A Systematic Review of Evidence on Caries Risk Assessment for Preschool Children and Recommendations for the Development of a Canadian Caries Risk Assessment Tool for Screening Purposes

## Prepared for: The Office of the Chief Dental Officer, Public Health Agency of Canada

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**Background:** Despite all the advancements in dental prevention over the past decades, the problem of early childhood caries (ECC) and severe ECC (S-ECC) persists in the twenty first century. Evidence from the United States would suggest that while the prevalence of caries among older children, youth and adults has declined, the prevalence of ECC in the preschool population has actually increased.<sup>1</sup> Indigenous children (including First Nations, Métis, Inuit, American Indian, and Alaska Natives), immigrants and refugees, children living in poverty, and those residing in isolated rural and remote communities are more likely to be affected by ECC than other children in North America.<sup>2-7</sup> However, while ECC may be concentrated in children from these groups, it does not discriminate and can also cross cultural and socioeconomic boundaries.

For many children with S-ECC, dental surgery under general anesthesia is the only treatment option.<sup>8</sup> In-hospital day surgery to treat S-ECC is the most common day surgical procedure in Canada.<sup>9</sup> The hospital costs to perform these dental surgeries exceeds \$21 million each year.<sup>9</sup> Rates of dental surgery performed under general anesthesia are a useful indicator of the oral health status of young children when national clinical surveillance data is unavailable as it provides a snapshot of the most severe cases.<sup>10</sup> A recent report from the Canadian Institute of Health Information in 2013 revealed that the rate of dental surgery to treat S-ECC in Canada is 12.5/1000 children 1-5 years of age.<sup>9</sup> Children living in rural regions of Canada, from the least affluent households, and residing in neighbourhoods with a high percentage of Indigenous residents demonstrate higher rates of dental surgery.<sup>9</sup> The rates of dental surgery for S-ECC are even higher in northern portions of Canada (up to 227/1000 children), where many First Nations and Inuit communities are located.<sup>9, 10</sup> Unfortunately, this surgical approach

fails to address the underlying risk factors for S-ECC as many develop new or recurrent caries within months of surgery.<sup>8</sup> It is not uncommon for some children to undergo repeat visits to the operating room because of recurrent caries.<sup>8</sup> This highlights the importance of implementing an upstream effective prevention regimen to complement restorative care.

Like other chronic diseases, ECC is multifactorial in origin. While we are all familiar with the basic etiological triad, including teeth, bacteria, and sugars, there are other oral environmental, social, economic, personal factors and lifestyle behaviours at play.<sup>11, 12</sup> Childhood caries is shaped by a broad range of determinants of health. The Fisher-Owens conceptual model describes the various child (e.g. biological and genetic endowment, physical and demographic characteristics, use of dental care, etc.), family (e.g. socioeconomic status and family finances, health practices and behaviours, culture, family make-up, etc.), and community (e.g. health and dental care systems, physical and social environments, culture, etc.) level factors that shape a child's dental health. The multiple factors at play is what makes preventing caries so difficult in young children. The Canadian Dental Association (CDA) recognizes the role that these non-biomedical factors have in caries development and specifically mentioned that ECC is heavily influenced by the social determinants of health in their formal position statement on this disease process.<sup>13</sup>

The goal of caries-risk assessment is to help predict development or progression of caries lesions overtime, while at the same time aiding in providing patient-centered caries prevention and management strategies for patients. What makes caries risk-based care unique over traditional surgical/restorative approaches to dealing with caries lesions is that there is emphasis on intervening before there is irreversible damage to teeth, tailored on individual

needs.<sup>14-16</sup> It is vital that dentists and other members of the dental team familiarize themselves on how to undertake periodic caries-risk assessments of their patients. Caries-risk assessment tools can also be used by non-dental professionals to screen children, determine their cariesrisk, and provide prevention services, including fluoride varnish and anticipatory guidance.

Several dental and pediatric organizations have developed tools that can be used to help guide practitioners in determining someone's likelihood of developing caries. These tools provide a means to allow practitioners to identify risk factors, disease causative behaviours that can promote caries, along with protective factors known to minimize the risk of onset.<sup>13</sup>

Timely risk assessment is an important first step in a combined approach to reduce the risk for ECC. <sup>17</sup> It can help identify whether a child is at low, moderate, or high likelihood of developing caries, and can serve as a guide to choosing appropriate preventive interventions and practices that can help minimize the risk for decay. These tools help guide the conversation between the dental provider and the parent or caregiver so that key information is obtained to assist in identifying many of the protective and caries-causing factors that are at play in a child's life.

# Update to Systematic Review Since Initial Report was Submitted to the Public Health Agency of Canda (PHAC):

The Office of the Chief Dental Officer (OCDO) initiated this caries risk assessment project and commissioned a contract in 2017 to first explore the body of evidence as a means to develop and create a Canadian caries risk assessment tool that would allow non dental primary

healthcare providers and dental providers in non-dental clinical settings to assess the risk of tooth decay for kids under the age of six.

In March 2018, the OCDO at PHAC convened an important interprofessional stakeholder meeting of experts and potential users to discuss the findings from the initial report systematic review of the literature (November 2017), the review of existing tools, and the draft version of the caries risk assessment tool. Participants at this two-day meeting included staff of the OCDO, representatives of the Canadian Paediatric Society, Canadian Academy of Pediatric Dentistry, and the Canadian Association of Public Health Dentistry. Representatives from the Canadian Dental Association, Canadian Dental Hygienists Association, Canadian Dental Assistants Association, Saskatchewan Dental Therapists Association, and the College of Family Physicians of Canada, the Canadian Dental Regulatory Authorities Federation and the Association of Canadian Faculties of Dentistry attended as observers attended as observers.

Participants and observers at this meeting discussed the draft version of a tool that was developed following a systematic review of the literature and accompanying assessment of the level of evidence, a comprehensive review of existing caries risk assessment tools for children, and informed by Canadian evidence of risk factors for ECC, to debate questions that should be included in a proposed tool for preschool children. Following deliberations, a leaner seven-item draft caries risk assessment tool resulted comprising three domains: clinical factors, sociodemographic and biological factors, and protective factors. The working group also recommended that the initial systematic review report be amended to include an additional robust critical appraisal and to focus group test the drafted tool with non-dental primary care providers and other experts and to propose a refined tool for discussion at a follow-up meeting

with the stakeholder group in November 2018. This necessitated the OCDO at the PHAC to enter into a second contract with the project lead to undertake these additional activities. However, that project does not include pilot testing of this tool to determine its potential sensitivity and specificity.

# Notable Reports and Systematic Reviews on Caries Risk Assessment (as reviewed by Fontana 2015):<sup>18</sup>

Over the years there have been several well conducted systematic reviews and commentaries

on the topic of caries risk assessment.<sup>19-26</sup> The following are some highlights:

# National Institutes of Health Consensus Development Conference Statement, March 26-28, 2001<sup>26</sup>

This NIH Conference discussed the question of "what are the best indicators for an increased risk of dental caries?". It concluded that although numerous risk indicators for caries exist, past caries experience is the most consistent predictor of caries risk in children. Other factors identified to increase risk included inadequate exposure to fluoride, inadequate oral hygiene and conditions that hinder regular long-term oral hygiene, fermentable carbohydrates consumption, medical conditions that impact salivary flow, the presence of mutans streptococci bacteria, and low socioeconomic status (SES).<sup>27</sup> However, much of the supportive evidence comes from cross-sectional correlations depicting accumulated caries experience, with few prospective predictive studies.<sup>27</sup>

## Swedish Council on Technology Assessment in Health Care (2007)<sup>28</sup>

This 2007 report was a systematic review of caries diagnosis, risk assessment, and non-invasive treatment. This review revealed that past caries experience is the strongest single predictor of

future caries risk, and other factors have limited accuracy when assessed individually to determine caries risk.<sup>18, 28</sup> This systematic review supported use of multivariate models for caries prediction.<sup>18, 28</sup>

#### Tellez et al 2013<sup>23</sup>

A 2012 systematic review by Tellez et al concluded that there was limited and weak evidence on the validity of several caries risk assessment systems in use.<sup>23</sup> The authors concluded that most of the existing evidence was associated with use of the Cariogram, a computer-based riskalgorithm software, and yet that this tool has limited prediction accuracy, particularly in preschool children.<sup>23</sup> They concluded that there is a considerable need to establish valid and reliable means to assess caries risk based on evidence rather than the opinion of experts in the field.<sup>23</sup>

#### Scottish Intercollegiate Guidelines Network (SIGN)<sup>29</sup>

In 2014 the Scottish Intercollegiate Guidelines Network (SIGN) published a report "Dental interventions to prevent caries in children – A national guideline".<sup>29</sup> This document reviewed caries risk indicators, and caries risk assessment tools.<sup>29</sup> Considerable numbers of caries risk indicators have been identified, including: dietary factors, oral hygiene factors, microbiological factors, socio-demographics, and previous caries experience.<sup>29</sup> The SIGN report concluded that there was generally high quality evidence from systematic reviews (of case control and cohort studies) and high quality case control and cohort studies with a very low risk of confounding or bias. There is a high probability that the relationship is causal for caries, for the following factors: microbiological risk factors (e.g. levels of mutans streptococci), sociodemographic risk factors (e.g. low socioeconomic status, those living in areas of high deprivation, low

birthweight), previous caries experience, reduced salivary flow, and parental influences (e.g. presence of active decay in mothers, maternal levels of oral mutans streptococci, high maternal sucrose intake).<sup>29</sup> However, there is only evidence from non-analytic studies (e.g. case reports) relating to parental deprivation as a risk indicator for caries development in their children, and there is only expert opinion that salivary markers have proved helpful in determining caries risk.<sup>29</sup>

Overall, the SIGN document recommended that the following be considered when determining future caries risk for children<sup>29</sup>:

- Clinical evidence of previous disease (i.e. past caries experience)
- Dietary habits, especially frequency of sugary foods and drinks
- Social histories, particularly socioeconomic status
- Use of fluorides
- Oral hygiene and plaque control
- Saliva
- Medical history

## Mejàre et al 2014<sup>20</sup>

This systematic review also identified that past caries experience is the best and most reliable predictor of future caries in preschool children, having moderate to good accuracy in this age group.<sup>20</sup> This review also indicated that the Cariogram has limited accuracy in predicting caries and supported the use of multivariate prediction models for preschool caries risk assessment.<sup>20</sup>

According to Twetman and Fontana, the following are some examples of factors

routinely considered for a caries risk assessment<sup>25</sup>:

Variable	Quantification	High-risk values
Sociodemographic		
Socioeconomic level	Education level	Low
Immigrant background	Parent generation	Mother 1 <sup>st</sup> generation
Behavioural		
Mental or physical disabilities	Case history	Medication, impaired priority
Awareness and attitudes	Interview	Poor "health choices"
Diet and sweet intakes	Frequency	Cariogenic and several times daily
Juice and soft drinks	Habit and frequency	Sipping and several times daily
Nocturnal meals (toddlers)	Frequency	Regular habit
Toothbrushing	Frequency	Irregular, not supervised
Fluoride exposure	Frequency	Non-daily
Clinical and radiographic		
Caries prevalence	dmft/DMFT	Clearly higher than average for
		age
Proximal enamel lesions	bitewing radiographs	> 2 new lesions or progression
Oral hygiene level	visible plaque index	> 50% of inspected sites
Gingival condition	bleeding on probing	> 20% of measured sites
Supplementary tests		
Bacterial challenge	Cultivation	High mutans streptococcus
		counts
Salivary secretion rate	Sialometry	< 0.5 ml/min (stimulated)
Salivary buffer capacity	Titration	Low (pH ≤ 4.0)
The indicated values are suggestiv	e of a high caries risk, bu	It may vary by age and population
and should be correspondingly ad	justed.	

Table 1 – Factors routinely considered in caries risk assessment tools

## Sensitivity and Specificity of Caries Risk Assessment Tools:

One of the limitations of many caries risk assessment tools is that the majority have not

been validated, and almost none has been validated across different population groups. The

validity of a tool can be determined by assessing the sensitivity and specificity of the

instrument.<sup>21, 22, 26</sup>.<sup>21,</sup> Sensitivity in the context of caries risk assessment refers to the capability

of the tool to predict future caries risk in someone who actually does develop caries lesions. Specificity refers to the likelihood that a tool will predict the absence of caries in those who actually do not go on to develop lesions. It has been suggested that for a caries risk assessment tool to be useful, it should have a combined sensitivity and specificity score of at least 160%, and should be relatively well-balanced between these two measures.<sup>22</sup>

Well-designed and contemporary caries risk assessment tools can facilitate clinical dental examinations as they help guide and prompt clinicians to review and query parents regarding a multitude of factors that are recognized to contribute to disease development and progression.<sup>26</sup> Unfortunately, many of these instruments are not validated. A study by Gao et al (2013) explored the validity of caries risk assessment programs and tools for use with preschool populations.<sup>22</sup> They explored the predictability, sensitivity and specificity of the American Academy of Pediatric Dentistry's (AAPD) Caries Risk Assessment Tool, the Caries Management by Risk Assessment (CAMBRA), the Cariogram, and the National University of Singapore caries risk assessment program (NUS- CRA).<sup>22</sup> They concluded that algorithm-based software programs like the NUS-CRA (which this group developed) and Cariogram had a better balance of sensitivity and specificity over the other checklist style caries risk assessment tools, with the NUS-CRA performing better than the Cariogram (Sensitivity/Specificity of its screening and comprehensive models were 82%/73% and 81%/85%).<sup>22</sup> However, these algorithm-based programs may not be always practical for use in screening situations.

**Objective/Goal:** Conduct critical appraisal of the most current evidence on caries risk assessment for children that will lead to a national assessment tool to be use by the body of

non-dental primary care providers working in medical homes and oral health professionals working in non-conventional clinical settings in order to assess the risk of tooth decay and thereby, leading to better determine their young patients' caries-risk level, and provide prevention services including fluoride varnish and anticipatory guidance.

#### Methods:

There were three main activities as part of this project. They were to:

- Critically appraise the evidence on caries-risk assessment for children to inform the refinement of the caries risk assessment tool for use by non-dental primary healthcare providers in Canada.
- 2. Review of existing tools.
- Build a form-based tool that can be easily administered and used by oral health and non-dental primary healthcare providers to assess caries susceptibility in Canadian children.

## Search Strategy:

A formal search strategy was undertaken by Janet Rothney (JR), Dentistry Librarian at the University of Manitoba (Table 2). The search strategy was informed by previous search strategies used in other systematic reviews on caries risk assessment.<sup>20-23, 30</sup> Systematic searches were conducted in MEDLINE Ovid (1946 to 2017 Aug 09), Cochrane Library (searched 11 August 2017), Embase Ovid (1974 to 2017 Aug 09) and Scopus (searched 10 August 2017). No language and publication date limits were employed; letters and editorials were excluded where possible. Search strategies were modelled on the MEDLINE Ovid strategy (Table 2). 1921 results were gathered and duplicates were removed in EndNote by JR, with a final tally of 980 unique articles (Figure 1).

All abstracts were reviewed by the project lead (RJS – Team 1) and two additional teams (Team 2: CG, TK, RS and Team 3: CD, DD, DD). Inclusion criteria for selection of articles appear in Table 1. Articles were fully reviewed if an abstract was selected by a minimum of two review teams. For the purpose of this project, only those articles involving children < 72 months of age were selected (65 articles – see Figure 1). Those articles involving children six years of age and older will serve as a separate CRA project (69 articles – see Figure 1). Potential variables to include into the draft caries risk assessment tool for use were based on strength of associations (e.g., odd ratios, relative risk, hazard ratios, etc.), frequency of occurrence in the identified studies and existing caries risk assessment tools, as well as factors that were feasible to include. Quality of the evidence assessments performed by at least two review teams through consensus following GRADE.

Table 2 – Ovid MEDLINE(R) Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to Present (Searched August 10, 2017)

1. exp dental caries/

2. risk assessment/

3. (risk\* adj3 assess\*).ti,ab.

4. dental caries.ti,ab.

5. 1 or 4

6. 2 or 3

7. infant/ or exp child/ or exp childhood/ or adolescent/ or adolescence/ or "minor (person)"/ or puberty/ or exp pediatrics/ or school/ or high school/ or kindergarten/ or middle school/ or nursery school/ or primary school/ or (infant\* or infantcy or newborn\* or baby\* or babies or neonat\* or preterm\* or prematur\* or postmatur\* or child\* or schoolchild\* or school age\* or preschool\* or kid or kids or toddler\* or adoles\* or teen\* or boy\* or girl\* or minors or pubert\* or pubescen\* or p?ediatric\* or pe?diatric\* or nursery school\* or kindergar\* or primary school\* or secondary school\* or elementary school\* or middle school\* or high school\* or highschool\*).ti,ab.

8. and/5-7

9. limit 8 to (editorial or letter) 10. 8 not 9

# Table 3 – Inclusion Criteria for Reviewing Articles from Caries Risk Assessment Literature Search (modified from Mejàre et al<sup>19</sup> and Zero et al<sup>30</sup>)

## Study Design:

- Prospective/longitudinal cohort studies OR randomized controlled trial
- Studies using the same sample, but a different prediction model for caries risk are acceptable
- Studies using ≥ 1 risk factors/etiological factors/causative factors as a predictor of caries risk are acceptable (e.g. past caries experience; microbiological factors; host factors – enamel defects/hypoplasia, saliva flow rate; diet, socioeconomic; fluoride exposure; oral hygiene; etc.)
- Studies only looking at previous caries experience as a predictor of caries risk are acceptable.

## Study Sample:

- Inclusion criteria for study defined, selection of study sample declared
- Population defined and representativeness of sample understandable (no appearance of selection bias)
- Demographic characteristics of participants described
- Clinical characteristics of participants described
- All participants initially involved should be included.

## Methods:

- Caries diagnostic criteria described
- Predictor factors/variables are defined
- Validation variables are defined
- Studies involving only 1 dental examiner allowed if the same person completed both baseline and follow-up exams.

## Follow-up Time:

- ≥ 1 year follow-up for primary teeth
- $\geq$  2 year follow-up for permanent teeth.

## **Outcomes and Analysis:**

- Caries incidence or caries increment (dentin and/or enamel) reported at the tooth and tooth surface level
- Predictive validity: sensitivity and specificity are reported, relative risk, odds ratio, hazard ratio, caries rate ratio (incidence density ratio) or area under ROC curve. For this systematic review we will only include articles that reported sensitivities and specificities derived from multivariate analysis, which allows us to compare predictors across included articles.
- Studies on post-eruptive age as a risk factor for caries will be included if caries rate (incidence density) or some other survival analysis is performed or possible to calculate from reported study data.

