OR, p<0.001) *Note: In decision analysis: Domejean et al. 2015 found this to be one of four main factors used in decision making by dental students using CAMBRA with patients	6 and older; primarily adults (n=12,954) [UCSF predoctoral dental clinic patients]	Bivariate association with outcome: Visible cavitation or radiographic penetration of the dentin at CRA baseline	Domejean, White & Featherstone. CAMBRA Caries Risk Assessment — A Six-Year Retrospective Study. CDA Journal. 2011;38(10): 709-715.
White spots	2.77 (OR, p<0.001) *Note: In decision analysis: Domejean et al. 2015 found this to be one of four main factors used in decision making by dental students using CAMBRA with patients	6 and older; primarily adults (n=12,954) [UCSF predoctoral dental clinic patients]	Bivariate association with outcome: Visible cavitation or radiographic penetration of the dentin at CRA baseline	Domejean, White & Featherstone. CAMBRA Caries Risk Assessment — A Six-Year Retrospective Study. CDA Journal. 2011;38(10): 709-715.
Evident tooth decay or white spots **Note:** Baseline: 63% with evident decay or restorations	55.1 (RD, p<0.05) Follow Up	6-72 months at baseline (n=1,315) [UCSF predoctoral dental clinic patients]	Bivariate association with (1) evident decay or white spot at baseline and (2) evident decay at follow-up (longitudinal unadjusted associations); follow-up time ranged 4-36 months	Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.
Presence of any cavitated lesion(s) *(aka ADA CCS moderate, ADA CCS Advanced, obvious caries)*				
Any cavitated lesion in last 3 years for new patient or since last caries risk assessment for existing patients				
Restorations (within 3 years)	1.46 (OR, *p*<0.001) *Note: In decision analysis: Domejean et al. 2015 found this to be one of four main factors used in decision making by dental students using CAMBRA with patients	6 and older; primarily adults (n=12,954) [UCSF predoctoral dental clinic patients]	Bivariate association with outcome: Visible cavitation or radiographic penetration of the dentin at CRA baseline	Domejean, White & Featherstone. CAMBRA Caries Risk Assessment — A Six-Year Retrospective Study. CDA Journal. 2011;38(10): 709-715.
Recently placed restorations (within 2 years) Note: Baseline: 63% with evident decay or restorations	15.5 (RD, p<0.05) Baseline 12.1 (RD, p<0.05) Follow-Up	6-72 months at baseline (n=1,315) [UCSF predoctoral dental clinic patients]	Bivariate association with (1) evident decay or white spot at baseline and (2) evident decay at follow-up (longitudinal unadjusted associations); follow-up time ranged 4-36 months	Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.

Summary of Study Results by Data Element: PROTECTIVE FACTORS

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Brushes twice a day with fluoridated toothpaste				

