



# **Maternal and Child Oral Health - Systematic Review and Analysis**

**A report for the New Zealand Ministry of Health**

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## **Introduction.**

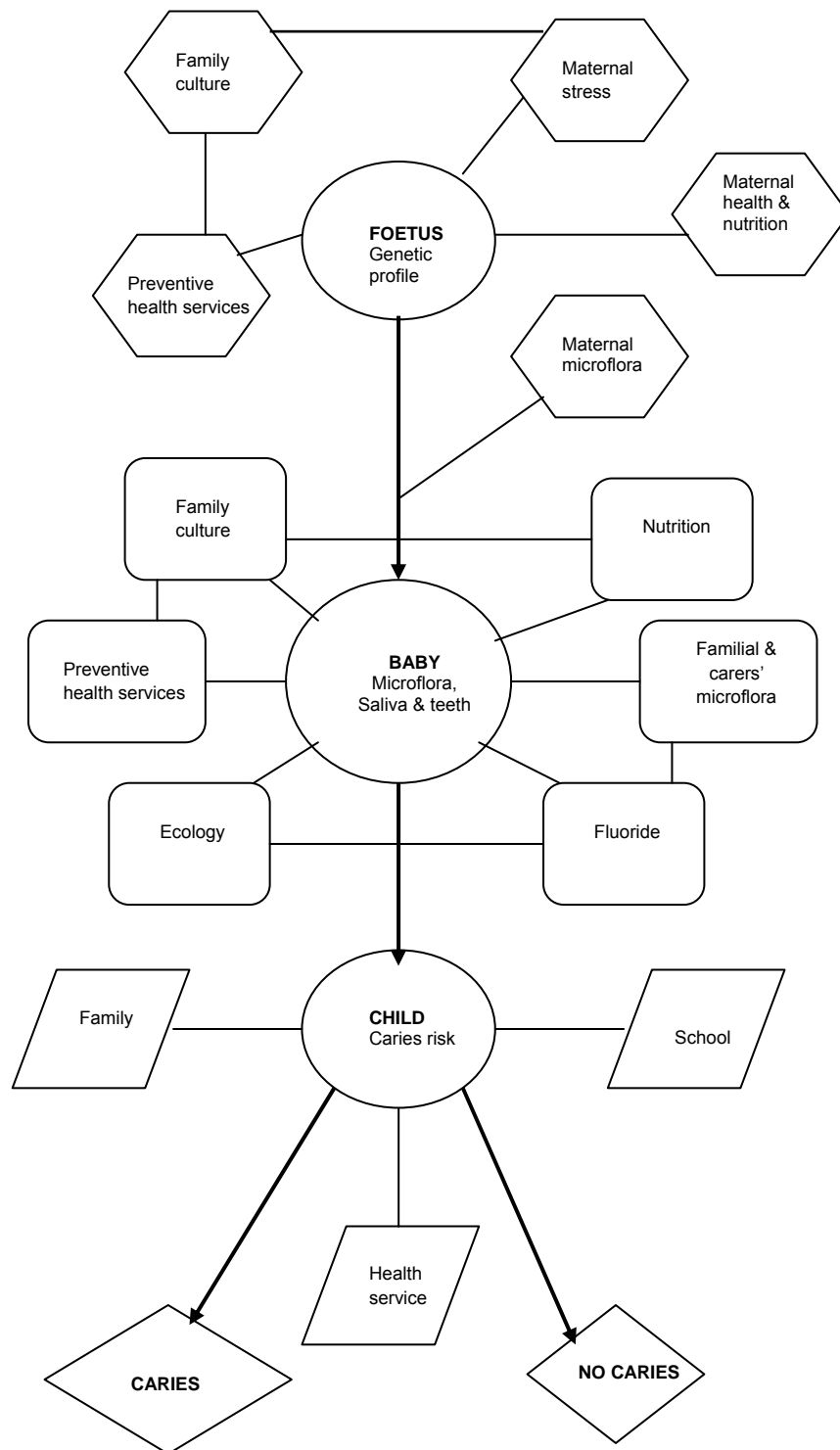
Despite being largely preventable Early Childhood Caries (ECC) remains one of the most common and costly diseases of childhood.<sup>1</sup> ECC may be painful and debilitating with a potential long-term impact on health and social outcomes.<sup>2,3</sup> The short-term sequelae of untreated ECC are pain, with up to 12% of 5 years olds experiencing toothache, infection and abscesses.<sup>4</sup> ECC is difficult to manage in the dental surgery, and antibiotics, general anaesthesia (GA) and hospital admission may be required.<sup>5</sup>