**Results:** 

## Part A – Systematic Review of the Current Evidence on Caries-Risk Assessment in Children

A total of 25 publications met the inclusion criteria for this systematic review (Figure 1).<sup>17, 22, 31-<sup>53</sup> All of the included studies were prospective in design, either beginning during early childhood or prenatally. Included articles were carefully scrutinized and data were extracted from each. Key findings from multivariate analyses in these publications appear in Table 4. Quality of the evidence assessment result can also be found in Table 4. Table 5 provides an overall synopsis of the evidence from the studies.</sup> Figure 1 – PRISMA Flow Diagram



# PRISMA 2009 Flow Diagram



Reference	Age at Start	Possible Predictors of	Outcome in Final Model	Quality of
	(years)	Risk Assessed		Evidence
Leverett et al	Birth cohort	Prenatal fluoride	Poisson regression:	⊕⊕⊕⊕ High
1997 <sup>47</sup>		supplementation	No significant association	
		Sex	of prenatal fluoride	
			supplementation with	
			caries at age 3 to 5 years	
Pienihakkinen	2 years at	Mutans streptococcus	Mutans streptococcus	
et al 2004 <sup>31</sup>	baseline	from plaque	from plaque (OR 3.9)	
		Previous caries		
		experience d1-3mfs	Previous caries	
		Visible plaque	experience d1-3mfs (OR	
		Gingival Bleeding	7.3)	
		Fluoride use		
		Frequency of candy	Frequency of candy	
		consumption	consumption (OR 3.6)	
Skeie et al	5 year olds	Previous caries	≥ 1 one caries lesion (d1-	<b>⊕</b> ⊕OO <b>Low</b>
200453		experience	5mfs) on proximal	
			surface or molars at 5	
			years of age (OR 4.4)	
			Total d1-5mfs > one	
			standard deviation above	
			mean at 5 years of age	
			(OR 3.8)	
li et al 2006 <sup>33</sup>	1.5 years at	Cariostat completed for	Risk factors at 18 months	
	baseline	each child	to predict caries at 42	<b>~~~~~</b>
			months:	
		Breastfeeding	Breastfeeding (OR 3.3)	
		Eat snacks while playing		
		Frequency of snacks	Eat snacks while playing	
		Brushing assistance by	(OR 2.3)	
		mother	. ,	
		Set time for snacks	Risk factors at 30 months	
			to predict caries at 42	
			months:	
			Eat snacks while playing	
			(OR 1.6)	
			No brushing assistance	
			by mother (1.8)	
Alaki et al	Birth cohort	Acute otitis media	Acute otitis media and	
2008 <sup>37</sup>		(medical claims)	respiratory tract	

Table 4 – Summary of Included Articles in Systematic Review (modified from Mejàre et al<sup>20</sup>)

		Respiratory tract	infection at 0-12 months	
		infections (medical	(HR 1.3)	
		claims)		
		Urinary tract infections	Male (HR 1.1)	
		(medical claims		
		Race	Hispanic (HR 1.8)	
		Sex		
			African American (HR	
			1.6)	
Hong et al	0.5-2 vears	Enamel hypoplasia	Logistic GEE model for	<b>AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA</b>
2009 <sup>41</sup>	at baseline	Sex	caries at age 5 years:	
	(lowa	Childhood illness	Enamel hypoplasia (OR	
	Fluoride	Gestational age	7.6)	
	Study birth	Birth weight	Dental exam age (OR 7.6)	
	cohort)	Breast-feeding for $\geq 6$	Breastfeeding < 6	
	,	months	months (OR 2.2)	
		Eluoride concentration	Average home tap water	
		of home drinking water	fluoride concentration	
		Average daily fluoride	1.0 ppm (OR 2.4)	
		intake		
		Average daily soda pop		
		intake	Logistic GEE model for	
		Daily toothbrushing	caries at age 9 years:	
		frequency	Enamel hypoplasia (OR	
		Previous caries	5.2)	
		experience	Average daily	
		experience	toothbrushing frequency	
			during 5-9 years old (OR	
			2.2)	
			Logistic GEE model for	
			caries incidence age 5-9	
			Previous caries	
			experience (OR 5 1)	
			Average daily fluoride	
			intake during 5-9 years of	
			age (OR 1 9)	
			Average daily	
			toothbrushing frequency	
			during 5-9 years of age	
			(OR 2.0)	
Warren et al	0.5-2 vears	Age	Age (OR 1.1)	
2009 <sup>38</sup>	at baseline	Presence of plaque		
	(lowa	Presence of Mutans	Presence of mutans	
	Fluoride	streptococcus	streptococcus (OR 4 4)	
	Study birth	Sugar-sweetened		
	cohort)	beverage consumption		

		Night time bottle feeding	Sugar-sweetened	
			beverage consumption	
			(OR 3.0)	
Gao et al	3-6 years	Age	Prediction Screening	
2010 <sup>44</sup>		Sex	Model:	
		Race	Age (OR 1.0)	
		Country of birth	Malay race (OR 1.8)	
		Parents' education level	Father's education level	
		Housing condition	(OR 0.6)	
		Feeding histories	Months of breastfeeding	
		Diet habits	(OR 1.0)	
		Oral hygiene	Frequency of between-	
		Fluoride applications	meal sweets (OR 1.4)	
		Dental attendance	No health problems (OR	
		Systemic disease	2.9)	
		Parental knowledge and	Past caries experience	
		attitudes on oral health	(baseline) (OR 7.3)	
		Plaque pH	Plaque index (5.1)	
		Mutans streptococcus		
		levels	Full Prediction Model:	
		Lactobacillus levels	Age (OR 1.1)	
		Past caries experience	Father's education level	
			(UR 0.6)	
			Wonths of breastfeeding	
			(UR 1.1)	
			than toothnasta) (OR	
			(OK	
			No appual dental check-	
			un because teeth didn't	
			bother child (OB 0 5)	
			No health problems (OR	
			2 7)	
			Past caries experience	
			(baseline) (OR 3.9)	
			Plaque index (8.9)	
			Mutans streptococcus	
			levels (OR 2.7)	
			Lactobacillus levels (OR	
			2.3)	
			Average pH (OR 0.01)	
			Risk Screening Model:	
			Age (OR 1.1)	
			Months of breastfeeding	
			(OR 1.0)	
			Bedtime feeding (OR 1.5)	

		Water only Daily toothbrushing frequency Water fluoride level Proportion of new non- cavitated lesions to	General linear mixed models (GLMM) regression for cavitated caries:	
Chankanka et al 2011 <sup>43</sup>	≤ 0.5 years (Iowa Fluoride Study birth cohort)	Powdered beverages Soda pop Juice drinks 100% juice Milk	General linear mixed models (GLMM) regression for non- cavitated caries: 100% juice exposure	⊕⊕OOLow
Chankanka et	≤ 0.5 years	Powdered beverages	fluoridated community (OR 0.7) Plaque index (9.1) Full Risk Model: Age (OR 1.1) Months of breastfeeding (OR 1.0) Plaque index (7.4) Mutans streptococcus levels (OR 2.6) Lactobacillus levels (OR 2.1) Average pH (OR 0.02) Community Screening Model: Age (OR 1.0) Malay race (OR 2.1) Using fluorides (other than toothpaste) (OR 2.6) Parent's belief that "tooth worm" as reason for caries (OR 0.1) Parents do not know that bedtime milk bottle is bad for teeth (OR 2.0) Child's number of decayed teeth estimated by parent (OR 12.8) General linear mixed	
			Frequency of between- meal sweets (OR 1.3) Bedtime sweets (OR 1.3)	

		surfaces at risk (10%	Powdered beverage	
		change)	exposure	
		Proportion of new	100% juice exposure	
		cavitated lesions to		
		surfaces at risk (10%	Multivariate General	
		change)	linear mixed models	
		Socioeconomic status	(GLMM) regression for	
		Sex	non-cavitated caries:	
		Dentition	100% juice exposure –	
			middle and high	
			frequency ( $\sqrt{37-50\%}$ )	
			Tooth brushing	
			frequency ( $\sqrt{33\%}$ )	
			Proportion of new	
			cavitated caries lesions	
			to surfaces at risk	
			(个110%)	
			High socieoeconomic	
			status (↓42%)	
			Multivariate General	
			linear mixed models	
			(GLMM) regression for	
			cavitated caries:	
			100% juice exposure –	
			high frequency (↓48%)	
			<b>o</b>	
			Proportion of new non-	
			cavitated caries lesions	
			to surfaces at risk	
			(个253%)	
MacRitchie et	1 vear olds	Caries experience	Model 1 – $d1mft > 0 at$	<b>ABOOLOW</b>
al 2012 <sup>40</sup>	,	Mutans streptococcus	age 4 years ("any caries	<b><i>www</i>wwwwwwwwwwwww</b>
		Lactobacillus	risk" model):	
		Yeasts		
		Height	Health visitor opinion of	
		Weight	caries risk	
		Head circumference		
		Immunization status	Deprivation Category	
		Ethnic origin	score	
		Illnesses		
		Medication	Parental smoking	
		Weaning		
			Breastfeeding	

		Use of comforter (i.e.		
		soother)	Use of comforter (i.e.	
		Vitamin	soother)	
		supplementation		
		Feeding problems	Model 2 – d3mft >0 at	
		Family history	age A years ("any caries	
		Parental employment	risk" model):	
		Parental health	nsk modelj.	
		Parental meding	Health visitor opinion of	
			Carles risk	
		accossment if shild at risk	Parantal smaking	
		for carios	Farental shloking	
		Deprivation Catagory	Food and drink at night	
		Deprivation Category	FOOD and drink at hight	
		Scule Broast/battle feeding	Model 2 d1 mft > 2 et	
		Moole	$\frac{1}{2} = \frac{1}{2} = \frac{1}$	
		Drinke	age 4 years ( high carles-	
		Drinks	risk model).	
		Taathhrushing	Turne of housing	
		Luorido	Type of housing	
		riuoride	Lice of a feeder our	
		Supplementation	Ose of a feeder cup	
		Sociodemographics		
			1000el 4 - 03ml 2 3 at	
			age 4 years ( nigh carles-	
			risk" model):	
			Turne of housing	
			Type of housing	
			line like sisikan animian of	
			Health visitor opinion of	
			carles risk	
			Use of vitamins	
Gao et al	3 years old	NUS-CRA, Carlogram,	CAT (screening) $\geq$ high	
2013-2		AAPD CAT, CAMBRA	(RR 2.0, 95% CI 1.1-2.5)	
		Age	CAT (screening)	
		Ethnicity	excluding $\geq$ high (RR 1.8,	
		Family socioeconomic	95% CI 0.99-2.4)	
		Status		
		Infant feeding history	CAT (comprehensive)	
			excluding socioeconomic	
		Fiuoriae	Tactors (KK 2.2 95% CI	
		Dental attendance	0.95-2.6)	
		Oral nygiene		
		Past carles		
		White spot lesions		

		Enamel defects	CAMBRA (screening) ≥	
		Dental appliance	moderate (RR 2.3 95% CI	
		Systemic health	1.8-2.5)	
		Medication		
		Salivary flow rate	CAMBRA (screening) ≥	
		Salivary buffering	high (RR 2.4 95% CI 2.1-	
		capacity	2.5)	
		Mutans strentococcus	,	
		levels	CAMBRA	
			(comprohensive) >	
		Laciobacilius ieveis	(comprehensive) 2	
			1 0 2 4)	
			1.9-2.4)	
			CAMBRA	
			(comprehensive) ≥ high	
			(RR 2.3 95% CI 2.1-2.4)	
			Cariogram (screening) ≥	
			38.5% chance of caries	
			(RR 2.2 95% CI 1.9-2.3)	
			Cariogram	
			$(comprehensive) \ge 37.6\%$	
			chance of caries (BR 2.2	
			95% (12 0-2 4)	
			5570 Cl 2.0 2.4)	
			NUS-CRA (screening) >	
			32.8% chance of caries	
			(BB 2 5 95% CI 2 3-2 5)	
			NUS-CRA	
			(comprehensive) > 35.2%	
			chance of caries (BB 2 5	
			95% (12 4-2 6)	
Hallett and	5-10 year	CariScreen reading (to	Visible cavitations	
O'Rourko		measure visible light	(Multivariate mean 2.0	UUUULOW
2012 <sup>52</sup>	lassassment	rologge from dental		
2015	(assessment		95% CI 3.0-4.9)	
	included	plaque)	Deduced celine flow	
	ntou	iviutans streptococcus	Reduced saliva flow	
	primary and	reading (CariCult)	(iviultivariate mean 3.6	
	permanent	Visible plaque	95% CI 2.5-4.7)	
	teeth	Visible cavitations		
	though)	present	Orthodontic appliances	
		Fillings within previous 3	(Multivariate mean 4.2	
		years	95% CI 2.5-5.9)	
		Reduced saliva flow		
		Exposed dentin		

		Deep enamel pits and		
		Radiographic provimal		
		White spot onemal		
		Vinte spot enamer		
		Outh a dantia anglianasa		
	<b>D</b> : 11	Orthodontic appliances	5 11 1 (05	
Schroth et al	Birth	Low annual income	Enamei hypopiasia (OR	
201433	conort.	Child's health status	8.9)	
	Assessed	Infant's teeth being		
	factors	cleaned or brushed	Infant age ( $\geq 14$ months)	
	prenatally	Enamel hypoplasia	(OR 5.0)	
	and in	Household employment		
	infancy	Government assistance	Prenatal vitamin D level	
		(i.e. social assistance)	(OR 2.0)	
		Infant age at time of		
		dental exam		
		Bottle feeding		
		Breastfeeding		
		Season		
		Prenatal vitamin D level		
Abanto et al	1-12 year	Caries risk	Survival analysis for new	<b>⊕</b> ⊕OOLow
201451	olds	Gingival bleeding index	initial caries lesions	
	(assessment	Dental plaque index	(adjusted model):	
	included	Caries experience	Past caries experience	
	both	Lesion activity	(dmft index) (HR 1.9 95%	
	primary and	assessment	CI 1.4-2.7)	
	permanent	Number of teeth with		
	teeth	active non-cavitated	Follow-up dental visits	
	though)	lesions	(HR 0.2 95% CI 0.1-0.6)	
		Sex		
		Age	Number of teeth with	
		Caregiver of child	active non-cavitated	
		Use of dental floss	lesions (HR 9.5 95% CI	
		Follow-up dental visits	5.6-16.2)	
			Survival analysis of active	
			initial lesions (adjusted	
			model):	
			Number of teeth with	
			active non-cavitated	
			lesions (HR 1.3 95% CI	
			1.1-1.5)	
			1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
			0.9]	
		1		1

			Follow-up dental visits	
			(HB 0 1 95% CI 0 05-0 1)	
Peltzer et al	Birth	Drinking water in	Drinking water in	
2014 <sup>34</sup>	cohort	bousehold	bousehold (rain well or	
2014	Conort.	Disthusiant	athor) (OB 2.0)	
	Assessed	Birthweight	other) (OR 2.0)	
	factors	Height at 6 months		
	prenatally	Smoking during		
	and in	pregnancy	Mother completed high	
	infancy.	Secondary smoke (at 1	school (OR 2.5)	
		year)	Mother completed post-	
	First dental	Mother had dental	high school (OR 3.2)	
	exam at 2	cavitation(s) at baseline		
	years	Mother's age at birth	Household income	
		Mother's education at	\$100,000-\$199,999 (OR	
		birth	0.4)	
		Household income	Household income ≥	
		Religious affiliation	\$200,000 (OR 0.3)	
		Single parent		
		Family size		
		Sex of child		
		Frist child in family		
		Psychological distress of		
		mother		
		Revenue		
		forth or		
		Parenting style		
		Family distress		
		Family support index		
		Spousal relationship		
		(mother) index		
		Spousal relationship		
		(father) index		
		Infant feeding (at 6		
		months)		
		Nocturnal feeding at 12		
		months		
		Introduction of soft		
		drinks (at 12 months)		
		Sleeping with bottle (at		
		30 months)		
		, Brushing teeth in past 2		
		weeks (at 12 months)		
		Sweet candy in days in a		
		week (at 30 months)		
		Bruch with toothooste		
		(at 12 months)		
		(at 12 months)		

		Brushing teeth (at 26		
		months)		
		Previous dental visit (at		
		30 months)		
Gao et al	3-5 year	Parent's education level	Mutans streptococcus	<b>AAAOO I ow</b>
2014 <sup>46</sup>	olds	Type of housing	levels:	
2021	0100	Age	Dentocult score 1 (RR	
		Sex	2 0)	
		Ethnicity	Dentocult score 2 (RR	
		Feeding history	3.4)	
		Diet habits	Dentocult score 3 (RR	
		Oral hygiene	4.6)	
		Fluoride exposures	- ,	
		Dental attendance	Lactobacillus levels:	
		Parental knowledge.	Dentocult score 1 (RR1.9)	
		attitudes and self-	Dentocult score 2 (RR	
		efficacy in protecting	2.7)	
		children's teeth	Dentocult score 3 (RR	
		Mutans streptococcus	2.7)	
		levels		
		Lactobacillus levels	Past caries experience	
		Past caries experience	(RR 1.6)	
			Model with Mutans	
			streptococcus:	
			Age (months) (OR 1.1)	
			Malay race (OR 1.8)	
			Father's education (OR	
			0.7)	
			Months of breastfeeding	
			(OR 1.0)	
			Fluoridated toothpaste	
			(OR 0.6)	
			No health problems (OR	
			2.4)	
			Past caries experience	
			(OR 4.3)	
			Plaque index (OR 5.2)	
			Mutans streptococcus	
			(OR 2.2)	
			Model with Lactobacillus:	
			Age (months) (OR 1.0)	
			Father's education (OR	
			0.6)	
			Months of breastfeeding	
			(OR 1.0)	