Fluoride toothpaste (at least daily)	0.81 (OR, p=0.003)	6 and older; primarily adults (n=12,954) [UCSF predoctoral dental clinic patients]	Bivariate association with outcome: Visible cavitation or radiographic penetration of the dentin at CRA baseline	Domejean, White & Featherstone. CAMBRA Caries Risk Assessment — A Six-Year Retrospective Study. CDA Journal. 2011;38(10): 709-715.
Fluoride toothpaste (at least daily) Note: Baseline: 63% with evident decay or restorations	5.3 (RD, p<0.05) Baseline NS Follow-Up	6-72 months at baseline (n=1,315) [UCSF predoctoral dental clinic patients]	Bivariate association with (1) evident decay or white spot at baseline and (2) evident decay at follow-up (longitudinal unadjusted associations); follow-up time ranged 4-36 months	Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.
Drinks fluoridated water				
Community water fluoridation	0.85 (OR, p=0.011)	6 and older; primarily adults (n=12,954) [UCSF predoctoral dental clinic patients]	Bivariate association with outcome: Visible cavitation or radiographic penetration of the dentin at CRA baseline	Domejean, White & Featherstone. CAMBRA Caries Risk Assessment — A Six-Year Retrospective Study. CDA Journal. 2011;38(10): 709-715.
Community water fluoridation Note: Baseline: 63% with evident decay or restorations	8.0 (RD, p<0.05) Baseline NS Follow-Up	6-72 months at baseline (n=1,315) [UCSF predoctoral dental clinic patients]	Bivariate association with (1) evident decay or white spot at baseline and (2) evident decay at follow-up (longitudinal unadjusted associations); follow-up time ranged 4-36 months	Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.
Drinks fluoridated water Note: Baseline: 63% with evident decay or restorations	NS Baseline NS Follow-Up	6-72 months at baseline (n=1,315) [UCSF predoctoral dental clinic patients]	Bivariate association with (1) evident decay or white spot at baseline and (2) evident decay at follow-up (longitudinal unadjusted associations)	Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.
Prescription home-use products (e.g. high concentration fluoride toothpastes)				
In-office applied fluoride products (e.g. fluoride varnish)				
FV in past 6 months Note: Baseline: 63% with evident decay or restorations	NS Baseline NS Follow-Up	6-72 months at baseline (n=1,315) [UCSF predoctoral dental clinic patients]	Bivariate association with (1) evident decay or white spot at baseline and (2) evident decay at follow-up (longitudinal unadjusted associations); follow-up time ranged 4-36 months	Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.
Over the counter fluoride products (e.g. mouth rinses)				
Fluoride mouthwash daily	0.80 (OR, p<0.001)	6 and older; primarily adults (n=12,954) [UCSF predoctoral dental clinic patients]	Bivariate association with outcome: Visible cavitation or radiographic penetration of the dentin at CRA baseline	Domejean, White & Featherstone. CAMBRA Caries Risk Assessment — A Six-Year Retrospective Study. CDA Journal. 2011;38(10): 709-715.

Summary of Study Results by Data Element: RISK FACTORS

Data Element	Results (OR, RD, RR, Sn, Sp)	Population **Note:** *n* represents sample size at final follow-up	Relationship Examined	Study
Deep pits and fissures				