Dental caries is an infectious chronic disease of the teeth that is moderated by diet and affects humans of all ages.<sup>6</sup> Early Childhood Caries appears to be a particularly virulent form of dental caries.<sup>7</sup> It is a term used to refer to a number of patterns of dental caries that occur in young children. Dental decay in very young children has a distinct pattern attacking first the maxillary anterior teeth, then the fissures of molars and finally the proximal surfaces of molars.<sup>6</sup> Since the 1960s various terms have been used in the dental literature to identify this pattern of dental caries including baby bottle tooth decay, nursing bottle mouth, nursing caries and nursing bottle syndrome.<sup>8</sup> These terms imply that the inappropriate use of the baby bottle plays a central role in the development of dental decay in infants and young children. However supporting epidemiological data is difficult to find.<sup>9</sup> The focus on the baby bottle also influences strategies promoted to prevent the disease and limits attention on other potentially more important factors. For this reason the term Early Childhood Caries is the now used to refer collectively to any dental decay in infants and preschool children and will be used as such throughout this report.

The problem of ECC is not unique to New Zealand. A review of international literature regarding ECC suggests that in most developed countries the prevalence ranges between 1-12%.<sup>8</sup> However in undeveloped countries and in disadvantaged groups within developed countries the prevalence could be as high as 70%. ECC is not equally distributed across the population with more socially disadvantaged groups, who are often excluded from regular use of healthcare systems, experiencing higher rates of the disease. Internationally there is a growing realization of the need to commence prevention at a very young age and that the best chance of reducing further inequalities in health relate to parents and in particular to mothers and children.<sup>10</sup>

As ECC has its aetiological roots in the first year of life, interventions that aim at primary prevention should be implemented in the very early stages of the child's life or perhaps before birth. This will optimize the chances that a child will remain caries free. As a result there is an increasing focus on the oral health of pre and post natal women, and the impact their oral health has on the prevention of ECC in their children. There is a clear public health imperative for well-funded interventions that aim to reduce ECC for those at highest risk. Interventions should focus on upstream determinants of family health of high-risk groups rather than individual downstream approaches which use traditional biomedical/behavioral strategies.<sup>11</sup> However, development of such targeted interventions requires a sound understanding of the risk and protective factors. These factors have been shown to be complex, spanning biological, environmental and socio-behavioural domains (Figure 1).<sup>12</sup>

**FIGURE 1:** Influences on ECC development



The aim of this report is to establish the contemporary evidence regarding the impact of the oral health of pre and post natal women (with special emphasis on disadvantaged or marginalised women) on the oral health (ECC) in their offspring.

The report will be presented in 4 sections.

1. Background literature
  - a. Aetiology of ECC
  - b. Existing local epidemiological data in relation to international data.
2. The contemporary evidence on the impact of maternal oral health on child oral health.

Specifically

- a. The influence of maternal oral health on gestational and peri natal events
  - b. The impact of maternal general health and perinatal events on the development of developmental defects of enamel.
  - c. The influence of maternal oral health on ECC experience in their offspring.
  - d. The influence of socio-cultural factors on a, b and c above.
3. The effectiveness of current and potential maternal health and oral health interventions in improving infant oral health outcomes (reducing ECC experience)
4. A summary of the details, outcomes and implications of the analysis including appropriate evidence based recommended options that the Ministry could explore further.

## **Background.**

### **Epidemiology.**

Dental caries has declined dramatically in the developed world over the last few decades. It is thought that this reduction is due primarily to the use of various fluoride modalities rather than changes to sugar consumption.<sup>2</sup> There are two issues associated with this decline; first there has been a significant change in prevalence and severity of dental caries in children, particularly in the permanent dentition where the decline is continuing. However there is mixed evidence with regard to continuing improvements in the primary dentition. Certainly in Australia there are contemporary reports suggesting that the caries decline has levelled out<sup>13</sup> or may be reversing.<sup>4</sup> The second aspect is that “the distribution of caries, while never completely normal has become increasingly skewed”.<sup>2</sup> This means that the disease is becoming concentrated in relatively fewer children.<sup>14</sup> These trends have significant implications for dental service delivery and health promotion efforts.

The problem of ECC is not unique to any one country. Similarly, knowledge regarding the prevalence of dental caries and its treatment in the pre-school aged group is limited. This is due to the difficulties faced in accessing this group and to the low attendance rates of pre-school aged children for routine monitoring at both private and public dental services. A review of international literature regarding ECC suggests that in most developed countries the prevalence ranges between 1-12%.<sup>8</sup> However in undeveloped countries and in disadvantaged groups within developed countries the prevalence could be as high as 70%.