			Frequency of sweet (OR	
			1.4)	
			Fluoridated toothpaste	
			(OR 0.6)	
			No health problems (OR	
			2.4)	
			Past caries experience	
			(OR 4.8)	
			Plaque index (OR 5.2)	
			Lactobacillus (OR 1.9)	
			Model with Mutans	
			streptococcus and	
			Lactobacillus:	
			Age (months) (OR 1.1)	
			Father's education (OR	
			0.6)	
			Months of breastfeeding	
			(OR 1.1)	
			Fluoridated toothpaste	
			(OR 0.6)	
			No nealth problems (OR	
			2.2)	
			(OB 2 0)	
			(OR 3.0) Diagua inday (OB E 2)	
			Mutans Streptococcus	
			(OP 2 1)	
			Lactobacillus (OR 1 9)	
Yokomichi et	< 1 year of	Sex	Boys (BRI 3)	
al 2015 <sup>39</sup>	age	Birth weight	Birth weight $> 4.000$ g	
	-80	Age of mother	(RRI 19)	
		Gestational age	Birth weight $< 2.500$ g	
		Birth order	(RRI -5)	
		Number of teeth (at 18	Age of mother < 25 (RRI	
		months)	17)	
		Parental employment	Age of mother ≥ 35 (RRI	
		Bottle use (at 18 months)	2)	
		Dental fluoridation	Not first born child (RRI	
		experience (at 3 years)	26)	
		Parental smoking (at 3	14-20 teeth at 18 months	
		years)	(RRI 13)	
		Sibling < 6 years (at 3	Both parents	
		years)	unemployed (at 3 years)	
		Someone who supports	(RRI 11)	
		child rearing (at 3 years)	Bottle use (at 18 months)	
			(RRI 4)	

		Parental brushing child's teeth (at 18 months) Parental brushing child's teeth (at 3 years) Drinking cow milk (at 18 months) Drinking cow milk (at 3 years) Irregular meals and snacks (at 18 months) Irregular meals and snacks (at 3 years) Watching TV or video daily (at 3 years)	Parental smoking (at 3 years) (RRI 15) No one supports child rearing (at 3 years) (RRI 17) Parents sometimes or never brushing child's teeth (at 18 months) (RRI 18) Parents sometimes or never brushing child's teeth (at 3 years) (RRI 22) Drinking cow milk (at 18 months) (RRI -12) Drinking cow milk (at 3 years) (RRI-5) Irregular meals and snacks (at 18 months)	
			(RRI 16) Irregular meals and snacks (at 3 years) RRI 16	
Ghazal et al 2015 <sup>49</sup>	< 2 years old	AgeSexDelivery type (standard,C-section, forceps, other)Premature deliveryBirthweightAllergiesChronic systemic medicalconditionAcute illness in previous6 monthsBreast fedBedtime bottleBottle useBeverages consumed(type, frequency, timing)Methods of drinkingliquids other than waterAmount of beveragesconsumedToothbrushingToothpasteDental historySources of drinkingwater	Model A – 3 year incidence: Premature delivery (< 37 weeks) (OR 0.2) 100% juice consumption ≥ 1 time per day (OR 0.4) Model B – Incidence from age 2 to 3 years: Greater daily frequency of toothbrushing at baseline (OR 0.3) Previous visit to dentist (OR 4.6)	⊕⊕OOLow

		Use of vitamin drops or		
		tablets with fluoride		
		History of dental		
		problem		
		Reason for last dental		
		visit		
		Presence of regular		
		dontist		
) A /o groot out o	Diuth ochout	Carias averariance		
wagner and				<b>AAOOrom</b>
Heinrich-	(< 12	Sex	between carles	
Weitzien	months of	Migration background	experience of children	
2016*2	age)	Socioeconomic status	and low socioeconomic	
		Single parent	status, family early	
		Mother/primary	childhood caries burden,	
		caregiver has active	systemic antibiotic	
		caries	medication, no use of	
		Family early childhood	vitamin D supplements,	
		caries burden	receives topical fluoride	
		Preterm birth	from health professional,	
		General disease/special	child has regular dental	
		health care needs	care and child has plaque	
		Medication	on teeth:	
		Systemic antibiotic		
		medication	Family early childhood	
		No use of vitamin D	caries burden (OR 2.2)	
		supplements		
		Child has > 3 between-	No use of vitamin D	
		meal sugar-containing	supplements (OR 1.9)	
		snacks/beverages per		
		dav	Child has regular dental	
		Child is put to bed with a	care $(OR 0.5)$	
		bottle containing natural		
		or added sugar	Plaque on teeth (OB 6 5)	
		Child's teeth were		
		brushed daily with		
		fluoridated toothpaste		
		Child receives topical		
		fluorido from hoolth		
		nuonue nom nealth		
		Child has dontal		
		nome/regular dental		
		Enamel defects		
		Plaque on teeth		
Hultquist &	1 year olds	Siblings	Siblings have dental	<b>⊕</b> ⊕OOLow
Bagesund		Siblings have dental	caries (OR 4.8)	
20161/		caries		

		Child eat or drink	Child eats or drinks at	
		anything except water at	night (OR 3.0)	
		night		
		Child still breastfed	Child drinks anything	
		Child have	except water between	
		illness/disease	meals (OR 7.1)	
		Child regularly takes		
		medication	High level of Mutans	
		Child drinks anything	streptococcus (score 2-3)	
		evcent water between	(OP 2 A)	
		meals	(01(3:4)	
		Baront bruchos child's		
		tooth		
		Number of tooth visible		
		is a suth		
		Mutans streptococcus		
		counts		
	Mean age 4	Gender	Score of carles risk	
201632	years at	Age	assessment using	
	baseline	Father's education level	Carlogram (OR 1.1)	
	who	Mother's education level		
	underwent	Diet frequency per day		
	pediatric	Snacks/drinks between		
	dental	meals		
	surgery for	Bedtime sweet without		
	ECC	brushing		
		Brushing by child or		
		parent		
		Frequency of tooth		
		brushing		
		Buffer capacity of saliva		
		Streptococcus mutans		
		count		
		Lactobacillus count		
		Plague index (oral		
		hygiene status)		
		Score of caries risk		
		assessment		
Wang et al	3-5 vear	Caries status (dmft)	Caries experience (OR	
2016 <sup>36</sup>	olds	Sex	5.0)	
		Age	,	
		Parental education	Parent helps child brush	
		Parental occupation	teeth daily (OR 0 9)	
		Income		
		Fating habits	Parents consider caries in	
		Oral hygiene hehaviours	nrimary teeth need to be	
			troated (OP 1 2)	
	1		Liealeu (UK 1.5)	1

Correa-Faria	4-7 year	Sex	Previous caries	
et al 2016 <sup>50</sup>	olds	Caries	experience (RR 1.5)	
		Oral hygiene		
		Place of residence		
		Mother's education level		
		Household income		
		Age		
Wagner and	Birth cohort	Sex	Model of association	
Heinrich-	(< 12	Age	between caries	
Weltzien	months of	Migration background	experience in children	
2017 <sup>48</sup>	age)	Socioeconomic status	and low socioeconomic	
		Age at start of tooth	status, start of tooth	
		brushing	brushing,	
		Frequency of tooth	supervision/regular	
		brushing	second brush by parent,	
		Supervision of tooth	frequency of tooth	
		brushing/regular second	brushing, first dental	
		brushing by parent	visit, frequency of dental	
		Use of fluoride salt	visits, application of	
		and/or fluoride	fluoride varnish,	
		toothpaste	frequency of in-between	
		Age at first dental visit	meals, sugar-containing	
		Number of dental	snacks/beverages per	
		visits/year	day, duration of	
		Application of fluoride	breastfeeding > 1 year,	
		varnish	duration of bottle	
		Frequency of in-between meals	feeding > 1 year:	
		Consumption of sugar-	Low socioeconomic	
		containing	status (OR 10.4)	
		snacks/beverages per		
		day	Started brushing in first	
		Duration of	year of life (OR 0.2)	
		breastfeeding		
		Duration of bottle	Supervision/regular	
		feeding	second tooth brushing by	
		Previous caries	parent (OR 0.1)	
		experience		
			≥ 2 dental visits per year	
			(OR 0.1)	
			Duration of breast-	
			/bottle-feeding > 1 year	
			(OR 6.2)	
Bernabe et al	1 year	Sex	Age (coefficient 0.16,	
2017 <sup>45</sup>		Birth order	95% CI 0.12-0.21)	
		Birth weight		

Maternal age at birth	Final Linear Mixed	
Maternal education	Effects model:	
Breastfeeding duration	Birth weight (p=0.039)	
Marital status	Parental employment	
Maternal smoking	(p<0.001)	
Parental employment	Maternal smoking	
Area deprivation	(p=0.006)	
Child's toothbrushing	Maternal education	
frequency	(p<0.001)	

Note: Odds Ratio (OR), Relative risk (RR), Hazard Ratio (HR)

## **Sociodemographic and Family Factors:**

Out of 11 studies that included age as a predictor, five studies reported that the age of the child was significantly associated with future caries risk with odds ratios ranging from 1.1-5.0.<sup>35, 38, 44-46</sup> This would justify including "age" as a variable in a CRA tool. It is well recognized that the risk for caries increases as children get older as they have more teeth and these teeth have been subjected to periods of demineralization longer than younger children.

Three out of 16 studies that assessed sex reported that male children were at greater risk for caries development (HR 1.1, RR 3.0) and one reported that males were at lower risk (HR 0.8).<sup>37, 39, 51</sup> Thus, there is very limited evidence to suggest including "sex" as a variable in a CRA tool. Additionally, only three out of five publications that examined ethnicity indicated that ethnicity was associated with increased caries risk.<sup>37, 44, 46</sup> One study suggested that both Hispanic (HR 1.8) and African American (HR 1.8) children were at risk while two indicated that Malay (both OR 1.8) children were at risk. Given the limited information on ethnicity and the considerable variability that exists in determining ethnic background of children there is limited evidence to suggest its inclusion as a variable in a CRA tool.

A total of six out of eleven studies identified that household socioeconomic factors,

including low SES (2.38X, OR 10.4)<sup>43, 48</sup>, deprivation<sup>40</sup>, parental employment status (RRI 11)<sup>39, 45</sup>, and income (OR 3.3 < \$200,000/year)<sup>34</sup> were significantly associated with caries risk. Living in a high SES home and having a high household income were protective against caries.<sup>34, 43</sup> Based on this evidence, low SES or other indicators of household income and employment should be part of a CRA tool. While these indicators should be included in the tool, it should be recognized that there is sensitivity in collecting household income information, and not all parents and caregivers may feel comfortable providing such information. Only one study out of three studies reported that the type of housing was associated with caries risk<sup>40</sup>, which may be a proxy for SES of the family. Another study identified that the household drinking water sourced from rain or well water or other non-traditional sources was associated with increased caries risk (OR 2.0).<sup>34</sup> However, this may be a proxy measure of access to fluoridated drinking water and SES. Four out of seven articles identified parental education level as a risk factor for future caries development; two revealed associations with maternal education (OR 2.5 high school, OR 3.2 > high school) and two with paternal education (OR 0.6, OR 0.7).<sup>34, 44-46</sup> Given that educational attainment of parents is likely reflected in household SES, there is limited evidence to suggest it be incorporated separately into a CRA tools being developed. It could be included as part of a general question on household SES.

Only one of three studies reported on the age of the child's mother with children whose mothers were < 25 years of age (RRI 17) and those  $\geq$  35 years (RRI 2) of age being at higher risk for caries.<sup>39</sup> Therefore, there is limited evidence to support including maternal age as a variable in a CRA tool. Meanwhile, three out of four studies reported an association with parental

smoking; one reported that maternal smoking and two reported that parental smoking was associated with increased caries risk (RRI 15 at 3 years of age).<sup>39, 40, 45</sup> Overall, there appears to be limited evidence to support the inclusion of parental smoking into a CRA tool.

Few studies reported findings on the association between special health needs of the child and caries risk. One included study revealed that acute otitis media and and respiratory tract infection at 0-12 months were associated with increased caries risk.<sup>37</sup> Meanwhile, two other papers indicated that children without health problems were at increased risk.<sup>44, 46</sup> Four included studies reported results on the association between prenatal and birth characteristics and caries risk in young children. One study identified that low prenatal vitamin D concentrations during pregnancy were associated with caries in infants (OR 2.0).<sup>35</sup> Another study reported that premature delivery (< 37 weeks) was associated with lower risk for caries (OR 0.2).<sup>49</sup> Two out of five included studies reported that birth weight may be associated with increased caries risk.<sup>39, 45</sup> One of these studies reported that low birth weights (< 2,500 g) (RRI 5) and birthweights  $\geq$  4,000 g are associated with caries (RRI 19).<sup>39</sup> Based on this current evidence there is limited evidence to support including any of these variables in a CRA tool.

Parental attitudes and knowledge can also influence childhood oral health. For instance, one study reported that a parent's belief that caries is a result of a "tooth worm" was found to lessen the risk for caries in their children.<sup>44</sup> Children of parents who are unaware that a bottle of milk at bedtime is bad for their child's teeth are at increased risk for decay.<sup>44</sup> Another study reported that parents who consider it necessary to treat caries involving primary teeth are more likely to have a child at risk for future caries.<sup>36</sup> Based on this limited evidence,

assessments of parental knowledge and attitudes towards early childhood oral health should not be included in a CRA tool.

Interestingly, some other child and family characteristics and dynamics may be associated with increased caries risk. For instance, one included study revealed that children who are not first born in the family (RRI 26) and those families who lack supports with child rearing (RR1 17) were more likely to have children at risk for future caries development.<sup>39</sup> Other variables that have been reported to be associated with caries risk include the family's ECC burden (OR 2.2) <sup>48</sup>, siblings having dental caries (OR 4.8)<sup>17</sup>, and health visitor opinions of children's risk for caries<sup>40</sup>.

Considering the limited evidence, these potential factors do not presently warrant consideration for inclusion in a CRA tool.

#### **Behavioural Factors:**

Oral hygiene behaviours:

Several included studies examined toothbrushing behaviours and its association with caries risk. Three out of nine studies reported that the frequency of toothbrushing was directly associated with risk of developing caries with odds ratio ranging from 2.0 - 4.6.<sup>41, 43, 49</sup> One study reported that initiating brushing in first year of life was protective (OR 0.2) and reduced the risk of caries.<sup>48</sup> A total of four out of six studies reported on the association between parental supervision of or assistance with child toothbrushing with an OR ranging from 0.1 - 1.8 and a RRI 18.<sup>33, 36, 39, 48</sup> One of these studies suggested that parents helping the child brush their teeth daily (OR 0.9) was associated with increased caries risk.<sup>36</sup> However, the other three concluded that supervised regular toothbrushing with the assistance of the parent was

protective against caries (OR 0.1)<sup>48</sup> while no parental involvement or infrequent involvement was associated with future caries development (OR 0.9 - 1.8).<sup>33, 36</sup> Overall, this suggests that a question about the frequency toothbrushing and/or the involvement of parents in supervising daily toothbrushing may be helpful if included in a CRA tool.

Exposure to fluorides was also reported in three out of eleven included studies. One study reported that use of fluoridated toothpaste was protective (OR 0.6).<sup>46</sup> Another study indicated that average daily fluoride intake was associated with caries (OR 1.9).<sup>41</sup> Access to fluoridated tap water is also a predictor of caries risk as fluoride levels in drinking water (OR 2.4)<sup>41</sup> and fluoridated water (OR 0.7)<sup>44</sup> can influence caries development. One of these studies also reported that fluoride use, other than toothpaste, is also associated with caries risk (OR 0.4).<sup>44</sup> However, this study did note that this could be a result of high caries burden at baseline.<sup>44</sup> Based on this evidence, an assessment of exposure to fluorides should be included in any CRA tool for preschool children.

#### Infant Feeding Behaviours:

Breast milk provides all the energy and nutrients that the infant needs according to the dietary references intakes. Health Canada and the World Health Organization recommend exclusive breastfeeding for the first six months and infants should then be offered nutrient dense and safe complementary foods, along with continued breast feeding. Several of the included studies reported on the association between infant feeding behaviours and caries risk, namely breastfeeding, feeding duration, and bottle feeding. Five out of ten studies provided evidence on breastfeeding and duration of breastfeeding.<sup>33, 40, 41, 44, 46</sup> Two studies revealed that breastfeeding was associated with an increased risk of caries.<sup>33, 40</sup> Another three studies on
breastfeeding duration, concluded that the months of breastfeeding (OR 1.0)<sup>44, 46</sup> and breastfeeding for fewer than six months (OR 2.2)<sup>41</sup> was associated with increased caries risk. Another study did not differentiate between feeding method, but reported that the duration of breast and bottle feeding for greater than one year increased the risk for caries (OR 6.2).<sup>48</sup> Only one study revealed that bottle use at 18 months of age was associated with caries (RRI 18).<sup>39</sup> One included study indicated that bedtime feeding was associated with caries risk (OR 1.5)<sup>44</sup> and the use of a feeding cup was also reported to increase childhood risk for caries.<sup>40</sup>

Based on this evidence it would be prudent for newly developed CRA tools to inquire about infant feeding practices and durations, but to separately ask about breastfeeding and bottle feeding.

Only one study reported that the use of a comforter or soother was associated with increased caries risk.<sup>40</sup> Based on this limited evidence, the use of a comforter or soother variable should not be included in a CRA tool.

#### **Dietary Habits and Behaviours:**

Snacking habits and behaviours were identified in eight out of eleven of the included studies. One study indicated that irregular meals and snacks increased the risk for caries (RRI 16 at 18 months).<sup>39</sup> Another revealed that eating snacks while playing increased risk (OR 2.3).<sup>33</sup> A third reported that the frequency of between-meal sweets was associated with greater risk for future caries development (OR 1.3).<sup>44</sup>

Two studies looked at the frequency of intake of sweets and reported associations with increased risk for decay; one indicated that the frequency of candy consumption was a risk factor (OR 3.6)<sup>31</sup> while the other revealed that the frequency of sweets increased risk (OR

1.4).<sup>46</sup> Three studies also mentioned that consuming foods and drinks at night increased children's risk for caries.<sup>17, 40, 44</sup> Eating and drinking food at night (OR 3.0)<sup>17, 40</sup> and sweets at bedtime (OR 1.3)<sup>44</sup> were all reported to increase caries risk.

The consumption of cow milk was found to be protective against caries at 18 months (RRI -12) and at 3 years (RRI -5). <sup>39</sup> Additionally, drinking anything except water between meals was associated with caries risk (OR 7.1)<sup>17</sup> several studies reported that a child's use of sugary beverages and frequency increased their risk for decay. Sugar-sweetened beverage consumption (OR 3.0)<sup>38</sup>, use of powdered beverages<sup>43</sup>, and exposure and frequency of 100% juice exposure (OR 0.4)<sup>43, 49</sup> were associated with future decay.