Deep pits and fissures	1.80 (OR, p<0.001)	6 and older; primarily adults (n=12,954) [UCSF predoctoral dental clinic patients]	Bivariate association with outcome: Visible cavitation or radiographic penetration of the dentin at CRA baseline	Domejean, White & Featherstone. CAMBRA Caries Risk Assessment — A Six-Year Retrospective Study. CDA Journal. 2011;38(10): 709-715.
Visible plaque on teeth				
Visible heavy plaque on teeth	2.55 (OR, p<0.001) *Note: In decision analysis: Domejean et al. 2015 found this to be one of four main factors used in decision making by dental students using CAMBRA with patients.	6 and older; primarily adults (n=12,954) [UCSF predoctoral dental clinic patients]	Bivariate association with outcome: Visible cavitation or radiographic penetration of the dentin at CRA baseline	Domejean, White & Featherstone. CAMBRA Caries Risk Assessment — A Six-Year Retrospective Study. CDA Journal. 2011;38(10): 709-715.
Heavy dental plaque Note: Baseline: 63% with evident decay or restorations	32.5 (RD, p<0.05) Baseline 17.6 (RD, p<0.05) Follow-Up	6-72 months at baseline (n=1,315) [UCSF predoctoral dental clinic patients]	Bivariate association with (1) evident decay or white spot at baseline and (2) evident decay at follow-up (longitudinal unadjusted associations); follow-up time ranged 4-36 months	Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.
Difficulty with home care due to physical or behavioral reasons				
Frequent sugar consumption (e.g. sugary drinks, snacks rich in fermentable carbohydrates)				
Bottle for nonmilk/nonwater Note: Baseline: 63% with evident decay or restorations	11.8 (RD, P<0.05) Baseline NS Follow-Up	6-72 months at baseline (n=1,315) [UCSF predoctoral dental clinic patients]	Bivariate association with (1) evident decay or white spot at baseline and (2) evident decay at follow-up (longitudinal unadjusted associations); follow-up time ranged 4-36 months	Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.
Bottle use in bed Note: Baseline: 63% with evident decay or restorations	8.2 (RD, P<0.05) Baseline NS Follow-Up	6-72 months at baseline (n=1,315) [UCSF predoctoral dental clinic patients]	Bivariate association with (1) evident decay or white spot at baseline and (2) evident decay at follow-up (longitudinal unadjusted associations); follow-up time ranged 4-36 months	Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.
Bottle use continuously Note: Baseline: 63% with evident decay or restorations	7.5 (RD; p<0.05) Baseline NS Follow-Up	6-72 months at baseline (n=1,315) [UCSF predoctoral dental clinic patients]	Bivariate association with (1) evident decay or white spot at baseline and (2) evident decay at follow-up (longitudinal unadjusted associations)	Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.
Frequent snack (>3 times daily between meals)	1.77 (OR, p<0.001)	6 and older; primarily adults (n=12,954) [UCSF predoctoral dental clinic patients]	Bivariate association with outcome: Visible cavitation or radiographic penetration of the dentin at CRA baseline	Domejean, White & Featherstone. CAMBRA Caries Risk Assessment — A Six-Year Retrospective Study. CDA Journal. 2011;38(10): 709-715.
Frequent snacking Note: Baseline: 63% with evident decay or restorations	29.8 (RD, P<0.05) Baseline 15.8 (RD, P<0.05) Follow-Up	6-72 months at baseline (n=1,315) [UCSF predoctoral dental clinic patients]	Bivariate association with (1) evident decay or white spot at baseline and (2) evident decay at follow-up (longitudinal unadjusted associations); follow-up time ranged 4-36 months	Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.
Dry mouth (due to medication, radiation, chemotherapy, drug use)				

Recreational drug use	1.95 (OR, p<0.001)	6 and older; primarily adults (n=12,954) [UCSF predoctoral dental clinic patients]	Bivariate association with outcome: Visible cavitation or radiographic penetration of the dentin at CRA baseline	Domejean, White & Featherstone. CAMBRA Caries Risk Assessment — A Six-Year Retrospective Study. CDA Journal. 2011;38(10): 709-715.
Salivary-reducing medications Note: Baseline: 63% with evident decay or restorations	10.9 (RD; p<0.05) Baseline 16.6 (RD; p<0.05) Follow-Up	6-72 months at baseline (n=1,315) [UCSF predoctoral dental clinic patients]	Bivariate association with (1) evident decay or white spot at baseline and (2) evident decay at follow-up (longitudinal unadjusted associations); follow-up time ranged 4-36 months	Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.
Orthodontic or prosthodontic appliances.				
Recent caries experience in parents or siblings				
Caregiver or sibling tooth decay Note: Baseline: 63% with evident decay or restorations	13.3 (RD; p<0.05) Baseline 10.1 (RD; p<0.05) Follow-Up	6-72 months at baseline (n=1,315) [UCSF predoctoral dental clinic patients]	Bivariate association with (1) evident decay or white spot at baseline and (2) evident decay at follow-up (longitudinal unadjusted associations); follow-up time ranged 4-36 months	Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.
Special healthcare needs				
Special care needs Note: Baseline: 63% with evident decay or restorations	7.1 (RD; p<0.05) Baseline NS Follow-Up	6-72 months at baseline (n=1,315) [UCSF predoctoral dental clinic patients]	Bivariate association with (1) evident decay or white spot at baseline and (2) evident decay at follow-up (longitudinal unadjusted associations); follow-up time ranged 4-36 months	Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.
Low SES				
Low SES Note: Baseline: 63% with evident decay or restorations	15.5 (RD; p<0.05) Baseline 10.4 (RD; p<0.05) Follow-Up	6-72 months at baseline (n=1,315) [UCSF predoctoral dental clinic patients]	Bivariate association with (1) evident decay or white spot at baseline and (2) evident decay at follow-up (longitudinal unadjusted associations); follow-up time ranged 4-36 months	Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.