International data which may be most comparable to the New Zealand experience is available from the United Kingdom, United States and Australia. The National Diet and Nutrition Survey in the United Kingdom included a dental survey of 1532 children aged 1.5 – 4.5 years.<sup>15</sup> Overall 17% of the children had experienced dental decay. Four percent of the youngest age group (1.5 – 2.5 year olds), 14% of the 2.5 – 3.5 year olds and 30% of the 3.5 – 4.5 year olds had some experience of dental caries. Most of this dental caries was untreated. Additionally this study established a significant association between dental caries in this cohort of preschool aged children and both socioeconomic status and geographical location. In the United States, dental caries is the most common chronic disease in childhood being five times more common than asthma and fourteen times more common than chronic bronchitis. As is the case in the UK a significant proportion of this dental caries remains untreated<sup>16</sup>.

The recent Australian Child Dental Health Survey<sup>17</sup> provides some data on the dental health of young children. According to these data the mean deciduous decayed, missing and filled teeth (dmft) for four-year-olds in Australia is 1.44. However the use of the mean score can mask the true pattern of disease distribution. A closer inspection reveals that for those that have decay (66% were caries free) the average dmft per child rises considerably to 4.23, with 80% untreated.

When comparing rural to metropolitan areas, data from Australia suggests that by school-entrance age, there are significant differences in oral health status. In Victoria for example 5-6 year old children

living in rural areas experience at least twice as much dental caries as those in metropolitan Melbourne.<sup>18</sup> Perhaps the strongest indication of inequalities in oral health related to children's geographical location is the data from the Ambulatory Care Sensitive Conditions Study.<sup>19</sup> Ambulatory Care Sensitive Conditions are those conditions for which hospitalization is thought to be avoidable with the application of preventive care and/or early disease management but have progressed to the point where hospitalisation is required. Dental decay is one such condition. The study showed that children under four years of age living in rural areas of Victoria are four times more likely to be admitted to hospital for a dental caries related problem than are children living in metropolitan centres. The reasons for these differences are not known but it is likely due to lack of access to fluoridated water and dental services and differences in socioeconomic status.

Indigenous children universally have significantly poorer oral health (up to four times more caries) than their non-indigenous counterparts and it has recently been suggested that indigenous status influences oral health outcomes irrespective of social disadvantage.<sup>20</sup>

### **New Zealand Data**

Recent New Zealand data shows a similar picture in terms of caries experience for five year old children.<sup>21</sup> These data are aggregated at a District Health Board (DHB) Region level and are subject to limitations related to the collection methods. However they do provide data by ethnicity and by water fluoridation status. According to these data in 2005 the average dmft for 5 year old children in New Zealand was 2.24, with just over half (51.9%) having no caries experience (the so-called caries free). When only those with caries are considered the average dmft for five year old children is much greater at 4.65.

Significant inequalities in burden of disease (measured both by severity and prevalence) are observed when comparing Maori and Pacific children with other children and between fluoridated and non-fluoridated areas. However the relationship between water fluoridation and lower caries experience is not universal. In most cases children in fluoridated areas have on average lower dmft than children in non-fluoridated areas within DHB Regions. However in some regions the dmft is similar or slightly less in non-fluoridated areas. This is due perhaps to other important mediating variables such as socio-economic status (SES) and ethnicity highlighting the complex interaction of risk and protective factor in dental caries. Although variations are observed within Maori and Pacific groups by fluoridation status and DHB region, Maori and Pacific children have fewer caries free and a greater mean dmft at age five years when compared to other New Zealand children. The 2005 SDS data showed the proportion of caries free children to be 30.7% and 30.5% for Maori and Pacific 5 year olds respectively compared to 60.8% for other children. Severity of disease also showed higher burden with dmft of 3.74 and 3.57 for Maori and Pacific children compared to 1.59 for others.<sup>21</sup>

## Aetiology.

It is well accepted that dental caries is a multi-factorial condition with influences beyond biological mechanisms. This is also consistent with contemporary models of health which have arisen in response to the recognised limitations of a strict biomedical approach. It is likely that biological, behavioural and environmental factors all contribute to the development and progression of dental caries. However the way in which these factors act directly, indirectly or interactively is not well understood. Understanding the role of each of these factors is important to allow the development of a complete aetiological model for dental caries.