Based on this evidence, dietary practices and habits should be integrated into CRA tools. This includes the frequency of snack foods and sugary drinks between meals.

Only two studies revealed data on the use of vitamins. One study reported that the use of vitamins was associated with an increased risk for caries<sup>40</sup> while the other indicated that the absence of vitamin D supplementation (OR 1.9) increased a child's risk for decay<sup>42</sup>.

#### Dental Home and Dental Attendance Behaviours:

Dental home and dental attendance behaviours were identified in six out of ten of the included studies. Three included studies reported that regular dental care is protective against caries.<sup>42, 48, 51</sup> One study indicated that follow-up visits to the dentists were protective (HR 0.1) another indicated regular dental care was protective (OR 0.5), while the other revealed that

two or more visits per year was protective against caries (OR 0.1).<sup>42, 48, 51</sup> An additional study reported that not seeking annual dental check-ups for their child because their teeth did not bother their child was protective against caries<sup>44</sup>. Meanwhile, another included study

reported that children with previous visits to the dentist were at greater risk for caries (OR 4.6).<sup>49</sup> The author noted that this association might be due to parent-identified need to see a dentist and/or refferals to dentists by the study team.<sup>49</sup> Hong et al (2009) reported that the child's age at the time of their dental exam was predictive of caries (OR 7.6).<sup>41</sup>

Based on this evidence, a history of dental visits and presence of a dental home should be considered in a CRA tool.

#### **Clinical Factors:**

Previous caries experience was the most commonly identified factor from the included studies with 9 of the 25 publications reporting its association with increased caries risk. <sup>31, 36, 43, 44, 46, 50-53</sup> Another study reported that the number of teeth with active non-cavitated caries lesions was also associated with future caries development (HR 9.5).<sup>51</sup> Therefore, there is ample evidence to include previous caries experience in any CRA tool for preschool children. The next most common clinical variable was presence of dental plaque or plaque index with an OR of 6.5, 8.9, 5.2 respectively.<sup>42, 44, 46</sup> Despite there being some evidence, any newly developed instrument should include an assessment of visible dental plaque. Only two of the included studies reported that enamel hypoplasia was a significant risk factor for future caries (OR 8.9 & 5.2).<sup>35, 41</sup> However, enamel hypoplasia has often been overlooked in past caries studies.

Fortunately, there is growing recognition that enamel hypoplasia increases the risk for caries. Therefore, enamel defects, including enamel hypoplasia, could be considered for inclusion in newly developed CRA tools.

One included study revealed that having 14-20 teeth by 18 months to be associated with increased caries risk (RRI 4). <sup>39</sup> Another study reported that the presence of an orthodontic

appliance was associated with caries development (Multivariate mean 4.2, 95% Cl 2.5-5.9)<sup>52</sup> Due to this limited evidence, neither of these variables are worth considering including into a proposed new CRA tool.

#### Salivary & Bacterial Factors:

Overall, two out of four studies were found to report significant associations between saliva and oral pH and caries risk. One study reported that an average oral pH (stimulated saliva flow rate) was protective against caries development (OR 0.2)<sup>44</sup> and the other revealed that reduced salivary flow increased the risk for caries (Multivariate mean 3.6, 95% CI 2.5-4.7) <sup>52</sup>. Based on this limited information there is little value in adding saliva flow and oral pH as variables in a newly developed CRA tool for preschool children, especially for use by non-dental professionals.

A total of five out of nine studies included publications reported that levels of mutans streptococci were significantly associated with future caries development, suggesting that consideration of this variable is warranted in CRA instruments.<sup>17, 31, 38, 44, 46</sup> Meanwhile, only two out of five included studies revealed an association between lactobacilli levels and future caries risk. <sup>44, 46</sup> However, assessing cariogenic bacteria levels is not feasible or possible for CRA developed for screening purposes and use by non-dental professionals.

Overall, based on this systematic review of evidence on CRA the following variables should be considered when developing a new CRA tool for use with preschool children: <u>Sociodemographic Factors</u>: child's age, SES of the family (i.e., low SES and household income, parental education level).

<u>Behavioural Factors</u>: Toothbrushing habits (i.e., frequency, involvement of parents in supervising daily toothbrushing), exposure to fluorides (i.e., fluoridated toothpaste, community water fluoridation), breastfeeding (i.e., frequency, duration > 12 months), bottle feeding (i.e., frequency, duration > 12 months, use at bedtime), dietary habits and behaviours (i.e., snacking and drinking between meals, intake of sugary beverages, intake of sweets), dental home and dental attendance (i.e., child has dental home, regular dental visits)

<u>Clinical Factors</u>: caries experience of the child (i.e., past and current caries experience, past treatment of caries), presence of visible plaque, developmental defects of enamel (i.e., enamel hypoplasia, enamel defects)

#### Salivary and Bacterial Factors:

Currently, assessments on saliva flow and bacterial levels are essentially limited to clinical settings (i.e., the dental office). Therefore, while salivary flow and levels of mutans streptococci and lactobacilli can be predictive of future caries risk, CRA tools that are designed for screening purposes and for use by persons outside of the oral health profession should not include assessments of these variables.

Table 5 : Summary of the evidence from the studies.

Factor/Variable	# of	# of Studies	Range of effect sizes	Expert
	Studies	which show		opinion on
	that	significant		inclusion of
	include	association		this factor
	that factor			(yes/no)
Sociodemographic a	nd family fact	ors		
Age <sup>35, 38, 44-46</sup>	11	5	OR 1.1 – 5.0	Yes
Sex <sup>37, 39, 51</sup>	16	3	HR 1.1 – 3.0	No
Ethnicity <sup>37, 44, 46</sup>	5	3	HR 1.1, 1.8	No
			OR 1.8, 2.1	
Household	11	6	2.38X	Yes
socioeconomic			OR 0.3 - 10.4	
factors <sup>34, 39, 40, 43, 45,</sup>			RRI 11	
48			p<0.001	
Housing type <sup>40</sup>	3	1	Data not available	No
Household water <sup>34</sup>	2	1	OR 2.0	No
Parental education	4	7	OR 0.6 - 3.2	No
level <sup>34, 44-46</sup>			P < 0.001	
Maternal age 39	3	1	RRI 2 . RRI 17	No
		_		
Parental smoking <sup>39,</sup>	4	3	RRI 15 , p = 0.006	No
40, 45				
Acute Otitis media	1	1	HR 1.3	No
37				
No health problems	2	2	OR 2.2 – 2.9	No
44, 46				
Prenatal Vitamin	1	1	OR 2.0	No
D <sup>35</sup>				
Premature Delivery	2	1	OR 0.2	No
(< 37 weeks) <sup>49</sup>				
Dirth		2		Na
Birth weight <sup>25</sup>	5	Z	RRI -5, RRI 19	NO
			p= 0.039	
Parent Attitude <sup>36, 44</sup>	3	2	OR 0.1 - 2.0	No
Child and Family	4	4	RRI 17, RRI 26	No
Characteristics <sup>32, 39,</sup>			OR 2.2, 4.8	
40, 42				
<b>Behavioural Factors</b>				
Frequency of	9	3	OR 2.0 – 4.6	Yes
Toothbrushing 41, 43,				
49				

Initiating brushing in the first year of life <sup>48</sup>	1	1	OR 2.0	No
Parental supervision or assistance with toothbrushing <sup>33, 36,</sup> <sup>39, 48</sup>	6	4	OR 0.1 – 1.8, RRI 18	Yes
Exposure to Fluorides <sup>41, 44, 46</sup>	11	3	OR 0.4 – 2.6	Yes
Evidence of Breastfeeding and duration of breastfeeding (BF) <sup>33, 40, 41, 44, 46</sup>	10	5	OR 1.0 – 6.2	Yes
Comforter or Soother <sup>40</sup>	1	1	Data not available	No
Snacking habits and behaviours <sup>31-33, 39,</sup> 40, 43, 44, 46	11	8	OR 1.4 – 7.1 RRI -5, RRI -12, RRI 16	Yes
Dental home and dental attendance behaviours <sup>41, 42, 44,</sup> <sup>48, 49, 51</sup>	10	6	OR 0.1 – 7.6 HR 0.1	Yes
Clinical factors				
Previous caries experience <sup>31, 36, 43,</sup> 44, 46, 50-53	25	9	OR 3.0 – 7.3 RR 1.6, RR 1.5	Yes
Salivary Bacterial Fac	tors	•		
Saliva and oral pH <sup>44,</sup> 52	4	2	OR 0.01, 0.02 multivariate mean 3.6	No
Mutans Streptococcus <sup>17, 31,</sup> 38, 44, 46	9	5	OR 2.1 - 4.4	Yes

#### Part B – Environmental Scan of Caries Risk Assessment Tools for Children < 6 Years of Age

We also undertook an environmental scan of existing caries risk assessment tools for children < 6 years of age. Our search approach included reviewing recognized tools developed by national and international dental, pediatric organizations, and experts (e.g., American Dental Association (ADA), American Academy of Pediatric Dentistry (AAPD), American Academy of Pediatrics (AAP), Caries Management by Risk Assessment (CAMBRA), and the Cariogram). We also searched the internet for other caries risk assessment tools that have been created. Caries risk assessment tools that were identified through our systematic literature review of caries risk factors were also reviewed.

Overall, we identified 22 different caries risk assessment tools that have been developed for use with young children (see Table 6). We modified a table developed by Gao<sup>22</sup> et al to identify and characterize the different variables and factors included in the caries risk assessment tools that we reviewed. More detailed descriptions of each of the caries risk assessment tools can be found in Table 7. Some of the notable and commonly recognized tools include CAMBRA, the American Dental Association's (ADA's) Caries Risk Assessment Form (Ages 0-6), the American Academy of Pediatric Dentistry's (AAPD's) tools, and the Cariogram.

While the majority of the identified caries risk assessment tools are paper-based, some are electronic-based. Copies of the caries risk assessment forms appear as figures at the end of this report. Caries risk assessment tools that are electronic-based programs include the Cariogram, MysmileBuddy, the EBHnow (McGill University) search engine, and the WesternU Axium tool.<sup>54-57</sup> These 22 tools present variations in the way tools are formatted, how questions are phrased, and how responses are used to assign a level of risk.

Two specific organizations were found to have two tools for use in children < 6 years of age. The AAPD has one tool for use by physicians and other non-dental health care providers for children 0-3 years of age, and another caries risk assessment tool for use by oral health providers for children 0-5 years of age.<sup>16</sup> AAPD created this tool based on the growing emphasis on caries risk assessment and the need to identify children before lesions reach the stage where they need to be restored. Meanwhile, the Texas Department of State Health Services has one tool for ages 6-35 months and another tool for children 3-5 years of age. Both of these tools created by Texas Health were adapted from other nationally recognized tools and were specifically designed for the population of Texas Medicaid children.

Upon review of Table 6, the most commonly considered variables incorporated into existing caries risk assessment tools included:

- Dietary habits and practices (21/22)
- Caries experience (Present and past caries experience, active caries (cavitated and non cavitated, and incipient (white spot) caries lesions) (20/22)
- Questions on oral hygiene and plaque (19/22)
- Exposure to fluorides (17/22)
- Caries experience of the child's caregiver or siblings (14/22)
- Infant feeding histories and behaviours (14/22)
- Child's age (13/22)
- Dental attendance and dental visit history (12/22)
- Toothbrushing habits and behaviours (10/22)
- Saliva flow (10/22)

- Special health care needs of the child (10/22)
- Systemic health (9/22)
- Socioeconomic status of the family (7/22)
- Enamel defects, including enamel hypoplasia (7/22)

While 10 caries risk assessment tools included assessments on saliva flow, this type of assessment is only conducive to caries risk assessments performed in clinical settings. It is not practical to include salivary flow, buffering capacity of saliva, oral pH concentrations, and levels of cariogenic bacteria (mutans streptococcus and lactobacillius) in caries risk assessment tools that are intended for screening purposes and for use by non-dental healthcare providers and for use by dental providers in non-clinical settings.

Overall, based on this environmental scan exercise it would be prudent to consider including the following variables when developing a new caries risk assessment tool for use with preschool children:

### Sociodemographic:

- Child's age
- Caries experience of the child's caregiver or siblings
- Socioeconomic status of the family
- Special health care needs of the child

### Behavioural:

- Dietary habits and practices
- Infant feeding histories and behaviours

- Oral hygiene and toothbrushing habits and behaviours
- Exposure to fluorides
- Dental attendance and dental visit history

### <u>Clinical</u>:

- Past caries experience of the child
- Active caries (cavitated or non-cavitated) and white spot caries lesions
- Presence of plaque
- Enamel defects, including enamel hypoplasia

Table 6 – Inventory of identified caries risk assessment tools for children < 6 years of age

Factors	ADA	AAPD	AAPD	AAP	Bankel	CAB	CAMBRA	CF	CMS
		(age 0-3)	(age 0-5)						
Socio-demographic					-				
Age	✓			✓			✓		✓
Ethnicity									
Family SES	✓	$\checkmark$	$\checkmark$	✓					
Recent Immigrant		$\checkmark$	$\checkmark$						
Special health needs	✓	$\checkmark$	~	✓			~	✓	
Caries experience of		1		./					
caregiver/siblings	v	•	v	v			v	•	
Educational level of									
caregivers/Health Literacy							$\checkmark$		
Behavioural									
Infant feeding history		~	✓	✓	~		$\checkmark$	~	
Diet	✓	✓	✓	✓	~	✓	✓	✓	✓
Fluoride	✓	✓	~	✓		✓	✓		✓
Dental attendance	✓	✓	✓	✓				✓	
Parental attitudes/beliefs									
								v	
Tooth brushing Habits		~	$\checkmark$	✓			✓		✓
Clinical									
Oral hygiene/ Plaque	✓	✓	✓	✓		✓	✓	✓	✓
Past caries		✓	✓	✓	~	✓	✓	✓	✓
White spot lesions or									
Active caries	.(			./		.(		./	
(cavitated/Non-cavitated)	v	v	$\checkmark$	v	v	v	v	v	v
Enamel defects		~	$\checkmark$				✓		
Dental appliance	✓							~	
Systemic health						✓	✓	✓	
Medication							✓	✓	
Other oral concerns (e.g.				./					
Gingivitis)				v					
Protective factors (e.g.									
sealants)									
Salivary & Bacterial									
Saliva flow	~					✓	✓	✓	
Saliva buffering capacity				1					1
Mutans Streptococci			✓	1	√		✓		1
Lactobacilli				1			✓		1
Reduced pH				1					1

Factors	CG	DCRAM	EBHnow (McGill)	FDI	Maine	MSB	NUS	PRAT
Socio-demographic			(incom)		<u> </u>			
Age			✓	✓	✓		✓	<ul> <li>✓</li> </ul>
Ethnicity		✓					√	
Family SES		✓		✓			√	
Recent Immigrant		✓					✓	
Special health needs			✓					
Caries experience of						./		
caregiver/siblings		v	v	v	v	v		
Education level of				1			1	
caregivers/Health Literacy				v			•	
Behavioural								
Infant feeding history		✓	$\checkmark$			$\checkmark$	$\checkmark$	$\checkmark$
Diet	$\checkmark$	$\checkmark$	$\checkmark$	✓		$\checkmark$	$\checkmark$	$\checkmark$
Fluoride	✓	$\checkmark$	$\checkmark$	✓		~	~	
Dental attendance			$\checkmark$		✓	$\checkmark$	$\checkmark$	
Parent attitudes/beliefs		$\checkmark$				$\checkmark$	$\checkmark$	
Tooth brushing Habits		✓			✓	$\checkmark$		$\checkmark$
Clinical								
Oral hygiene/ Plaque	✓	✓	✓	✓	✓		✓	~
Past caries	✓		$\checkmark$	✓	✓	~	✓	✓
White spot lesions or								
active caries (Cavitated/Non-	✓	✓	✓	✓	✓		$\checkmark$	
cavitated)								
Enamel defects			✓					
Dental appliance			~					
Systemic health	✓	~	✓				√	
Medication	✓	~		~				
Other oral concerns (e.g.	~							
Gingivitis)			✓		~			
Protective factors (e.g.				~				
sealants)								
Salivary & Bacterial				1 .	1		r	1
Saliva flow	~			~				
Saliva buffering capacity	✓			✓				
Mutans Streptococci	✓	✓	√				~	
Lactobacilli	~	✓	✓				✓	
Reduced pH	1			✓			√	

Factors	SSC	Texas	Texas	UCC	WesternU	Total
		(6 -35 months)	(3-5 years)	(Ireland)	CDM	
Socio-demographic					•	•
Age	✓	✓	✓	✓		13
Ethnicity						2
Family SES						7
Recent Immigrant						4
Special health needs		✓	✓		✓	10
Caries experience of						14
caregiver/siblings		•	•		•	14
Education level of						3
caregivers/Health Literacy						5
Behavioural						
Infant feeding history		✓	✓ ✓		✓	14
Diet	✓	√	✓	~	✓	21
Fluoride		√	✓	~	✓	17
Dental attendance		✓	✓		✓	12
Parent attitudes/beliefs						4
Tooth brushing Habits				✓		10
Clinical						
Oral hygiene/ Plaque	~	$\checkmark$	$\checkmark$		$\checkmark$	19
Past caries	✓	✓	~	~	✓	20
White spot lesions or active caries (cavitated/Non- cavitated)	~	$\checkmark$	~	~	~	20
Enamel defects		✓	✓	✓		7
Dental appliance					✓	4
Systemic health				✓	✓	9
Medication						5
Other oral concerns (e.g. Gingivitis)		~	✓	✓		7
Protective factors (e.g. sealants)				✓		2
Salivary & Bacterial						
Saliva flow	~	✓	✓		✓	10
Saliva buffering capacity	✓					3
Mutans Streptococci	✓					8
Lactobacilli	✓					6
Reduced pH						2

ADA – American Dental Association

**AAPD**- American Academy of Pediatric Dentistry (AAPD) **AAP**- American Academy of Pediatrics

Bankel – Bankel et al.