Included Studies

Chaffee, Featherstone, Gansky, Cheng, and Zhan. Caries Risk Assessment Item Importance: Risk Designation and Caries Status in Children under Age 6. JDR Clinical & Translational Research. 2016;(1)2:131-142.

Domejean, White & Featherstone. CAMBRA Caries Risk Assessment — A Six-Year Retrospective Study. CDA Journal. 2011;38(10): 709-715.

Domejean, et al. How Do Dental Students Determine Patients' Caries Risk Level using the Caries Management by Risk Assessment (CAMBRA) System? J Dent Educ. 2015;79(3):278-285.

Appendix 4: Identifying Data Elements/Factors for a CRA Tool – Summary of Expert Panel Discussions and Determinations

Data elements from all major CRA tools currently in use were included to form a comprehensive list. The list was divided into three categories of data elements:

- Disease Indicators
- Protective Factors
- Risk Factors

Disease Indicators

	Data Element in Delphi I	Discussions following Delphi surveys	CRA Tool Factors
1	White Spot Lesions	Disease is already present even if the lesion is at a non-cavitated stage. Important to distinguish between "active" and "inactive" lesions: The ADA CCS paper has a clear guide that can support practical determination of "activity". "Smooth surface" vs. "occlusal pit and fissures" are often are considered different types of disease. But diagnostic coding at tooth-level will capture this. Activity and extent are more important.	***Active initial lesion(s)*** *(i.e., enamel lesions, white spots)*
2	Non-cavitated enamel defect		
3	ADA CCS initial lesion(s)		
4	Active pit and fissure caries		
5	Past pit and fissure caries		
6	New or active non-cavitated occlusal or smooth surface enamel lesions		
7	New or active non-cavitated approximal enamel lesions		
8	Interproximal demineralization		
9	One or more interproximal lesions(s)		***Active moderate or advanced lesion(s)***
10	ADA CCS moderate or advanced lesions		
11	Obvious caries		

12	Cavitated smooth surface carious lesion		
13	One new smooth surface restoration due to caries within the past year	Difficult to say why a restoration was delivered. "Past experience of caries" is an important predictor of future disease. Having a time-box of 3 years is restrictive and doesn't allow the patient to be re-categorized and sends the message that once at high risk patient remains for 3 years and doesn't need reassessment. Also having a time-box may not take into account severe disease just beyond that time box. But not having a time-box doesn't allow a patient to be re-categorized ever. A three year time box for children under age 6 is inappropriate.	***Moderate or advanced lesion(s) in the last 3 years or since last assessment***
14	Restorations or cavitated lesions		
15	Interproximal restorations		
16	Direct Restorations		
17	Indirect restorations		
18	Missing teeth due to caries		
20	dmft/DMFT		
21	Caries experience (high DMFT/dmft, interproximal restorations, root caries, direct or indirect restorations, fillings, crowns and bridges)		
19	Root Caries	Not relevant for children	Do not include

Protective Factors

Note: Most of these "protective" factors can also be viewed as "risk factors" – i.e., lack of protective factors indicates greater risk for disease or presence of disease. Clinicians preferred them to be worded positively: i.e., use "Brushes with fluoridated toothpaste – Yes/No" rather than "Does not brush with fluoridated toothpaste – Yes/No".