A comprehensive review of the evidence surrounding the aetiology of ECC is beyond the scope of this report however several systematic reviews exist on this topic including one published by this research team.<sup>22, 23</sup>

Several findings have been well established through these reviews:

1. In order for the caries process to be initiated and progress to cavitation a combination of substrate, cariogenic bacteria and a susceptible host/tooth is required over time.
2. As well as the recognized dietary factors, early infection of the oral cavity by mutans streptococci (MS) predispose an infant to developing caries.<sup>24</sup> These are a group of phenotypically similar microorganisms which have been shown to be associated with the initial development of dental caries. The MS that are most frequently associated with human dental caries are *S. mutans* and *S. sobrinus* known collectively as *S. mutans*.
3. Pre-school aged children with high levels of *S. mutans* experience more caries and are at greater risk for developing new lesions than those children with low levels of *S. mutans*.<sup>25, 26, 27,</sup>
4. Furthermore, the timing of first *S. mutans* infection appears to be a strong determinant of future caries experience. Colonization with *S. mutans* at a young age is important for early caries initiation.<sup>28, 29, 30</sup> The earlier the colonization the greater the future caries risk<sup>31, 24</sup> and more significantly, those children in whom *S. mutans* do not colonise remain caries free.<sup>32</sup>
5. Sugars (such as sucrose, fructose and glucose) and other fermentable carbohydrates (such as highly refined flour) play an important role in the initiation and development of dental caries.<sup>33</sup>
6. There is a significant relationship between developmental defects of the tooth surface and dental caries.<sup>34, 35, 36, 37, 23</sup>

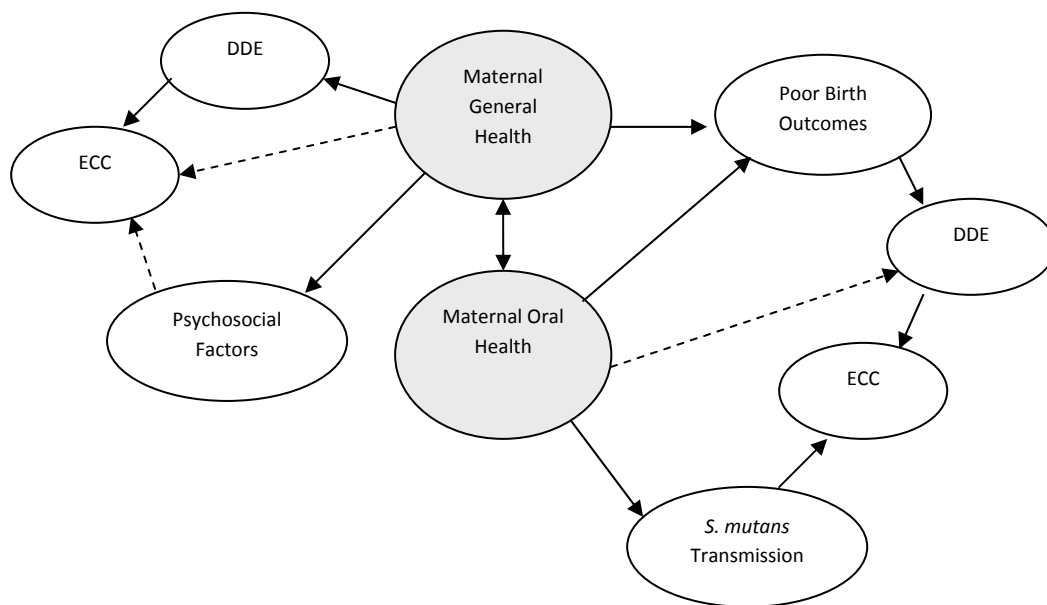
The role of genetic susceptibility to ECC remains unclear, but may be mediated through alterations in saliva flow and composition however there is little evidence to support this concept. What evidence is available to date has primarily focused on the biological factors influencing caries initiation and progression. In addition whilst the evidence is mixed, there are a number of other variables including; self-efficacy and locus of control, stress and infant dietary practices which are linked to poor infant oral health. The importance of these factors in influencing oral health outcomes for both mother and child should not be overlooked particularly when planning and evaluating interventions.

Behavioural and psychosocial factors also impact at a higher family level on health and well being in general. Given that mothers are most often the primary care givers and are therefore generally

responsible for care, decisions around healthcare and accessing services they are the mediators of the higher level influences. The prenatal time period therefore provides an opportunity for health education, support and parenting advice. However it is important to establish the strength of evidence for an association between maternal health and well being and the oral health outcomes of their infant.

Figure 2 summarises the putative relationships between maternal health/oral health and infant oral health. The relationship is influenced by two main factors that predispose the infant oral cavity to colonization with *S. mutans* namely; the oral health of the source of the *S. mutans* (i.e. the primary caregiver) and secondly the impact of poor birth outcomes (pre term birth and low birth weight) on the developing dentition (because immature or hypomineralised teeth are more susceptible to developing caries).

**FIGURE 2.** The putative relationships between maternal general/oral health and infant oral health.



The above figure is an attempt to present the potential relationships between mother and child health based on hypothesized relationships arising from the currently available evidence. Some of these relationships have a stronger empirical basis than others. A number of these hypothesized relationships have longer causal chains making them more difficult to test. Other relationships appear more direct but they themselves could have moderating or mediating influences.