CAR Cohrol Lilcort Tohor

CAB- Cabral, Hilgert, Faber, & Leal et al. (University of Brasilia) CAMBRA- Caries Management by Risk Assessment CF- CariFree

**CMS** – Caries Management System

**CG**- Cariogram (Electronic Program)

**DCRAM**- Dundee Caries Risk Assessment Model

EBHnow- (McGill University) Online Search Engine for CRA

FDI- World Dental Federation

Maine- Maine Oral Health Risk Assessment and Referral Tool MSB- My Smile Buddy (Electronic iPad based program) NUS- National University of Singapore Caries Risk Assessment PRAT- Pediatric Risk Assessment tool (Shenkin et al.) Academy of General Dentistry

**SSC-** Sugar Snack Caries Risk Test

Texas - Texas Department of State Health Services

UCC- University College Cork (Ireland)

WesternU (CDM) – AxiUm Electronically Modified-Caries Risk Assessment Form 0-5 Years of Age

CRA Tool	Year	Variable/Risk Factor Considered
	Developed	
Texas	Revised	- Caries activity
Department of	2017	- Demineralized areas
State Health		<ul> <li>Parent/primary caregiver</li> </ul>
Services (DHSH)		- Family history- siblings
(Ages 6-35		- Presence of plaque, gingivitis
months/3-5		- Fluoride exposure
years)		- Sugar consumption (including sippy cup use)
		- Dental home
		- Special conditions
		Special needs patient
		Enamel hypoplasia
		Impaired salivary flow
FDI World	2017	Pathological Factors
Dental		- Frequent consumption of dietary sugars
Federation		- Inadeguate fluoride
		- Biofilm homeostatic imbalance
		- Salivary dysfunction
		Protective Factors
		- Tooth-healthy diet
		- Fluoride toothpaste twice daily
		- Professional topical fluoride
		- Preventive and therapeutic sealants
		- Normal salivary function
		High caries Risk
		- Demineralization- Disease (lesion progression)
		- 3 or more incipient or cavitated primary or secondary carries
		lesions in the last 2 years
		Moderate Caries Risk
		- 1 or 2 incipient or cavitated primary or secondary caries lesions in
		the last 2 years
		Low Caries Risk
		- Remineralization – health (lesion arrest or regression)
		- No incipient or cavitated primary or secondary caries lesions
		during the last 2 years and no change in the risk factors that may
		increase caries
EBHnow (McGill	2017	Age
University)		- Less than 6 months
online search		- 6-12 months
engine for		- 1-3 years
caries risk		- 3-6 years
assessment		Fluoride concentration in drinking water
		- Less than 0.3 ppm
		- 0.3 - 0.6 ppm

Table 7 – Specific contents of identified caries risk assessment tools for children < 6 years of age

		- Over 0.6 ppm
		- Don't know
		Presence of caries
		- No incinient or cavitated primary or secondary carious lesions
		during the last 3 years
		- One of two incinient or cavitated primary or secondary carious
		lesions in last 3 years
		- Three or more incinient or cavitated primary or secondary carious
		lesions in last 3 years
		Caries Risk Factors
		- High titers of cariogenic bacteria
		- Poor oral hygiene
		- Prolonged nursing (bottle or breast)
		- Poor family dental health
		- Developmental or acquired enamel defects
		- Teeth genetically abnormal
		- Many multi-surface restorations
		- Chemotherapy or radiotherapy
		- Eating disorders
		- Drug or alcohol abuse
		- Irregular dental care
		- Cariogenic diet
		- Active orthodontic treatment
		- Exposed root surfaces
		<ul> <li>Restoration overhangs and open margin</li> </ul>
		- Unavailability of performing proper oral health care
		- Xerostomia
		- Low socioeconomic status
		More than two of the above
WesternU CDM	2016	Contributing Conditions
– AxiUm		- Are you exposed to fluoride (through drinking water, toothpaste,
Electronically		professional applications, supplements, etc.)?
Modified-Caries		o Yes (low)
<b>Risk Assessment</b>		o No (moderate)
(0-5 years)		<ul> <li>Frequency of sugary, starchy foods or drinks (including juice,</li> </ul>
		carbonated, noncarbonated soft drinks, energy drinks, medicinal
		syrups, etc.)
		<ul> <li>Primarily at mealtimes (low)</li> </ul>
		<ul> <li>Frequently between meals (moderate)</li> </ul>
		<ul> <li>Bottle or sippy cup with anything but water (high)</li> </ul>
		<ul> <li>Caries experience of mother, caregiver, and or/other siblings</li> </ul>
		<ul> <li>No carious lesions in last 24 months (low)</li> </ul>
		<ul> <li>Carious lesions last seven to 23 months (moderate)</li> </ul>
		$\circ$ Carious lesions in the last six months (high)
		<ul> <li>Dental home: establishing patient of record, receiving regular</li> </ul>
		dental care in dental office
		o Yes (low)

		<ul> <li>No (moderate)</li> </ul>
		General health conditions
		- Special health care needs (including developmental physical
		medical or mental disabilities that prevent or limit adequate oral
		(are)
		0 NO (IOW)
		Clinical conditions
		<u>Clinical conditions</u>
		- visual or radiographically evident cavitated lesions
		<ul> <li>No active cavitated lesions in one year (low)</li> </ul>
		<ul> <li>No active cavitated lesions or restorations in last six</li> </ul>
		months (moderate)
		• Presence of lesions/restorations in last six months (high)
		- Non-cavitated ACTIVE carlous lesions (e.g. active brown/white
		spot lesions)
		<ul> <li>No incipient active lesions in one year (low)</li> </ul>
		<ul> <li>No incipient active lesions in last six months (moderate)</li> </ul>
		<ul> <li>Presence of incipient non-cavitated lesions in last six</li> </ul>
		months (high)
		<ul> <li>Teeth missing due to caries</li> </ul>
		o No (low)
		<ul> <li>Yes (high)</li> </ul>
		- Visible plaque
		<ul> <li>Yes (moderate)</li> </ul>
		o No (low)
		<ul> <li>Dental/orthodontic appliances (fixed or removable)</li> </ul>
		o No (low)
		<ul> <li>Yes (moderate)</li> </ul>
		- Salivary flow
		<ul> <li>Visually adequate (low)</li> </ul>
		Visually inadequate (high)
Sugar Snack	2016	Caries Activity/Risk Measurement
<b>Caries Risk Test</b>		- 0 weeks Baseline, 5 <sup>th</sup> week, 10 <sup>th</sup> week, 14 <sup>th</sup> week
(Tooth Saver		<ul> <li>Sugar snack test (SST)</li> </ul>
Team)		<ul> <li>Saliva Secretion Rate (SSR)</li> </ul>
-		• Plague Score
		<ul> <li>Mutans Streptococcus (SM)</li> </ul>
		<ul> <li>Buffering Capacity (BC)</li> </ul>
		o Lactobacilli (Lb)
		o Diet
		<ul> <li>Decayed Teeth (DT)</li> </ul>
		<ul> <li>Decayed, Missing, Filled Surfaces (DMFS)</li> </ul>
		OHI, 1% NaF. 0.2% NaF. 0.2% CHX
MvSmileBuddy	2015	- Dietary cariogenicity
(MSB)		Frequency duration and timing of simple carbohydrate
	l	exposure

- iPad based		- Food grouping system and scoring method (timing, physical form,
interactive		retention characteristics)
program		- Dietary risk exposure scores
		- Fluoride exposure (eg. Toothpaste used)
		- Family history (eg. Parental experience with tooth decay)
		- Feeding practices (eg. Sippy cup use)
		Thoughts and feelings about oral health (eg. Confidence in reducing tooth
		decay)
American	2014	Scoring based on low or high risk
Academy of		Biological
Pediatric		<ul> <li>Mother/primary caregiver has active caries</li> </ul>
Dentistry		<ul> <li>Parent/caregiver has low socioeconomic status (SES)</li> </ul>
AAPD		<ul> <li>Child has &gt;3 between meal sugar-containing snacks or beverages</li> </ul>
(0-3 year old –		per day
For physicians		- Child is put to bed with a bottle containing natural or added sugar
and non-		- Child has special health care needs
healthcare		- Child is recent immigrant
providers)		Protective
		<ul> <li>Child receives optimally- fluoridated drinking water or fluoride</li> </ul>
		supplements
		<ul> <li>Child has teeth brushed daily with fluoridated toothpaste</li> </ul>
		<ul> <li>Child receives topical fluoride form health professional</li> </ul>
		<ul> <li>Child has dental home/regular dental care</li> </ul>
		Clinical Findings
		<ul> <li>Child has white spot lesions or enamel defects</li> </ul>
		<ul> <li>Child has visible cavities or fillings</li> </ul>
		- Child has plaque on teeth
Cabral, Hilgert,	2014	Caries experience
Faber, & Leal et		<ul> <li>Dmft was considered higher or lower than average in relation to</li> </ul>
al. (University		the age of the patient
of Brasilia)		- Score 0-9 (min), 11-13 (max)
		Related diseases
		<ul> <li>Parents were asked if children presented diseases related to</li> </ul>
		dental caries, such as asthma or others
		- Scores: 0 (min), 2-4 (max)
		Sugar consumption
		<ul> <li>Parents were asked about consumption of fermentable</li> </ul>
		carbohydrates
		- Score: 0-5 (min), 13-20 (max)
		Frequency of food consumption
		<ul> <li>Parents were asked about children's diets- the quantity of</li> </ul>
		meal/snacks consumed per day
		- Scores: 0-5 (min), 13-20 (max)
		<u>Oral hygiene</u>
		- Visible plaque index
		- Scores: 0-4 (min), 8-15 (max)
		Fluoride Sources

		- Parents were asked about fluoride availability
		- Score: 0-5(min). 10-50(max)
		Salivary flow
		- Suspicion of hyposalivation
		Score: 0-2 (min), 5-20 (max)
Maine Oral	2013	Dental Home Assessment & Caries
Health RA		- Does child have teeth?
		- Has child seen a dentist in the past year
		<ul> <li>Does child have his/her teeth brushed</li> </ul>
		<ul> <li>Does the child have his/her teeth brushed daily with toothpaste</li> </ul>
		<ul> <li>Has the child ever had cavities or fillings</li> </ul>
		- Has the mother/primary caregiver had active/untreated cavities in
		the past year
		Oral Evaluation and Plan
		- Is there visible plaque on teeth
		- Are there signs of visible decay or white spot lesions on the teeth
		- Does the child have other oral conditions of concern (abscess,
		broken tooth, pain, etc.)
		Oral Health Plan
		- Should consider Fluoride varnish if multiple risk factors
		<u>For all children</u>
		- Prescribed fluoride supplement
		- Fluoride supplements not indicated
		For children who have not seen a dentist in past year
		- Completed CRA w/ Oral Evaluation
		- Applied Fluoride Varnish
		- Patient/Family declined Fluoride Varnish
		- Referred Child to deficist
		- Routine referral/Immediate referral
		- The child has special health care needs
		- There are factors that could hinder performing an oral health
		exam or x-rays for this child
		- Oral sensitivities
		- Difficulty following directions
		- Latex allergies
		- Difficulty swallowing
		- Difficulty sitting still
		- Does not tolerate knee-to-knee exam
		- Food sensitivities
		- Bruxism
Dundee Caries	2012	Dental examination
Risk Assessment		- Direct vision and illumination by pen light
Model (DCRAM)		Microbiological saliva sampling (Tongue loop method)
		- Mutans streptococci
		- Lactobacilli

		- Yeasts
		Health Visitor Questionnaire
		- Height, weight, head circumference, immunization status, ethnic
		origin, illnesses, medication, weaning, use of comforter, vitamin
		supplementation, feeding problems, family history, parental
		employment, parental health, parental smoking and housing
		status
		- Oninion on caries risk
		- Deprivation category score
		Parental Questionnaire
		- Breast/hottle
		- Feeding
		- Meals drinks snacks
		- Tooth brushing
		Eluoride supplementation
University	2012	
Collogo Cork	2012	Age 0.2 with carios (cavitated or non-cavitated)
(UCC) - Iroland		- Age 0-5 with carles (cavitated of holi-cavitated) Age 4.6 with dmft $>2$ or DMET $>0$
(OCC) – irelaliu		- Age 7 and over with active smooth surface caries (cavitated or
		- Age 7 and over with active smooth surface cartes (cavitated of
		Now carios locian in last 12 months
		- New Calles lesion in last 12 months
		- Hyperinneralised perinalient molars
		- Medical of other conditions where dental carles could put the
		Madical or other conditions that could increase the patient's risk
		- Medical of other conditions that could increase the patient's risk
		Of developing definitions that may reduce the nations's shility
		- Medical of other conditions that may reduce the patient's ability
		to maintain their oral health, or that may complicate dentai
		Consideratione
		Considerations:
		- Age 7-10 with dmit >3 of Diviri >0
		- Age 11-13 with DMFT >2
		- Age 14-15 With DIVIFT >4
		- Deep pits and fissures in permanent teeth
		- Full medical card
		- Sweet shacks or drinks between meals more than twice a day
		Protective Factors
		- Fissure sealants
		- Brushes twice a day or more
		- Use toothpaste containing 1000ppm F or more
		Fluoridated water supply
American	2011	Scoring based on low, moderate or high risk
Dental		<u>Contributing Conditions</u>
Association		- Fluoride exposure
Caries Risk		Through drinking water, supplements, professional
Assessment		applications, toothpaste
ADA (0-6)		<ul> <li>Sugary foods or drink</li> </ul>

	r	
		<ul> <li>Including juice, carbonated or non-carbonated soft</li> </ul>
		drinks, energy drinks, medicinal syrups
		<ul> <li>Eligible for Government Programs</li> </ul>
		<ul> <li>WIC, Head Start, Medicaid or SCHIP</li> </ul>
		- Caries experience of mother, caregiver, and/or other siblings
		- Dental home
		<ul> <li>Established patient of record in dental office</li> </ul>
		General Health Conditions
		- Special health care needs (developmental physical medical or
		mental disabilities that prevent or limit performances of adequate
		oral health care by themselves or caregivers)
		Clinical Conditions
		<u>Clinical Conditions</u>
		- visual of radiographically evident restorations/cavitated carlous
		lesions
		- Non-cavitated (incipient) carlous lesions
		- Teeth missing due to carles
		- Visible plaque
		<ul> <li>Dental/orthodontic appliances present</li> </ul>
		Fixed or removable
		- Salivary flow
American	2011	Risk Factors
Academy of		<ul> <li>Mother or primary caregiver has had active decay in the past 12</li> </ul>
Pediatrics (AAP)		months
		<ul> <li>Mother or primary caregiver does not have a dentist</li> </ul>
		- Continual bottle/sippy cup use with fluid other than water
		- Frequent snacking
		- Special health care needs
		- Medicaid eligible
		Protective Factors
		- Existing dental home
		- Drinks fluoridated water or takes fluoride supplements
		<ul> <li>Eluoride varnish in last 6 months</li> </ul>
		- Flucifice Valifish in fast o months
		- Has teeth brushed twice daily
		<u>Clinical Findings</u>
		- White spots of visible decalchications in the past 12 months
		- Obvious decay
		- Restorations (fillings) present
		- Visible plaque accumulation
		- Gingivitis (swollen/bleeding gums)
		- Teeth present
		- Healthy teeth
		Assessment/Plan
		- Caries risk
		<ul> <li>Low/high</li> </ul>
		- Completed
		Anticipatory guidance
		Fluoride varnish

		Dental Referral
		- Self management goals
		Regular dental visits
		Dental treatment for parents
		Brush twice daily
		Use fluoride toothpaste
		Wean off bottle
		• Less/no juice
		Only water in sippy cup
		Drink tap water
		Healthy snacks
		<ul> <li>Less/no junk food or candy</li> </ul>
		<ul> <li>No soda</li> </ul>
		Xvlitol
Bankel et al.	2011	2 years of age
"Carious lesions		- Initial caries
and caries risk		- Sugar intake
predictors in a		<ul> <li>Scores: 1&lt;14= 14-21, 3= 22-27, 4&gt;27 sucrose containing</li> </ul>
group of		items/week)
Swedish		<ul> <li>Breastfeeding at night</li> </ul>
children 2 to 3		<ul> <li>Score: 1 = none, 2 = breastfeeding</li> </ul>
years of age.		<ul> <li>Salivary mutans streptococcus</li> </ul>
One year		<ul> <li>Scores: 0 = none or few cfu per ml saliva, 1= &lt;105 cfu per ml</li> </ul>
observation"		saliva, 2= 105-106 cfu per ml, 3= >106 cfu per ml saliva
		<u>3 years of age</u>
		- Initial caries
		- Sugar Intake
		<ul> <li>Scores: 1&lt;14= 14-21, 3= 22-27, 4&gt;27 sucrose containing</li> <li>items (use b)</li> </ul>
		Items/week)
		- Diedstieeunig at ingit
		- Salivary mutans streptococcus
		- Scores: $0 - none or few cfu per missiva 1 - <105 cfu per mi$
		saliva, $2 = 105-106$ cfu per ml $3 = >106$ cfu per ml saliva
Caries	2011	Scoring: 1. 2 or 3 where 1 = high risk
Management by		Risk Factors
Risk Assessment		- Mother or primary caregiver has had active dental decay in the
CAMBRA (0-5		past 12 months
years)		- Bottle with fluid <u>other</u> than water, milk and/or formula
		- Continual bottle use
		<ul> <li>Child sleeps with bottle, or nurses on demand</li> </ul>
		<ul> <li>Frequent (&gt;3 times/day) between-meal snacks of sugars/cooked</li> </ul>
		starch/sugared beverages
		<ul> <li>Saliva reducing factors are present including:</li> </ul>
		<ul> <li>Medications (eg. Some for asthma [albuterol] or</li> </ul>
		hyperactivity)
		Medical (cancer treatment) or genetic factors

		Child has developmental problems (CSUCN (shild with special
		- Child has developmental problems/CSHCN (child with special bealth care needs)
		- Caregiver has low health literacy is a WIC participant and/or
		child participates in Free Lunch Program and/or Farly Head Start
		Distortive Easters
		Child lives in a fluoridated community or takes fluorida
		- Child lives in a hubridated community of takes hubride
		supplements by slowly dissolving or as chewable tablets (note
		resident ZIP code)
		- Child drinks fluoridated water (eg. Use of tap water)
		- Teeth brushed with fluoridated toothpaste (pea-size) at least once
		daily
		- Teeth brushed with fluoride toothpaste (pea-size) at least 2x daily
		<ul> <li>Fluoride varnish in last six months</li> </ul>
		<ul> <li>Mother/caregiver chews/dissolves xylitol chewing gum/lozenges</li> </ul>
		2-4x daily
		Disease Indicators/Risk Factors – Clinical Examination of Child
		<ul> <li>Obvious white spots, decalcifications enamel defects or obvious</li> </ul>
		decay present on the child's teeth
		<ul> <li>Restorations present (past caries experience for the child)</li> </ul>
		<ul> <li>Plaque is obvious on the teeth and/or gums bleed easily</li> </ul>
		- Visually inadequate saliva flow
		- New remineralisation since last exam (List teeth)
		Child's overall caries risk (high, medium or low)
		Child bacteria and saliva test
		Caregiver: Bacteria/saliva test results
		Self management goals
		Treatment guidelines
	2010	Children's demographic background
	2010	
		- Gender
		- Gender
		- Race
		- Country of birth
		Socioeconomic status
		- Parents education attainment
		- Housing condition
		<u>Children's oral nealth practice</u>
		- Feeding histories
		- Diet habits
		- Oral hygiene measures
		- Fluoride applications
		- Dental attendance
		Systemic disease
		Parental knowledge and attitudes on oral health
CariFree (CF)	2009	Patient Use Only
(Age 0-5)		Risk Factors
		<ul> <li>Plaque build up on my child's teeth</li> </ul>
		- Child takes medication daily