	Data Element in Delphi I	**Discussions following Delphi surveys**	**CRA Tool Factors**
1	Brushes twice a day	More evidence for effect of the fluoridated toothpaste rather than the brushing itself.	***Brushes twice a day with toothpaste containing fluoride***
2	Uses fluoride toothpaste		
3	Drinks fluoridated water	Difficult to say how much a person drinks and thus exactly what the contribution will be to the persons' risk/protection. Also there is a "halo" effect in which people that live in non-fluoridated communities consume	***Predominantly drinks fluoridated water/beverages made from fluoridated water***

		beverages that may have been produced in fluoridated communities	
4	Other home-use fluoride products	These are interventions that follow assessment of risk. So if these are present as "protective factors" that just means someone has assessed risk and deemed these interventions as being necessary. They have an additive effect on lowering risk. Keep these elements separate. They may all have an equivalent contribution to the risk, but from a clinician perspective this is all good information to have for care planning. Rinse evidence: https://www.ncbi.nlm.nih.gov/pubmed/27472005	***Uses at-home prescription fluoride products***
5	Fluoride mouth rinse		***Uses over the counter mouth rinse that says "fluoride-containing"*** *(consider for older children)*
6	High-concentration fluoride toothpaste		***Receives professionally applied fluoride***
7	Fluoride varnish		
8	Antiseptic or antimicrobial mouthwashes	Insufficient evidence that the intervention lower risk. Intervention following risk assessment but because a person was prescribed doesn't tell us why it was prescribed.	Do not include.
9	Xylitol use	Insufficient evidence that the intervention lower risk	Do not include
10	Xylitol gum		
11	Xylitol lozenges		
12	Calcium phosphate pastes	Insufficient evidence that the intervention lower risk	Do not include
13	Salivary flow	- Not relevant for children **-** Strong evidence that when the flow rate is lower there is higher association with caries risk (Leone et al., J Dent Ed, 2001;65:1054-1062). - Time to saturate a cotton roll used in previous research. Many considerations	Do not include as a separate factor; consider with "dry mouth" as a risk factor (see below)

		exist: Is there a chairside tool that is accurate? Stimulated or not? Mucous or serous or both and in what combo? Is It flow or consistency or constituency? We know, for example, that calcium rich saliva has an anti-caries effect, but what is "enough"? In young children, this may be a fairly subjective metric, due to their inability to reliably spit into a tube. - The factor that is important is "Dry Mouth" **by clinical appearance or measured**. Clinical observation and judgement of dry mouth is often all that is required, if the patient's mouth is wet, it is wet and if it is dry, it is dry. There is a lot of debate about stimulated and unstimulated saliva measurement. For those who measure stimulated saliva, less than 1mm/min over 3 minutes, indicates dry mouth. In practical terms, some clinicians only measure saliva when it is not clear if the patient is wet or dry. The presence of dry mouth, elevates risk one level, i.e. from low to moderate, moderate to high and high to extreme. - But clinically difficult to use and interpret.	

Risk Factors (Person-centered parameters)

	Data Element in Delphi I	Discussions following Delphi surveys	CRA Tool Factors
1	Deep pits and fissures	Operational definition? Will multiple clinicians view this and come to the same conclusion? Clinicians feel "yes" May be important for younger kids. Just like we had "fluoride" as a protective factor, should we not have "sealants" as a protective factor?	***Susceptible deep, un-coalesced, and unsealed pits and fissures***
2	Visible plaque on teeth	Children usually have an opportunity to brush before their dental visit. When a child comes in with visible plaque even with this opportunity then we need to consider this as a risk factor. Clinicians feel this can be operationalized. Evidence supports http://onlinelibrary.wiley.com/doi/10.1111/j.1600-0528.1994.tb02049.x/full	***Visible plaque***