## **Systematic Review of Evidence.**

This review will be sub-divided in to 4 questions. A fifth question considers the evidence for interventions which target mothers and their infants to reduce risk of ECC.

### **Question 1.**

What is the influence of maternal oral health on gestational and peri natal events?

*Hypothesis.* That poor maternal oral health predisposes to poor birth outcomes.

*Rationale;* that poor maternal oral health (predominantly periodontal disease) has been linked with prematurity/low birth weight.

### **Question 2.**

What is the impact of maternal health and pre and peri-natal events on the development of developmental defects of enamel?

*Hypothesis.* That poor maternal health and/or birth outcomes predispose to developmental defects of the primary teeth.

*Rationale:* that developmental defects of primary teeth are associated with increase caries risk.

### **Question 3.**

What is the influence of maternal general health on the ECC experience in their offspring?

*Hypothesis.* That poor maternal health is associated with increased caries experience in their infants

*Rationale:* that the health and well-being of mothers influences their capacity to optimize their child's oral health.

### **Question 4.**

What is the influence of maternal oral health on ECC experience in their offspring?

*Hypothesis.* That poor maternal oral health is associated with increased caries experience in their infants.

*Rationale:* that poor maternal oral health (predominantly caries) is associated with an increased risk of transmitting MS, the principal micro-organism associated with initiation of ECC.

### **Question 5.**

How effective are interventions involving mothers in reducing ECC in their infants?

*Hypothesis.* That reducing maternal caries experience will reduce the caries experience of their infants.

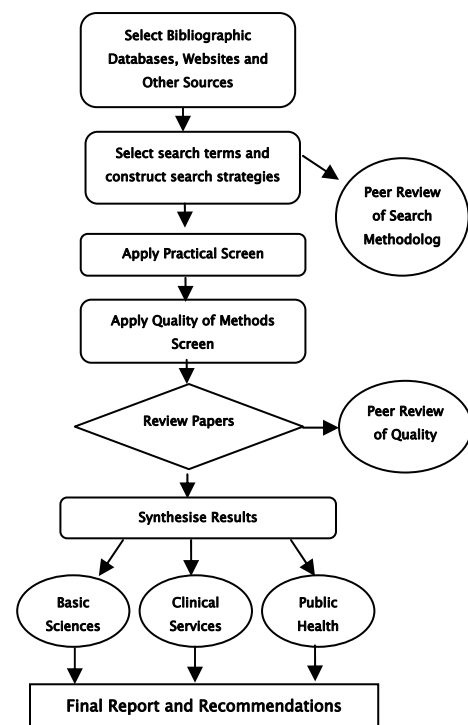
*Rationale:* targeting maternal oral health will, through a variety of pathways, improve infant oral health.

## Methods

The scope of the literature related to this area is wide. It spans the areas of biological and laboratory-based sciences, clinical treatment and service research and the area of public health and health promotion. Methods of enquiry and evaluation are also varied and include, systematic reviews, meta-analyses, randomised controlled trials, quasi-experimental trials, observational studies, qualitative study designs and action based research. This poses some challenge for a synthesis of evidence which aims to inform policy and public health programs. In particular there are problems regarding access to reports and evaluations of oral health promotion activity or other oral health interventions that aim to improve oral health outcomes for children. Much oral health promotion is implemented by community agencies or small organizations who do not seek to publish reports in peer reviewed journals. This review has therefore also included the so-called 'grey literature' † in the section addressing interventions (Question 5) as appropriate in the synthesis. Only programs that have reported evaluations were included. They may have included process, impact and/or outcome measures using qualitative and/or quantitative methods and must have oral health as either a primary focus or explicitly included and evaluated as a secondary focus.

## Data Search

Data bases and other sources of information included Medline, Embase, PyschInfo, Cinnahl, Infotrac, Cochrane Library, Ovid, Te Puna, and ProQuest. The grey literature was searched using the Google search engine with appropriate domain restrictions and through contact with other researchers and workers in the area. Personal and professional networks were also used to identify unpublished work that may fit inclusion criteria. Reference lists of retrieved papers were also scanned to identify further publications and sources. Search terms and strategies were developed with reference to those published in peer reviewed works and modified appropriately for each data base. A list of search strings used in Ovid Medline format can be found in Appendix 1. Each search string was modified appropriately for each database.



## Practical screen

It is acknowledged that the literature to be included in this review will vary in terms of the research design and evaluation techniques. A practical screening was developed to ensure that each literature type was assessed for inclusion in the review using appropriate inclusion and exclusion criteria. Retrieved studies were limited to those published after 1997 as per the funder's brief.

† Such studies generally do not undergo the scrutiny of a rigorous research and ethics approval process and as such caution needs to be exercised when considering the recruitment and follow up strategies with particular respect to bias.