		1
		<ul> <li>Child sees the same dentist regularly</li> </ul>
		<ul> <li>Child has special needs that prohibit adequate care at home</li> </ul>
		- Child continuously sips on something other than water during the
		day, sleeps with a bottle, or nurses on demand
		- Child snacks 1-3 times daily between meals
		- Other health concerns: diabetes, asthma, allergies, or other
		Clinician Use Only
		- Mother/caregiver active caries
		- New/progressing visible cavitation's
		- New/progressing approvimal radiographic radiolucencies
		- New/active white snot lesions
		- Decay history is a concern
		Professional Accessment Summary
		Pick factors are a concorn
		- Risk factors are a concern
		- Disease indicators are a concern
		Low/moderate risk – moderate risk- nigh/extreme risk
		- Risk factors
		- Disease indicators
Caries	2009	10-step non-invasive strategy to arrest and remineralize early lesions
Management		1. Diet assessment
System (CMS)		2. Plaque assessment
		3. Bitewing radiographic survey
		<ol><li>Diagnosis and caries risk assessment</li></ol>
		- Diet
		- Fluoride exposure
		- Clinical examination
		<ul> <li>Plaque distribution</li> </ul>
		<ul> <li>Examination using ICDAS II criteria (International</li> </ul>
		Caries Detection & Assessment System)
		5. Case presentation to the patient
		6. Diet advice and oral hygiene coaching
		- Emphasize value of fluoridated water
		- Bottle feeding of sugar-containing products discouraged
		- Discourage sugary foods, especially around bedtime
		-
		7 Clinical management
		8 Monitoring of patient's progress
		9 Recall programme tailored to caries risk status
		Criteria for Carles Risk for Child with Primary Dentition
		- Low
		= 1000  GeV = 0
		O ICDAS II COUR <2
		O NO radiolucencies
		o ino sites with Plaque Index = 3
		<ul> <li>&lt; 1 new lesion per year and no progression of existing</li> </ul>
1	1	lesions

			At Risk
			• DMFS > 0
			<ul> <li>Demineralized enamel – ICDAS II codes &gt; 1</li> </ul>
			<ul> <li>C1 or greater radiolucencies</li> </ul>
			<ul> <li>1 new lesion per year and/or progression of existing</li> </ul>
			lesions
			• Any site with Plaque Index = 3 in cases where DMFS = 0
		-	High
			<ul> <li>Any site with Plaque Index = 3 in cases where DMFS =0</li> </ul>
			<ul> <li>&gt;1 new lesion per year</li> </ul>
Cariogram (CG)	2004	Circums	<u>tances</u>
		-	Caries experience
			<ul> <li>Past caries experience (cavities, fillings and missing teeth</li> </ul>
			due to caries)
			DMFT & DMFS
		-	Related diseases
			<ul> <li>General disease or conditions associated with dental</li> </ul>
			caries
			Medical history
			Medications
		<u>Diet</u>	
		-	Diet content (weekly diet diary)
			<ul> <li>Estimation of cariogenicity of the food, in particular</li> </ul>
			fermentable carb. content
			Diet history
			Lactobacillus test count
		-	Diet frequency (weekly diet diary)
			<ul> <li>Estimation of number of meals and snacks per day, mean</li> </ul>
			for a normal day
			<ul> <li>24 hour recall or 3 days dietary recall</li> </ul>
		<u>Bacteria</u>	
		-	Plaque quantity
			Estimation of hygiene
			Silness-Loe Plaque Index (PI)
			<ul> <li>Crowded teeth leading to difficulties in removing plaque</li> </ul>
			interproximally should be taken into account
		-	Streptococcus mutans
			• Estimation of mutans streptococci (streptococcus mutans,
			streptococcus sobrinus) in saliva, for example using strip
			mutans test
		<u>Suscepti</u>	ibility
		-	Fluoride program
			<ul> <li>Estimation of as to what extent fluoride is available in</li> </ul>
			the oral cavity over the coming period of time (fluoride
			exposure- interview patient)
		-	Salivary secretion (stimulated saliva test)

		<ul> <li>Estimation of amount of saliva, for example using</li> </ul>
		paraffin-stimulated secretion and expressing results as
		ml saliva per minute
		- Saliva huffer canacity
		<ul> <li>Estimation of canacity of saliva to buffer acids for</li> </ul>
		• Estimation of capacity of saliva to bullet acids, for
		Opinion of dental examiner, clinical feeling . Examiners own clinical and
		personal score for the individual patient
Pediatric Risk	2002	- Risk based on point system
Assessment		<ul> <li>Low Risk = 0-4 points</li> </ul>
Tool (PRAT)		<ul> <li>Moderate Risk = 5-10 points</li> </ul>
		<ul> <li>High Risk &gt; 10</li> </ul>
		- 11 components:
		<ul> <li>Number of drinking occasions</li> </ul>
		<ul> <li>Evening/night soft drink consumption</li> </ul>
		<ul> <li>Oral Hygiene</li> </ul>
		<ul> <li>Previous history of dental caries</li> </ul>
		<ul> <li>Total formula/milk</li> </ul>
		<ul> <li>Total juice/juice drinks</li> </ul>
		• Total regular pop/Kool-Aid, sports drinks, other sugar
		heverages
		<ul> <li>Total water other sugar-free heverages</li> </ul>
		<ul> <li>Hard or chewy candy, regular gum (occasions)</li> </ul>
		<ul> <li>Baked starch/sugar (occasions)</li> </ul>
AAPD (aka CAT)	2002	Scoring based on low moderate, or high rick
(0.5  year old -	(Povisod	Biological
(U-5 year olu -	(Revised	<u>Diological</u>
For dental	2014)	- Would'/ primary caregiver has active cares
providers)		- Parent/caregiver has low SES
		- Child has >3 between meal sugar-containing shacks or beverages
		per day
		- Child is put to bed with a bottle containing natural or added sugar
		- Child has special health care needs
		<ul> <li>Child is recent immigrant</li> </ul>
		Protective
		<ul> <li>Child receives optimally- fluoridated drinking water or fluoride</li> </ul>
		supplements
		<ul> <li>Child has teeth brushed daily with fluoridated toothpaste</li> </ul>
		<ul> <li>Child receives topical fluoride form health professional</li> </ul>
		<ul> <li>Child has dental home/regular dental care</li> </ul>
		Clinical Findings
		<ul> <li>Child has &gt;1 decayed/missing/filled surfaces</li> </ul>
		- Child has active white spot lesions or enamel defects
		- Child has elevated mutans streptococci levels
		<ul> <li>Child has plaque on teeth</li> </ul>

#### Some Canadian Context – Risk Factors for ECC in the Canadian Literature:

While outside the scope of this systematic review of evidence on caries-risk, we felt it was important to review the Canadian literature on ECC to identify common risk factors associated with ECC in cross-sectional studies. This was undertaken to provide some "Canadian context" in identifying factors to include in a Canadian style caries-risk assessment tool. We reviewed literature since the establishment of a case definition for ECC in 1997. Cross-sectional studies were considered. Only those studies reporting risk factors associated with ECC using logistic regression analyses were considered.

A total of six articles were identified to have reported variables associated with ECC in Canadian literature following logistic regression analyses.<sup>35, 58-62</sup> The main risk factors identified in these studies appear below in Table 8. Based upon these data it could be justified to include the following variables into a caries-risk assessment tool for use by non-dental professionals in Canada:

- Age of child,
- Existence of a dental home and past dental attendance,
- Lack of dental insurance,
- Family income, specifically low income,
- Family size,
- Frequency of snacking,
- Inappropriate bottle use and infant feeding habits,
- Brushing habits of child,
- Parental ratings or perception of child's dental status,

- Presence of enamel hypoplasia,
- Presence of plaque on teeth.

Table 8 – Variables associated with ECC and S-ECC in Canadian studies following logistic regression

Study	Risk Factors for ECC	Risk Factors for S-ECC
Schroth & Cheba <sup>60</sup>	<ul> <li>Male child</li> <li>Age at first dental visit         <ul> <li>(&gt; 23 months)</li> </ul> </li> <li>Low monthly income             (≤ \$2,000)</li> <li>History of failed dental             appointment</li> <li>Not being single parent</li> </ul>	
Tiberia et al <sup>61</sup>	<ul> <li>Leaving bottle with child</li> <li>Problems brushing</li> <li>Holding liquids in mouth for prolonged time</li> </ul>	
Werneck et al <sup>62</sup>	<ul> <li>No insurance</li> <li>No family dentist</li> <li>Frequency of snacks</li> <li>(≥ 2/day)</li> </ul>	
Schroth et al <sup>63</sup>	<ul> <li>Age of child</li> <li>Maternal rating of child's teeth</li> <li>Number of children in household</li> </ul>	
Schroth et al⁵⁴	<ul> <li>Enamel hypoplasia</li> <li>Infant age</li> <li>Prenatal 25(OH)D level</li> </ul>	
El Azrak et al <sup>64</sup>	<ul> <li>Age of child</li> <li>Parent thinks child has dental problems</li> <li>Enamel hypoplasia</li> </ul>	<ul> <li>Debris score</li> <li>Parent thinks child has dental problems</li> <li>Enamel hypoplasia</li> </ul>

Poon and colleagues embarked on a caries risk assessment tool development project in 2007/2008, which included a literature review, a review of best-practices, consultations with dental public health staff and a review of recommendations from the British Columbia (BC)

Early Childhood Dental Programs Evaluation Subcommittee.<sup>63</sup> Despite this undertaking they were unable to develop a standardized caries risk assessment tool for children aged 0-5 years of age in BC.

### <u>Part C – Proposed Caries Risk Assessment Tool for Screening Purposes for Preschool Children</u> <u>in Canada</u>

The intent of this project was to ultimately identify those factors that should be included in an early childhood caries risk assessment tool for use by non-dental providers and to develop a draft of such tool. However, while it is important to have such a tool for use for screening purposes in Canada, there is considerable utility in developing a complementary tool for use by dental professionals. The drafted caries risk assessment tool in this report could theoretically be used by both non-dental and dental providers. The development of this tool was informed by Project A (systematic review of the literature) and Project B (environmental scan of existing caries risk assessment tools). Canadian literature on risk factors for ECC was also considered to provide some "Canadian context" of potential risk factors for caries that are currently not included in some of the existing caries risk assessment tools.

The caries risk assessment tool that has been developed as part of this project appears in Figure 2. This is the first caries risk assessment tool that has been developed for use in Canada with children < six years of age. While this is a very exciting and promising development for early childhood oral health in Canada, some caution should be exercised. Prospective studies involving Canadian preschool children are needed in order to validate and determine the sensitivity and specificity of this caries risk assessment tool to predict caries risk.

Figure 3 presents versions of the draft caries risk assessment tool arising from the March 2018 stakeholder meeting. Focus group pilot testing of this drafted tool is currently underway and results will be discussed at a November 2018 meeting of the stakeholder group.





## Figure 3a and 3b – Draft Caries Risk Assessment Tool Arising from March 2018 Stakeholder Meeting

CANA-P - Canadian Pediatric Caries Risk Assessment Tool (< 6 years) Off

PE-CAN - Pediatric Canadian Caries Risk Assessment Tool

(<6 years) OR CAN-CART Canadian Caries Risk Assessment Tool (<6 years)

DRAFT VERSION A- April 2018

Child's Name\_\_\_\_\_ Child's Date of Birth\_ Parent/caregiver's name

Date

FACTORS			LEVEL		RECOMMENDED ACTIONS
Clinical Factors	High	Risk	Low	Risk	Actions
Child has cavities (including white spot lesions) and/or has fillings for past cavities		Yes		No	
Child has visible plaque on top front teeth	0	Yes	0	No	
Biological/Behavioral Factors	High	Risk	Low	Risk	Actions
Infant feeding practices that can increase the risk for cavities: - bottle feeding > 12 months, - frequent bottle use, - bedtime bottle with contents other than water, - bottle or breastleeding after solid foods have been introduced, without a good oral hygiene routine established	0	Yes	o	No	
Châd usually snacks or drinks sugary and acidic beverages between meals (including fruit juices and sports drinks)	•	Yes	0	Ne	
	High	n Risk	Low	Risk	Actions
Child has teeth brushed daily (by parent/caregiver), at least twice a day for two minutes		No		Yes	
Child is exposed to fluoride (i.e., uses fluoridated toothpaste daily, drinks fluoridated water, or receives regular fluoride varnish)	•	No	٥	Yes	
verall carles risk status			2		

ARIES MANAGEMENT Low Risk	High Risk:
Refer to dental home (by 12 months/6 months after eruption of 1st tooth)     Recommend 2x dely brushing with fluendated toethpaster.     Simer (grain of noe size) of boothpaste for 0-3 years of age     Pea size of toothpaste for 3-6 years of age     Caregiver Education/Anticipatory Guidance	Refer to dental home (by 12 months/6 months after eruption of 1st tooth)     Necommend 2x daily brushing with fluendated toothpaste:     Smear (grain of non-size) of toothpaste for 0-3 years of age     Professional Fluende warrish applications at each visit     Caregiver Education/Antipatory Guidance

\*Based on AAPD Carles Management, Establishment of the Dental Home & CDA Position Statements on EDC, First Visit, Use of Fluoride in Carles Prevention

CANA-P - Canadian Pediatric Caries Bisk Assessment Tool (< 6 years) *OR* PE-CAN - Pediatric Canadian Caries Bisk Assessment Tool

	High Risk	Low Risk	Actions
Sociodemographic/Biological/Behavioral Factors			
hild's family is of low socioeconomic status (low income, receiving government ssistance/welfare, parent/caregiver has low education/limited education)	Tes Tes	No No	
Infant feeding practices that can increase the risk for cavities:     battle feeding > 12 months,     frequent bottle use,     bedtime bottle with contents other than water,     bedtime bottle withcontents other than water,     bedtime rotative disg after solid foods have been introduced, without a good oral     hygiene routive established	0 Ye	D No	
hild usually snacks or drinks sugary and acidic beverages between meals (including fruit juices nd sports drinks)	C Yes	No No	
Protective Factors			
hild has teeth brushed daily (by parent/caregiver), at least twice a day for two minutes	No No	Yes Yes	
hild is exposed to fluoride (i.e., uses fluoridated toothpaste daily, drinks fluoridated water, or receives regular fluoride varnish	No	Yes Yes	
Clinical Factors	12		
hild has cavities (including white spot lesions) and/or has fillings for past cavities	Tes Yes	No No	
hild has visible plaque on top front teeth	Tes Yes	No No	

Child's Name

DRAFT VERSION B- April 2018

errol 2x data to adapt, with the stated to itemsets. Series Jacobi of rise sign of testherests for 0.3 years of any Provision of Testherests for 1.6 errors of any et the story Petiticantos i Series. 

## Appendix <u>American Dental Association Caries Risk Assessment Form</u>Age 0-6 years

<b>C</b> -	rios Pick Assossment Form (Aco O d	3	America's leading advoc	at ASSOCIATION" ate for oral health
Patie	nes Risk Assessment Form (Age 0-6	,		
Birth	n Date:		Date:	
Age:			Initials:	
		Low Risk	Moderate Risk	High Risk
	Contributing Conditions	Check o	Circle the conditions t	hat apply
J.	Fluoride Exposure (through drinking water, supplements, professional applications, toothpaste)	Ves	No	
11.	Sugary Foods or Drinks (including juice, carbonated or non-carbonated soft drinks, energy drinks, medicinal syrups)	Primarily at mealtimes	Frequent or prolonged between meal exposures/day	Bottle or sippy cup with anything other than water at bed time
III.	Eligible for Government Programs (WIC, Head Start, Medicaid or SCHIP)	□No		□Yes
IV.	Caries Experience of Mother, Caregiver and/or other Siblings	No carious lesions in last 24 months	Carious lesions in last 7-23 months	Carlous lesions in last 6 months
V.	Dental Home: established patient of record in a dental office	Ves	No	
	General Health Conditions	Check o	Circle the conditions t	hat apply
ï	Special Health Care Needs (developmental, physical, medi- cal or mental disabilities that prevent or limit performance of adequate oral health care by themselves or caregivers)	No		□Yes
	Clinical Conditions	Check o	r Circle the conditions t	hat apply
Ł	Visual or Radiographically Evident Restorations/ Cavitated Carious Lesions	No new carious lesions or restorations in last 24 months		Carious lesions or restorations in last 24 months
н.	Non-cavitated (incipient) Carlous Lesions	No new lesions in last 24 months		New lesions in last 24 months
Ш.	Teeth Missing Due to Carles	No		Ves
IV.	Visible Plaque	□No	Yes	
V.	Dental/Orthodontic Appliances Present (fixed or removable)	No	Ves	
VI.	Salivary Flow	Visually adequate		Visually inadequate
Ove	erall assessment of dental caries risk:	Low	Moderate	High

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# <u>American Academy of Pediatric Dentistry</u> Age 0-3 years & Age 0-5 years

Factors	High Risk	Low Risk
Biological		
Mother/primary caregiver has active cavities	Yes	
Parent/caregiver has low socioeconomic status	Yes	
Child has >3 between meal ragar-containing snacks or beverages per day	Yes	
Child is put to bed with a bottle containing natural or added sugar	Yes	
Child has special health care needs	Yes	
Child is a recent immigrant	Yes	
Protective		
Child receives optimally-fluoridated drinking water or fluoride supplements		Yes
Child has teeth brushed daily with fluoridated toothpaste		Yes
Child receives topical fluoride from health professional		Yes
Child has dental home/regular dental care		Yes
Clinical Findings		
Child has white spot lesions or enamel defects	Yes	2
Child has visible cavities or fillings	Yes	
Child has plaque on teeth	Yes	
	and the second second second	

Factors	High Risk	Moderate Risk	Low Risk
Biological			
Mother/primary caregiver has active caries	Yes		
Parent/caregiver has low socioeconomic starus	Yes		
Child has s3 between meal sugar containing stacks or beverages per day	Tes		
Child is put to bed with a bottle containing rutural or added sugar	Yes	1	
Child has special health care beeds Child is a secont immierant		Yes	
Protection	1		
Child receives optimally flaoridated drinking water or fluoride numlements			Yes .
Child has work brushed daily with flueridated toothpaster			Ym
Child receives topical fluoride from health professional			Yes
Child has dental homo/regular dental carr			Ven
Clinical Findings			
Child has >1 decayed/missing/filled surfaces	Yes		
Child has active white spot lesions or enamel defects	Yes		
Child has elevated mutata streptscosci levels	Yes	1000	
Child has plaque on teeth		Yes	
Citcline those conditions that apply to a specific patient helps the practitioner	and patient understa	and the factors that cost	eribine to

## American Academy of Pediatrics (AAP) Oral Health Risk Assessment Tool

## **Oral Health Risk Assessment Tool**

The American Academy of Pediatrics (AAP) has developed this tool to aid in the implementation of oral health risk assessment during health supervision visits. This tool has been subsequently reviewed and endorsed by the National Interprofessional Initiative on Oral Health.