3	Difficulty with home care due to physical restrictions	Combine into one. Consider whether this can be associated with “brush twice a day with F toothpaste” because if they physically can’t then that item may be impacted. However some may be able to “brush” but not do that properly.	***Physical or behavioral health issues that impede home care***
4	Difficulty with home care due to psychological restrictions		
5	Diet rich in carbohydrates	Diet rich in complex carbohydrates is ok. It’s the sugar that’s the problem	***Consumers more than 3 sugary beverages or snacks between meals each day (If infant, is the child put to bed with a bottle containing beverage with sugar)***
6	Frequent sugary snacks		
7	Frequent sugary drinks		
8	Dry mouth	- Can be combined since the reason for dry mouth isn’t as important as the condition itself from a CRA perspective	***Clinically little saliva or medical condition or medication that causes dry mouth***
9	Medication induced dry mouth		
10	Radiation induced dry mouth		
11	Recreational drug use		
12	Exposed roots	- NA in children	Do not include
13	Orthodontic or prosthodontics appliances	- Include	***Orthodontic or prosthodontic appliances that impede oral hygiene***
14	Parent or caregiver has active caries	- Activity can’t be recorded without an exam	***Parents or siblings have cavitated lesion(s) in the last year (consider for children under age 14)***
15	Siblings have active caries		
16	General health conditions	Too many permutations/combinations. Element should include emerging healthcare conditions.	***Physical or behavioral health***
17	Major health changes		

18	Special healthcare needs		***issues that impede home care***
19	Eating disorders		
20	Chemo/radiation therapy		
23	Saliva pH	Adds cost. Limited evidence. Difficult measuring chair-side. It contributes to risk but it varies throughout the day, so isn't reliable as a one-time measure.	Do not include

Risk Factors (Population Parameters)

	Data Element in Delphi I	Discussions following Delphi surveys	CRA Tool Factors
21	Parent or caregiver has low socioeconomic status	Inclusion considerations: - SES is a population parameter. Low SES and Medicaid status are being used as a proxy for poverty which is a proxy for various exposures and behaviors which would then affect caries risk as a risk factor. This is not straightforward as say someone with physical limitations affecting their ability to brush. - Predictive ability of any risk factor is assessed in populations and applied to individuals. - Significant evidence for strong **correlation** between SES and caries incidence. - However, Chaffee, et. al. reports in a group of children under 6 (n=1,289), those with low SES 57.6% (n=859) had decay and 47.2% (n=430) did not, **a risk difference of only** 10.4%. - Most people doing caries risk place the variable as either a disease indicator, risk factor or protective factor. Disease indicators elevate risk all on their own. Risk factors, generally take more than one to elevate risk. Protective factors decrease risk. SES can be a risk factor that when	Do not include as data element. But include guidance about how to factor SES into the CRA process.
22	Medicaid enrollment		

		combined with other risk factors raises the risk level. - Insufficient evidence to determine whether SES is a risk factor outside of the other disease indicators/risk factors that we were looking at, or whether it more so correlated in that those with low SES tend to have other caries risk factors? <u>Definition considerations</u> "Medicaid" and "Government programs" are not good definitions. Use family level measures (income and parental education are two of the easiest to determine). In many settings income/parent education are not collected and it makes some people uncomfortable to ask these question	

Additional Data Elements Not Included in Delphi 1

	Additional Factors not included in Delphi I	**Discussions following Delphi surveys**	**CRA Tool Factors**
1	Mutans Streptococci	Adds cost that is not present in a "look and ask" CRA. Mixed evidence interpretation. Recent research suggests numbers may decline but virulence rises after treatment. Strains of S mutans would make this a more complicated test and (maybe) affect its utility as a point-or-service test. There are both pathologic and non-pathogenic species in the biofilm and that their ratio is important in predicting future caries. Assessing bacterial species or even assessing the degree of challenge from a particular patient's biofilm is not likely to be chair-side easy. Newer chairside methods are in development.	Do not include
2	Bacterial Challenge		
3	Recall compliance	May assist in determining course/intensity of treatment but not predictive of future disease occurrence	Do not include
4	Locus of control	Extent to which parents have control over their child's behavior e.g. getting them to brush. Some research available but not overwhelming support	Do not include