### **Quality of methods screen**

The quality of included papers was assessed using the Critical Appraisal Skills Programme (CASP) tools.<sup>38</sup> These critical appraisal tools were developed by the Public Health Resource Unit of the UK National Health Service and allow the assessment of reviews, trials, studies, evaluations and diagnostic tests in an integrated manner thus allowing the same quality ratings across all study types. CASP templates were used to assess each of the studies in three areas; validity (internal validity), reporting quality and the degree to which outcomes and their applications (external validity) are articulated.

### **Presentation of the findings**

A summary of the evidence is presented under individual headings addressing each of the five key questions. Appendix 3 comprises tables describing the included studies and summarizing the strength of the evidence and findings. Where available systematic reviews were evaluated along the parameters described above and the literature searched for studies published after the most recent systematic review. Where systematic reviews are not available the literature was searched for all studies falling within the search criteria and then subjected to a rigorous evaluation of strength of evidence. A discussion in which the implications of the review are then presented followed by recommendations for future research direction and public health policy strategies.

### **Quality assurance**

To ensure quality and appropriateness of the literature search and review process itself a panel of experts was used. This panel provided feedback and advice at three time points during the review and report writing process. Details of the expert review panel can be found in Appendix 2.

## **Question 1: What is the influence of maternal oral health on gestational and peri natal events?**

The oral health of mothers may have effects beyond any direct effects on the oral health status of their children. Poor oral health in pregnant mothers could increase the risk of poor birth outcomes. Such outcomes can include preterm (premature) birth and low birth weight or both. Preterm birth and/or low birth weight have been associated with many longer term health and child development problems which are costly to the community. This alone makes examination of this relationship worthwhile. Additionally preterm birth and/or low birth weight may also be related to poorer oral health outcomes either directly or through increased incidence of developmental defects of enamel (see below Question 2). To date, most research exploring the impact of maternal oral health on gestational and peri-natal events has focused on the periodontal condition of expectant mothers. This research is part of a wider and increasing interest in dental and medical literature on the systemic effects of periodontal disease with a major focus on cardiovascular disease.

The aetiology of birth complications is undoubtedly multi-factorial and includes genetic, nutritional and environmental factors. The potential causal mechanism behind the relationship between poor birth outcomes and periodontal disease has been investigated by a number of authors.<sup>39,40,41</sup> There appears to be a number of clinically plausible pathways for a causal relationship. The first is the proximity of the periodontal tissues and its associated infection to the vascular system. With increased blood flow in gingivae associated with oestrogen during pregnancy there is an increased risk of bacteraemia from gram negative organisms followed by placental seeding.<sup>42</sup> This hypothesis is supported by a number of case reports where periodontal pathogens have been cultured from amniotic fluid of neonates.<sup>43, 44</sup> Another mechanism of the haematogenous introduction and spread of bacteria appears to be the ability for the bacteria to initiate an inflammatory marker that is common to both periodontal disease and parturition. An increased microbial load seen in periodontal disease allows greater exposure of the host's immune response to bacterial products, such as lipopolysaccharides, a potent stimulator of the inflammatory response. In addition, the infected and inflamed periodontal tissues are a reservoir for pro-inflammatory cytokines, such as prostaglandins that may enter the circulation and initiate the birthing process.<sup>40, 41</sup>

Offenbacher and colleagues were the first to link periodontal disease to adverse pregnancy outcomes when they reported an odds ratio of 7.9 for pregnant women with periodontal disease having preterm and LBW infants.<sup>45</sup> Since that time numerous case-control, cohort, clinical and cross sectional studies have been conducted. These studies have been included in a number of systematic reviews, critical reviews and a meta-analysis. As indicated in Table 1A, the majority of studies included in these reviews have found some association between periodontal disease and poor birth outcomes. These studies have been conducted around the world on different ethnic groups but the relationship appears to be more prominent in disadvantaged communities. Indeed Xiong et al<sup>46</sup> observed a clear difference

in studies conducted in the United States when compared to those conducted in European countries and in Canada. The former group of studies tended to include women from socially disadvantaged groups and consistently reported poorer birth outcomes whereas the later group included women who have access to universal health care. They speculate that the effects of periodontal disease on adverse birth outcomes may be moderated by socio-economic status and access to care.

Despite the general observation of some association, most reviews are cautious in their conclusions suggesting further more robust research is required to increase evidence in this area. Poor study design, small numbers of participants and lack of control for confounding variables limits the ability to make definitive conclusions. Most studies controlled for a small number of confounding variables such as smoking and previous histories of adverse pregnancy outcomes. Some studies also adjusted for race, SES, smoking and other variables by regression analysis but it is likely that residual confounding effects remain increasing the probability that any associations were due to chance.<sup>47</sup> Finally, most reviews highlight the difficulties of conducting meta-analyses or a more rigorous review/weighting of the studies because of the heterogeneity in definitions of periodontal disease and adverse pregnancy outcomes across studies.