#### Instructions for Use

This tool is intended for documenting caries risk of the child, however, two risk factors are based on the mother or primary caregiver's oral health. All other factors and findings should be documented based on the child.

The child is at an absolute high risk for caries if any risk factors or clinical findings, marked with a A sign, are documented yes. In the absence of A risk factors or clinical findings, the clinician may determine the child is at high risk of caries based on one or more positive responses to other risk factors or clinical findings. Answering yes to protective factors should be taken into account with risk factors/clinical findings in determining low versus high risk.


# <u>Bankel et al.</u>

		2	years of ag	je		3 years	of age	
ID	Carles defs plus d <sub>i</sub> <sup>a)</sup>	Sucrose- intake 1, 2, 3 & 4 <sup>b)</sup>	Breastfeeding at night 1 & 2 <sup>C)</sup>	MS in saliva score 0-3 <sup>d)</sup>	Carles defs plus d <sub>i</sub> <sup>a)</sup>	Sucrose- intake 1, 2, 3 & 4 <sup>b)</sup>	Breastfeeding at night 1 & 2 <sup>C)</sup>	MS in saliva score 0-3 <sup>d</sup>
1	2	1	2	0	2	1	1	0
2	18	1	2	1	19	1	2	0
3	3	4	2	0	9	2	1	2
4	1	4	2	3	7	4	1	3
5	2	4	1	1	8	4	1	3
6	0	4	1	0	1	1	1	0
7	0	4	1	0	7	3	1	1
8	0	4	1	3	0	1	1	1
9	0	4	1	0	0	3	1	0
10	0	4	1	0	0	3	1	0
11	0	4	1	0	0	1	1	0
12	Ô	4	1	0	0	1	1	0
13	0	4	1	0	0	2	1	0
14	0	4	2	0	0	3	2	0
15	0	4	1	0	0	1	1	0
16	0	4	1	1	0	2	1	1
17	0	4	1	0	0	4	1	0
18	0	4	2	0	0	3	1	0
19	0	1	2	0	0	1	1	0
20	0	1	2	2	0	4	1	0
21	0	2	2	0	0	3	2	0
22	0	1	2	0	0	1	1	0
23	0	1	1	3	0	1	1	2
24	0	1	1	1	2	2	1	2
25	0	1	1	2	0	2	1	0

a) di = initial caries, b)1<14, 2=14-21, 3=22-27, 4>27 sucrosecontaining items/wk; c) 1=none, 2=breastfeeding; d) Score 0 = none or few cfu per ml saliva, score 1=<105 cfu per ml saliva saliva, score 2=105-106 cfu per ml and score 3=>106 cfu per ml saliva

# Cabral, Hilgert, Faber & Leal (University of Brasilia)

Variable	Description	Instrument used		Sco	ores	
Caries experience	dmft was considered higher or lower		Mini	mum	Maxi	mum
	than average in relation to the age of the patient	dmft	0	9	11	13
Related diseases	Parents were asked if children presented diseases related to dental caries, such as asthma or others	Questionnaire	1	0	2	4
Sugar consumption	Parents were asked about the consumption of fermentable carbohydrates	Questionnaire	0	5	13	20
Frequency of food consumption	Parents were asked about childrens' diets - the quantity of meals/snacks consumed per day	Questionnaire	0	5	13	20
Oral hygiene	Visible Plaque Index	Visible plaque index	0	4	8	15
Fluoride Sources	Parents were asked about fluoride availability	Questionnaire	0	5	10	50
Salivary flow	Suspicion of hyposalivation	Clinical Examination	0	2	5	40

dmft=decayed, missing, filled teeth

Figure 2- Variables assessed, their description, the instrument used and the scores of each variable according to severity

# Caries Management by Risk Assessment (CAMBRA)

#### TABLE 2

ssessment Date: Please circle: E	BASELINE, three-	month follow-u	p or six-month fo	llow-up
	1	2	3	
NOTE: Any one Yes in Column 1 signifies likely "High Risk" and an indication for bacteria tests	Yes -CIRCLE	Yes -CIRCLE	Yes =CIRCLE	Comments:
1. Risk Factors (Biological Predisposing Factors)				
(a) Mother or primary caregiver has had active dental decay in the past 12 months*	Yes			
(b) Bottle with fluid <u>other</u> than water, plain milk and/or plain formula	÷	Yes		Type of fluid
(c) Continual bottle use	5	Yes		17
(d) Child sleeps with a bottle, or nurses on demand		Yes		
(e) Frequent (>3 times/day) between-meal snacks of sugars/cooked starch/sugared beverages		Yes		#times/day:
(F) Saliva-reducing factors are present, including: 1. medications (e.g., some for asthma [abuterol] or hyperactivity) 2. medical (cancer treatment) or genetic factors		Yes		
(g) Child has developmental problems/CSHCN (child with special health care needs)		Yes		
(h) Caregiver has low health literacy, is a WIC participant and/or child participates in Free Lunch Program and/or Early HeadStart		Yes		
2. Protective Factors	3 - X		26	- 14 - 14 - 14 - 14 - 14 - 14 - 14 - 14
(a) Child lives in a fluoridated community or takes fluoride supplements by slowly dissolving or as chewable tablets (note resident ZIP code)			Yes	
(b) Child drinks fluoridated water (e.g., use of tap water)			Yes	
(c) Teeth brushed with fluoridated toothpaste (pea size) at least once daily	1		Yes	1
(d) Teeth brushed with fluoride toothpaste (pea size) at least 2x daily			Yes	
(e) Fluoride varnish in last six months	3 9		Yes	1
(f) Mother/caregiver chews/dissolves xylitol chewing gum/lozenges 2-4x daily			Yes	
3. Disease Indicators/Risk Factors – Clinical Examination of Child				
(a) Obvious white spots, decalcifications enamel defects or obvious decay present on the child's teeth*	Yes			1
(b) Restorations present (past caries experience for the child)*	Yes			
(c) Plaque is obvious on the teeth and/or gums bleed easily		Yes		
(d) Visually inadequate saliva flow	3	Yes		1
hild's Overall Caries Risk* (circle): High	Moderate		Low	
hild: Bacteria/Saliva Test Results: MS: LB:	Flow Rate:		Mi/min:	Date:
aregiver: Bacteria/Saliva Test Results: MS: LB:	Flow Rate:		ml/min:	Date:
ielf-management goals:	1			
· · · · · · · · · · · · · · · · · · ·			VISUALIZE	

\*Assessment based on provider's judgment of balance between risk factors/disease indicators and protective factors.

## **CariFree**

# CRA FORM First name:

Last name:

Date:

 $\mathbf{n}$ 

Children Age 0-5

Due to new research on cavities and what causes them, we know everyone is at risk of developing decay at some point during their lifetime. The goal of this assessment form and the bacterial screening test is to determine your likelihood of experiencing new decay in the next 12 months. Please fill out the "Patient Use" section of this form to the best of your ability. These items will be discussed with your dental professional during your appointment today. Questions about this form? See the back for Q&A.

Would you like a free assessment determine his/her risk for cavitie:	for your child to help ?	yes		no
If diagnosed at risk for cavities toda in discussing treatment options for	y, would you be interested your child?	yes	maybe	no
If needed, are you willing to modify habits?	your child's dietary	yes	maybe	no
ISK FACTORS				
I notice plaque build-up on my chil	d's teeth.	no		yes
My child takes medication daily. (#_		no		yes
My child sees the same dentist regu	ilarly.	no		yes
My child has special needs that pro home.	hibit adequate care at	no		yes
My child continuously sips on some during the day, sleeps with a bottle	thing other than water , or nurses on demand.	no		-
My child snacks 1-3 times daily betw	veen meals.	no		yes
Do any of these other health conce (check all that apply) Diabetes Asthma Other	ms apply to your child? ergies her	no		her
Inadequate saliva flow		no	1	yes
Appliances present		no		yes
ISEASE INDICATORS				
Mother/Caregiver Active Caries		no		yes
New/Progressing Visible Cavitation		no		yes
New/Progressing Approximal Radio	graphic Radiolucencies	no		yes
New/Active White Spot Lesions		no		yes
Decay History is a Concern		no		yes
ROFESSIONAL ASSESS	MENT SUMMARY			
Risk Factors are a Concern		no		yes
Disease Indicators are a Concern		no		yes
ISK IDENTIFICATION	ansfer information above to b	oxes below to d	etermine risk.	
Fisk Factors	N Y	h	Risk Factors	85
LOW/MODERATE RISK	MODERATER	ISK	HIGH/EXT	TREME RISK

□ RECOMMENDED □ PROVISIONAL □ DECLINE

# BIOFILM CHALLENGE (OPTIONAL) CariScreen Bacterial Assessment is a concern (0-1500 low, 1501-9999 high) low high

ConFine

# Caries Management System (Evans & Dennison, 2009)

# Table 1. Ten-step summary of the Caries Management System

1	Diet assessment
2	Plaque asssment
3	Bitewing radiographic survey
4	Diagnosis and caries risk assessment
5	Preparation of oral care plan
6	Case presentation at which patient is informed about: • Dental caries
	o Arrest
	o Reversal/Natural repair (Remineralization)
	• Prevention
	<ul> <li>Number and status of current lesions</li> </ul>
	o Role of dental practitioner in caries management
	<ul> <li>Role of home care in caries prevention</li> </ul>
	o Current caries risk status
	<ul> <li>Result of diet assessment and recommendatons</li> </ul>
7	Oral hygiene coaching
8	Clinical management
	<ul> <li>Topical fluoride application (both professional and home care)</li> </ul>
	<ul> <li>Sealant or GIC application</li> </ul>
9	Monitoring of plaque control and treatment outcomes at each visit
10	Recall programme tailored to caries risk status

Table 3. Criteria	for caries i	risk for a child	who has a	primary	dentition onl	ÿ
-------------------	--------------	------------------	-----------	---------	---------------	---

Caries risk	New patient	Recall patient
Low	<ul> <li>dmfs = 0</li> <li>ICDAS II codes &lt; 2</li> <li>No radiolucencies</li> <li>No sites with Plaque Index = 3</li> </ul>	<ul> <li>&lt; 1 new lesion per year* and no progression of existing lesions</li> </ul>
At-risk	<ul> <li>dmfs &gt; 0</li> <li>Demineralized enamel – ICDAS II codes &gt; 1</li> <li>C1 or greater radiolucencies</li> </ul>	<ul> <li>1 new lesion per year* and/or progression of existing lesions</li> <li>Any site with Plaque Index = 3 in cases where dmfs = 0</li> </ul>
At-risk – High	<ul> <li>Any site with Plaque Index = 3 in cases where dmfs = 0</li> <li>Not assigned to new patient</li> </ul>	<ul> <li>&gt; 1 new lesion per year*</li> </ul>

\*... on approximal surfaces as diagnosed by bitewing scores C1 or greater or else on other surfaces diagnosed as ICDAS II code 2 or greater.

# <u>Cariogram</u>

# Caries related factors according to the program

Factor	Comment	Info/data needed
Caries experience	Past caries experience,	DMFT, DMFS, new caries
	including cavities, fillings	experience in the past one
	and missing teeth due to	year.
	caries. Several new	
	cavities definitely	
	appearing during	
	preceding year should	
	score '3' even if number	
	of fillings is low.	
Related general diseases	General disease or	Medical history,
	conditions associated with	medications.
	dental caries.	
Diet, contents	Estimation of the	Diet history, (lactobacillus
	cariogenicity of the food,	test count).
	in particular fermentable	
	carbohydrate content.	
Diet, frequency	Estimation of number of	Questionnaire results (24-
	meals and snacks per day,	h recall or 3 days dietary
	mean for a normal day.	recall).
Plaque amount	Estimation of hygiene, for	Plaque index.
	example according to	
	Silness-Löe Plaque Index	
	(PI). Crowded teeth	
	leading to difficulties in	
	removing plaque	
-	interproximally should be	
	taken into account.	
Mutans streptococci	Estimation of levels of	Strip mutans test or other
	mutans streptococci	similar test.
	(Streptococcus mutans,	
	Streptococcus sobrinus) in	
	saliva, for example using	
	Strip mutans test.	
Cont. next page.		

# Continued Cariogram...

Eluoride programme	Estimation of as to what	Eluoride exposure
r huoride programme	extent flyeride is evailable	interview the notiont
	extent illuoride is available	interview the patient.
	in the oral cavity over the	
	coming period of time.	
Saliva secretion	Estimation of amount of	Stimulated saliva test -
	saliva, for example using	secretion rate.
	paraffin-stimulated	
	secretion and expressing	
	results as ml saliva per	
	minute.	
Saliva buffer capacity	Estimation of capacity of	Dentobuff test or other
	saliva to buffer acids, for	similar test.
	example using the	
	Dentobuff test.	
Clinical judgement	Opinion of dental	Opinion of dental
	examiner, 'clinical	examiner, 'clinical
	feeling'. Examiners own	feeling'. A pre-set score of
	clinical and personal score	1 comes automatically.
	for the individual patient.	

#### Dundee Caries Risk Assessment Model

#### Data collection

Dental examination. This used a combination of direct vision and illumination by a pen-light, with the child in the supine position at age 1 year (and upright position for the remaining years). Examination was carried out within 1 month of the child's birthday wherever possible. Caries detection was at the  $d_1$  caries into both enamel and dentine threshold. All lesions were recorded according to the criteria developed for the Dundee selective threshold methods for caries detection/detection (25). All children were examined by a calibrated, single examiner (HBM).

Microbiological saliva sampling. The tongue-loop method of saliva sampling (26) was carried out by the child's health visitor (HV), and mutans streptococci, lactobacilli and yeasts were cultured and analysed as described previously (23, 24). Health Visitor Questionnaire (HVQ). This annual questionnaire was completed by the child's HV, as an addition to their routine child health monitoring programme, at the same time as saliva sampling or at a later date. HVs are qualified nurses working within the community with a wide remit that includes child health monitoring. All 57 HVs employed in Dundee at that time participated in the study. The HVQ provided data such as height, weight and head circumference; immunization status; ethnic origin, illnesses, medication, weaning, use of comforter, vitamin supplementation, feeding problems, family history, parental employment, parental health, parental smoking and housing status. One of the initial questions asked the HVs to give their opinion as to whether the child was at caries risk (Yes/No). This was a subjective assessment (hunch) and involved no specific training or calibration. The Deprivation Category (DEPCAT) score (27), a measure of deprivation, was also obtained from information provided by the questionnaire.

Parental Questionnaire. This annual questionnaire was given to the parent/guardian of the study child by the HV at the time of saliva sampling. This provided data on breast/bottle feeding, meals, drinks, snacks, toothbrushing, fluoride supplementation as well as other sociodemographic variables.