Further evidence of the causal link between periodontal disease and poor birth outcomes could be found by examining studies which seek to demonstrate that the treatment of the disease will reduce the level of poor birth outcomes once all confounding factors have been removed. Recently a small number of studies have been conducted looking at periodontal treatment and birth outcomes. A search was conducted to identify studies published in the last decade and which assess the effect of periodontal therapy on birth outcomes. Studies which did not utilize a control or comparison group were excluded from this review (see Appendix 1 for search strategy).

From the retrieved studies included in this review (see Table 1B) a consistent trend is observed suggesting treatment of existing periodontal diseases may reduce the risk of poor birth outcomes. However a single high quality study has recently been published that has raised doubt on this relationship. The large study conducted by Michalowicz and colleagues could not find a relationship between periodontal treatment and subsequent reductions of LBW or preterm birth. Interestingly they did find that there was a significant decrease in the total rate of spontaneous abortions or stillbirths as a combined outcome.<sup>48</sup>

To date, none of the studies on this topic have included a large number of women (>1000) and/or controlled for all known confounding factors, making definitive statements on a causal relationship difficult. Further study is required in this area to determine if treatment of periodontal disease at any time before gestation will improve birth outcomes. There is a large study being conducted at present in the United States examining the treatment of periodontal disease and birth outcomes (see [http://clinicaltrials.gov/ct2/show/NCT00097656?term=mouth+and+tooth+diseases&rank=36&show\\_desc=Y#desc](http://clinicaltrials.gov/ct2/show/NCT00097656?term=mouth+and+tooth+diseases&rank=36&show_desc=Y#desc)), although to date no outcomes have yet been reported.

## **New Zealand perspective**

No studies examining the relationship between periodontal disease and adverse birth outcomes conducted in New Zealand were identified. However a recent study carried out in Fiji involved 670 multiethnic pregnant women.<sup>49</sup> The women were interviewed to identify any confounding variables including smoking, alcohol consumption and history of preterm births. They underwent a comprehensive periodontal exam. Only a small proportion of these women (1.9%) delivered preterm but of those who did approximately 50% had moderate to severe periodontal disease compared with 13% of women who delivered at term. These authors concluded that there was a highly significant association between moderate to severe periodontal disease and preterm birth. Contextual differences including dental services, access to prenatal care and better social conditions limits generalization of these findings to similar ethnic groups living in New Zealand.

Information regarding the periodontal status of women of child bearing age in New Zealand is limited. Two studies provide some information although neither was designed specifically to sample this particular population. Thirty six percent of 35-44 year old NZ adults of both genders have been reported to have shallow pocketing<sup>§</sup> and 8% deep pocketing.<sup>50</sup> In the Dunedin Multidisciplinary Health and Nutrition Study 14.8% of 26 year olds showed probing depths of 4mm or greater.<sup>51</sup> Furthermore of 100 randomly sampled 26 year old females 13% had probing depths of 4mm and/or greater.<sup>52</sup> From these results a cautious estimate of the prevalence of periodontal pocketing could be somewhere between 15 and 36% for women of child bearing age. No estimates can be made of the disease experience of ethnic or social subgroups of women.

### **Summary Box 1**

**Highest level of available evidence:** Type I Systematic Review

**Strength of evidence:** Moderate

- Periodontal disease in pregnancy is associated with higher risk of poor birth outcomes in women from disadvantaged groups.
- Treatment of periodontal disease in pregnant women to reduce risk of poor birth outcomes is currently not supported by evidence however is likely to be beneficial.
- Control of plaque for the treatment and prevention of periodontal disease is likely to be beneficial to both mother and child.

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<sup>§</sup> Pocketing measured by probing depths greater than 3 mm is an indication of loss of attachment of the periodontal tissues (gums) to the teeth. This loss of attachment is due to irreversible damage to the periodontal tissues (periodontitis) as opposed to the earlier and reversible condition known as gingivitis (or inflammation only of the gums).

## **Question 2: What is the impact of maternal health and pre and peri-natal events on the development of developmental defects of enamel?**

A large number of studies have shown a significant relationship between developmental defects of teeth (DDE) and dental caries.<sup>34, 35, 53, 36, 54, 37, 55</sup> Loss of integrity of the surface enamel allows additional plaque accumulation on what would otherwise be a smooth surface, reducing the resistance of the tooth to the sugar challenge.<sup>56</sup> The first systematic review to address this question concluded that no association could be determined.<sup>2</sup> However the limited number and quality of studies made their conclusions “cautious”. In a more recent systematic review only five studies were identified that examined this relationship in young children and that were of sufficient quality to draw conclusions confidently.<sup>35, 53, 36, 54, 55</sup> Four of the five studies were cross sectional and demonstrated that if enamel hypoplasia was present, then the odds of having caries were greater. The single cohort study found a weaker relationship but this may be due to the low levels of hypoplasia found in the study group. All studies were conducted in developing countries and therefore generalisation of results to the New Zealand context should be made with caution.