## EBHnow -Online Search Engine (McGill)

#### http://ebhnow.com/apps/0120/index.php

#### Age

- less than 6 months

- 6-12 months

- 1-3 years
- 3-6 years

#### Fluoride concentration in drinking water

- Less than 0.3 ppm

- 0.3 0.6 ppm
- Over 0.6 ppm
- Don't know

#### Presence of caries

- No incipient or cavitated primary or secondary carious lesions during the last 3 years
- One of two incipient or cavitated primary or secondary carious lesions in last 3 years
- Three or more incipient or cavitated primary or secondary carious lesions in last 3 years

#### **Caries Risk Factors**

- High titers of carogenic bacteria
  - Poor oral hygiene
- Prolonged nursing (bottle or breast)
  - Poor family dental health
- Developmental or acquired enamel defects
  - Teeth genetically abnormal
  - Many multisurface restorations
  - Chemotherapy or radiotherapy
    - Eating disorders
    - Drug or alcohol abuse
    - Irregular dental care
      - Cariogenic diet
  - Active orthodontic treatment
    - Exposed root surfaces







# Maine Oral Health Risk Assessment and Referral Tool

Ma	ine Oral Health R	isk Assessme For Ch	int and Referral	Tool—Primary Car	Version	15
PRACTICE NAME		TOT CI		PHONE	FAX	
Patient Name				Medical Record	Today's Date	9
Date of Birth	Age	M F	Provider Name			
Parent/Guardian Name				Dental Insurance		None/Self-Pay
Relationship to Child of	Mother 🗆 Father :	o Other		□ MaineCare ID#_		100 part 124 904212
Best Phone Number to	Call			O Other Insurance		
	Sect	ion A: Oral H	lealth Risk Asses	isment Questions		
DENTAL HOME ASSESSI May Be Administered by	MENT & CARIES RIS Clinical Support Staff	SK SCREENING	QUESTIONS		22	
Q1. Does the child ha	ve teeth?	NO	P & Reassess at n tinue to Q2 of Ris	ext well child visit k Questions (below)	Answers in indicate Pre	shaded boxes below esence of Risk Factor*
Q2. Has the child seen	n a dentist in the p	past year?			C YES	I NO
Q3. Does the child have	ve his/her teeth b	rushed daily	with toothpaste	?	C YES	C NO
Q4. Has the child ever	had cavities or fi	llings?			C YES	C NO
Q5. Has the mother/p	rimary caregiver	had active/u	ntreated cavities	in the past year?	T YES	I NO
K		Section B	Oral Evaluation	n and Plan	1	1001
ORAL EVALUATION Must Be Performed by Pri	imary Care Provider					1.62.5
Q6. Is there visible pla	que on the teeth	?			TYES	D NO
Q7. Are there signs of	visible decay or v	white spot les	sions on the teet	h?	C YES	D NO
Q8. Does the child ha	ve other oral cond	ditions of con	cern (abscess, bro	ken tooth, pain, etc.)?	C YES	D NO
ORAL HEALTH PLAN Must Be Performed or De *Consider fluoride varnisi	legated by Primary C h for one or more Ris	are Provider & Factors from	Sections A and/or I	B	Caries Risk As	sessment lisk Factors) /High (1+ Risk Factors)
For all children: Pres Provided Oral Health For children who have Completed Carles Ri Applied Fluoride Var Referred Child to De	scribed Fluoride Su h Anticipatory Guid not seen a dentist i sk Assessment w/C mish if moderate/hig ntist (see Section C)	oplement (circ ance Co in past year (C tral Evaluation th risk (D1206) Soction	ie dose) 0.25mg ( mpleted Caries Ri 22): Patient/Famil C. Referral Info	0.5mg 1.0mg □ Flu sk Assessment w/Ora y declined Fluoride V. rm=tion	ioride Suppler I Evaluation ( arnish	nents not indicated ⊐ Other:
	This section	n to be comple	ted by referring phy	vsician and faxed to der	ntist	
Dentist Name				Phone	Fá	<b>x</b> 2
Routine Referral     Immediate Referral			This child has sp Yes Explain:	ecial health care need	is. 🗆 N/A	
There are factors that of Oral sensitivities Difficulty sitting still	Difficulty follo	ning an oral h wing direction rate knee-to-k	ealth exam or X-ra ns Other, mee exam	rys for this child. /Comments	□ N/A	
Physician Name			Physician Signati	ure		Date
	This section to	o be completed	by dentist and fax	ed back to referring oh	ysician	
Date of Dental Appt.	Summary of Der	vtal Findings/F	Plan			
Dentist Signature					Date	
Maine Draft 2/27/2013 v1	2 Adopted from the No	eth Corolina POR	RT Form 8/4/09 Ver	sion 7 and the Washington	State Oral Healt	h Rick Assessment Tool

# My Smile Buddy

#### Table 1

#### MYSMILEBUDDY PARENT EARLY CHILDHOOD CARIES RISK ASSESSMENT RESPONSES (N=35)

Child cavity in the last 12 months (a=35)		
	N	
Yet	6	17.1
No	23	65.7
Don't Know	6	17.1
Child routine deutsi checkup in the last 12 menths	(s=35)	195
27	N	5
Yes	15	42.9
No	20	57.1
Paste type (n=26)		
	N	
Adult Fluoride	4	15.4
Child Fhioride	13	50.0
Non Finorade	9	34.6
Child tooth brushing (n=28)		
	N	
None	14	50.0
Osce	3	10.7
Twice or More	11	39.3
How offen to bed with a bottle or sippy cup with ca	loric beverage? (n#35)	
	N	
Always	5	14.3
Often	2	5.7
Sometimes	4	11.4
Never	24	68.6
Number of risky distary exposures (n=35)		
	N	
None	21	60.0
1 10 2	13	37.1
3 to 4	1	2.9
Who braches (2=33)		
(d)	N	5
Both	11	33.3
Child	1	3.0

J Health Care Poor Underserved. Author manuscript; available in PMC 2015 August 04.

# (My Smile Buddy) Continued....

Parent	21	63.6
Parental toothache in last 12 months	(n=34)	
	N	%
Yes	8	23.5
No	26	76.5
I am confident that I can reduce the	chances of my child getting tooth decay (n=3	5)
	N	%
Agree	23	65.7
Disagree	4	11.4
Not Sure	8	22.9
Not Sure It is often difficult to cut back on the	8 e number of sweets my child eats because the N	22.9 y get upset (n=34) %
Not Sure It is often difficult to cut back on the Agree	8 e number of sweets my child eats because the N 12	22.9 y get upset (n=34) % 35.3
Not Sure It is often difficult to cut back on the Agree Disagree	8 e number of sweets my child eats because the N 12 15	22.9 y get upset (n=34) % 35.3 44.1
Not Sure It is often difficult to cut back on the Agree Disagree Not Sure	8 e number of sweets my child eats because the N 12 15 7	22.9 y get upset (n=34) % 35.3 44.1 20.6
Not Sure It is often difficult to cut back on the Agree Disagree Not Sure In general, how much of a problem l	8 e number of sweets my child eats because the N 12 15 7 have you or your other children had with toot	22.9 y get upset (n=34) % 35.3 44.1 20.6 h decay? (n=33)
Not Sure It is often difficult to cut back on the Agree Disagree Not Sure In general, how much of a problem l	8 e number of sweets my child eats because the N 12 15 7 have you or your other children had with toot N	22.9 y get upset (n=34) % 35.3 44.1 20.6 h decay? (n=33) %
Not Sure It is often difficult to cut back on the Agree Disagree Not Sure In general, how much of a problem I	8 e number of sweets my child eats because the N 12 15 7 have you or your other children had with toot N 3	22.9 y get upset (n=34) % 35.3 44.1 20.6 h decay? (n=33) % 9.1
Not Sure It is often difficult to cut back on the Agree Disagree Not Sure In general, how much of a problem I A Lot Some	8 e number of sweets my child eats because the N 12 15 7 have you or your other children had with toot N 3 10	22.9 y get upset (n=34) % 35.3 44.1 20.6 h decay? (n=33) % 9.1 30.3
Not Sure It is often difficult to cut back on the Agree Disagree Not Sure In general, how much of a problem I A Lot Some Few	8 e number of sweets my child eats because the N 12 15 7 have you or your other children had with toot N 3 10 11	22.9 y get upset (n=34) % 35.3 44.1 20.6 h decay? (n=33) % 9.1 30.3 33.3

# National Singapore CRA (NUS-CRA)

J Dent Res 89(6) 2010

Caries Risk Assessment Models for Children

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Table 1. Various Models Constructed

	Models Constructed**				
	Prediction Model		£34		
	Screening	Fullblown	Screening	Fullblown	Community acreenin Model
Outcome variable					
1-year increment Ladmh	4	4	4	4	
Baseline dell > 2 or 5 2					
Independent variables*					
Fectures Categories	All features Demographic Socia-economic Behaviaral Clinical	All features Demographic Socio-economic Behavioral Clinical	Selected Features Demographic Socia-economic Behavioral Clinical	Selected Features Demographic Socia-economic Behavioral Clinical	All factures Demographic Socia-economia Behavioral
Source of information	Questionnaire Clinical examination	Biological Questionnaire Clinical examination Biological tests	Questionnaire Clinical examination	Biological Questionnaire Clinical examination Biological tests	Questionnaire

The independent variables are described in the Appendix. Two types of models, prediction models and risk models, were explored, involving all features and selected features (age, prediction models and risk models), both hallows not screening models were built, with and without information from biological textures card selected features (age, prediction models and risk models), both hallows nod screening models were built, with and without information from biological textures cardioverse four models were all "app-risk" models, with "any cartes increment in 1 year (adent > 0 or = 0)" as the discharmous outcome variable. In addition, for screening the high risk childres in the community setting without a cloic visit, a communityscreening model was explored, with all features excluding the chinical and biological categories. This model is a "high-risk" model for identifying about 25% of children with high cories burden (Beck at al., 1992) (Scaeline dest > 2 in this population) through a questionnaire.

#### Table 2. Caries Risk AssessmentMadels and Their Performance

		Odds R	atio (95% Confidence Int	rerval)*		
	Predictio	n Models	Risk	Models		÷.
Factors/Indicators (X)	Screening	Full-Bown	Screening	Full-blown	Community-screening Model	Cariogram**
Age (mos)	1.045 (1.017-1.073)	1.060 (1.009-1.113)	1.058 (1.029-1.087)	1.060 (1.009-1.114)	1.042 (1.015-1.072)	Related diseases
Malay race	1.837 (1.174-2.876)				2.053 (1.269-3.308)	Diet frequency
Father's education level	0.645 (0.5420.767)	0.606 (0.4360.841)				Diet content
Months of breastfeeding	1.037 (1.012-1.063)	1.067 [1.0161.120]	1.033 [1.010-1.057]	1.027 (1.008-1.087)		Plaque amount
Bedtime feeding			1.484 (1.106-1.928)			Fluoride appli cations
Frequency of between-med sweets	1.368 (1.102-1.698)		1.338 (1.007-1.685)			Lactobacilli level
Bedtime sweets			1.332 (1.006-1.682)			Mutans streptococa level
Never lived in non-fluoridated community			0.676 (0.5760.796)			Saliva flow rate Saliva buffering capacity
Using fluorides (other than fluoride in tooth paste)		0.420 (0.2020.876)			2.633 (1.188-5.796)	
No annual check because teeth did not bother the child		0.475 (0.256-0.781)				
Age regarded by parents as appropriate for dental check		1.300 (1.071-1.639)				
Parent's belief of 'toath worm' as reason for caries ***					0.103 (0.012-0.837)	
Parents do not know bedtime milk bottle is bad for teeth					1.999 (1.228-3.326)	
Child's number of decayed teeth estimated by parent					12.835 (8.908-18.673)	
No health problems	2.869 (1.7374.736)	2.669 (1.1985.945)				
Past (baseline) caries	7.316 (5.135-10.423)	3.948 (1.9338.060)				
Plaque Index	5.050 (3.2637.814)	8.902 (3.822.20.726)	9.061 (6.548-12.461)	7.367 (4.102-12.987)		
Level of mutans streptococci		2.700 (2.025-3.599)		2.555 (2.016-3.335)		
Level of Lactobacilli		2.272 (1.5873.471)		2.123 (1.481-3.304)		
Average pH		0.010 (0.0040.024)		0.016 (0.008-0.031)		
		Constant of the state of the st		and the second		

# Pediatric Risk Assessment (Shenkin)

Pres Last k Assessment T	ent Caries Risk: Low : Caries Risk: Low Me	Moderate High oderate High N/A					
Last k Assessment T	Caries Risk: Low M	oderate High N//					
k Assessment T		Last Caries Risk: Low Moderate High N/					
is reasoning the t	ool (PRAT)						
oints	Score <sup>1</sup> 1 point	2 points					
	6-9	>9					
soft driaks in ning or nighttime	Evening/before bedtime soft drinks	Nighttime/at or during bedtime soft drinks					
shes 2X day	Brushes 1X day	Brushes <1X day					
ly	Occasionally	Never					
ĸ	1-3 lesions	>3 lesions					
32.02	<18 oz; 33~48 oz	>48 oz					
oz	9–16 oz	>16 oz					
02	9–16 oz	>16 az					
0z	17-32 oz	0-16 oz					
	3-4	>4					
	3-4	>4					
	soft drinks in ning or nighttime shes 2× day ly re 32 oz oz oz	Score*       points     1 point       6-9       soft drinks in ning or nighttime     Evening/before bedtime soft drinks       shes 2X day     Brushes 1X day       ly     Occasionally       re     1-3 lesions       32 os     <18 oz; 33=48 oz;					

Fig. 3. Sample Pediatric Risk Assessment Tool.

# Sugar Snack Caries Test

	TEST RESULTS *			
CARIES ACTIVITY/RISK MEASUREMENTS	0 Weeks	5 <sup>th</sup>	10 <sup>th</sup>	14 <sup>th</sup>
	Baseline	Week	Week	Week
Sugar Snack Test (SST)	5	5	4	3
Saliva Secretion Rate (SSR)	3	1	1	1
Plaque Score	5	2	3	1
mutans Streptococcus (SM)	5	5	3	1
Buffering Capacity (BC)	4	4	4	3
Lactobacilli (Lb)	5	5	5	5
Diet	5	5	5	5
Decayed Teeth (DT)	0	0	0	0
Decayed, Missing, Filled Surfaces (DMFS)	53	53	53	53
<ul> <li>* shading &amp; enlarged number font represent a change in the test result from the previous test</li> </ul>	OHI OHI OHI 1% NaF 0.2% NaF 0.2% CHX			
		Treatments E	Between Tests	
TABLE 4. SUMMARY OF CASE REPORT TEST RESULTS				

# <u>Texas Department of State Health Services</u> <u>Texas Health Steps First Dental Home Caries Risk Assessment Tool</u>

## Age 6-35 months

# Texas Health Steps Caries Risk Assessment Tool

FACTOR	LOW	MODERATE	HIGH
Caries Activity	None	Within 24 months	Within 12 months
Demineralized Areas	No white spots	1 white spot	> 1 white spot
Family History - Mother	No decay	Low caries rate	High caries rate
Family History - Father	No decay	Low caries rate	High caries rate
Family History - Siblings	No caries activity	Low caries rate	High caries rate
Presence of plaque, gingivitis	None	Moderate	Visible plaque on anterior teeth
Fluoride Exposure	Optimal	Low to optimal	Low
Sugar Consumption (Including bottle or sippy cup use)	With meals only	1-2 between meals	> 3 between meals
Dental Home	Established	Irregular use	None
Special Conditions			Enamel hypoplasia Special needs patient Impaired salivary flow

# <u>Texas Department of State Health Services</u> <u>Texas Health Steps First Dental Home Caries Risk Assessment Tool</u> Age 3-5 years

Patient I	Name	33
Age	Date of Visit	
Dentist	Dentist Signature	

## Caries Risk Assessment Tool - Ages 3 through 5 years

FACTOR	LOW	MODERATE	HIGH
Caries Activity	None	Within 24 months	Within 12 months
Demineralized areas	No white spots	Inactive white spot	Active white spots
Parent/Primary Caregiver	No decay	Low caries rate	High caries rate
Family History – Siblings	No caries activity	Low caries rate	High caries rate
Presence of plaque, gingivitis	None	Moderate	Visible plaque on anterio teeth
Fluoride exposure	Optimal	Low to optimal	Low
Sugar consumption (including sippy cup use)	With meals only	1-2 between meals	> 3 between meals
Dental home	Established	Irregular use	None
Special conditions		Special needs patient	Enamel hypoplasia Impaired salivary flow



## University College Cork – Ireland Caries Risk Assessment Checklist

### **Caries Risk Assessment Checklist**

Dentist's name: \_\_\_\_\_ Date: \_\_\_\_\_

Child's name: \_\_\_\_\_\_ School: \_\_\_\_\_ First assessment Y / N

1

Risk Factors/Indicators A "YES" in the shaded section indicates that the child is likely to be at high risk of or from caries		Please circle the most appropriate answer	
Age 4-6 with dmft>2 or DMFT>0	Y	es	No
<ul> <li>Age 7 and over with active smooth surface caries (cavitate non-cavitated) on one or more permanent teeth</li> </ul>	d or Y	'es	No
New caries lesions in last 12 months	Y	es	No
Hypomineralised permanent molars	Y	es	No
<ul> <li>Medical or other conditions where dental caries could put t patient's general health at increased risk</li> </ul>	he Y	es	No
<ul> <li>Medical or other conditions that could increase the patient developing dental caries</li> </ul>	's risk of Y	'es	No
<ul> <li>Medical or other conditions that may reduce the patient's a maintain their oral health, or that may complicate dental t</li> </ul>	ability to Y	es	No
Age 7-10 with dmft>3 or DMFT>0	Y	es	No
Age 7–10 with dmft>3 or DMFT>0	Y	es	No
Age 11-13 with DMFT>2		es	NO
Age 14-15 with DMFT>4		es	No
Deep pits and fissures in permanent teeth     Eulimedical cond		es	NO
Full medical card		les	No
- succession with a between means more than three a			110
Protective Factors			
A "NO" in this section indicates the absence of protective factors which may increase the child's risk of developing	e caries		
Fissure sealants		/es	No
Brushes twice a day or more		les	No
<ul> <li>Uses toothpaste containing 1000 ppm F or more</li> </ul>		ſes	No
Fluoridated water supply		'es	No/Don know
Is this child at high risk of or from caries?	YES		NO

ge 0-3: Any child under the age of 4 who shows any evidence of caries - with or without cavitation should be considered high risk, as the consequences of any caries for this age group can mean recourse to general anaesthesia for treatment.

### WesternU- CDM

#### WesternU CDM – AxiUm Electronically Modified-Caries Risk Assessment Form 0-5 Years of Age

#### Contributing conditions

1. Are you exposed to fluoride (through drinking water, toothpaste, professional applications, supplements, etc.)?

- a. Yes (low) b. No (moderate)
- 2. Frequency of sugary or starchy foods or drinks (including juice, carbonated or noncarbonated soft drinks, energy drinks, medicinal syrups, etc.)
  - a. Primarily at mealtimes (low)
  - b. Frequently between meals (moderate)
  - c. Bottle or sippy cup with anything but water (high)
- 3. <sup>1</sup>Caries experience of mother, caregiver and/or other siblings
  - a. No carious lesions in last 24 months (low)
  - b. Carious lesions last seven to 23 months (moderate)
  - c. Carious lesions in the last six months (high)
- 4. Dental home: Established patient of record, receiving regular dental care in dental office.

a. Yes (low) b. No (moderate)

#### General health conditions

Special health care needs (including developmental, physical, medical or mental disabilities that prevent or limit adequate oral care)?

 a. No (low)
 b. Yes (high)

#### **Clinical conditions**

- 1. \*Visual or radiographically evident cavitated lesions
  - a. No active cavitated lesions in one year (low)
  - b. No active cavitated lesions or restorations in last six months (moderate)
  - c. Presence of lesions/restorations in last six months (high)
- 2. \*Non-cavitated ACTIVE carious lesions (e.g. active brown/white spot lesions)
  - a. No incipient active lesions in one year (low)
  - b. No incipient active lesions in last six months (moderate)
  - c. Presence of incipient noncavitated active lesions in last six months (high)
- Teeth missing due to caries
   a. No (low)

b. Yes (high)

Visible plaque

 a. Yes (moderate)

b. No (low)

- 5. Dental/orthodontic appliances (fixed or removable) a. No (low) b. Yes (moderate)
- 6. Salivary flow
  - a. Visually adequate (low) b. Visually inadequate (high)

TOTAL (auto-calculates electronically): High, moderate or low caries risk assessment.

<sup>1</sup>If the child showed improvement after six months with no change in the parent's caries experience, the child was noted as "moderate" risk. <sup>‡</sup>DentaQuest ECC Phase III definition of law, moderate and high caries risk assessment associated with cavitated or noncavitated lesions.

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