Having established a relationship between DDE and caries experience, it is important to identify the aetiological risk factors associated with DDE. Poor maternal health and poor birth or neonatal health outcomes have been linked to DDE however there appears to be a lack of supporting evidence. Enamel hypoplasia has been associated in some studies with premature or low birth weight, pre and post-natal infection/illness, nutritional deficiencies and a variety of environmental pollutants (see Seow<sup>57</sup> for a review) including maternal smoking.<sup>39</sup>

The complex relationship (and probable lack of independence) between factors such as prematurity, low birth weight and neonatal illness coupled with the lack of consistency in outcome measure, examiner calibration and blinding of assessments limits the strength of the evidence. Of the 12 studies identified five were excluded from this review either because they did not report on the prevalence of defects in the primary dentition or because the primary outcome criteria were too broad to be useful.<sup>58, 59, 60, 61, 62</sup> The remaining relevant 7 (Table 2) studies are cohort and/or case control studies and most had relatively small sample sizes. Five studies report an increase in DDE in children born either with a low/very low birth weight<sup>34</sup> or premature<sup>63, 64</sup> or both.<sup>65, 66</sup> Where multivariate analysis has been used, preterm birth and history of neonatal intubation seem to be the most influential factors with birth weight itself adding little to the risk.<sup>65-67</sup> Finally there is moderate evidence from a well designed cohort<sup>67</sup> and a cross sectional<sup>66</sup> study to suggest that maternal health, or more specifically poor maternal nutrition (using size for gestational age as a proxy) and exposure to infections, during pregnancy are associated with an increase in prevalence of dental defects however the sample size in both studies are relatively small.

In summary although it appears that problems during pregnancy, birth and during the neo-natal period contribute to a higher incidence of enamel defects in the primary dentition, the specific aetiological factor/s responsible have not been identified and may prove difficult to isolate due to the existence of multiple confounding factors. Nevertheless promotion of maternal health during pregnancy in order to minimise poor birth outcomes and reduce peri-natal morbidity is likely to enhance infant oral health, not only through the influence on the developing dentition but also by increasing maternal well being, reducing stress and enhancing their broader parenting abilities.

## Summary Box 2

**Highest level of available evidence:** Type IV Observational Study

**Strength of evidence:** Low to moderate

- Promotion of good prenatal maternal health and nutrition may lower risks of developmental defects of enamel in their child.
- Children born prematurely or those with history of significant illness in early infancy should be considered high risk for developmental defects of enamel and therefore early childhood caries.

### **Question 3: What is the influence of maternal general health on the ECC experience in their offspring?**

Maternal health-related practices and the choices they make for their children will influence child health and well-being. Mothers are often referred to as the 'key figure' in their child's general and dental health as they are usually the primary care givers. Dental health of children is related to their diet, oral hygiene practices and dental attendance patterns and those of their mothers. If a mother is incapacitated for any reason, such as chronic mental or physical illness this could impact on health related practices, including oral health, of their children. A search was therefore conducted for studies that provided information on the impact of poor maternal health and well being on ECC experience in their children however very few studies were identified. Of the limited literature available two areas have been researched; maternal mental health and parental smoking practices.

Literature from non-dental health fields show that poor mental health or stress may impair the ability of mothers to engage in and maintain health promoting behaviours.<sup>68, 69</sup> The literature pertaining to oral health (Table 3A) shows no clear or consistent relationship. Mothers who have depressive symptoms have been shown to be less likely to take their children to a dental professional.<sup>70</sup> However there has been no attempt to relate depressive symptoms to children's actual caries rate. There is also some evidence that parental stress levels are associated with ECC in 1-3 year olds but not in 4-5 year olds where in fact parental stress appears to either be unrelated to<sup>71</sup> or even protective against ECC.<sup>68</sup> It is possible that if such a relationship does exist, it is masked by other much stronger factors such as SES and childhood nutrition. Further studies are required in this area.

Passive smoking is thought to influence child caries experience in two ways; firstly exposure to smoke increases the risk of developing associated medical conditions, such as asthma or respiratory infections. These conditions and the medications used to treat them may increase risk for ECC.<sup>72</sup> Secondly, smokers may consume more sugar in their food and the same, highly cariogenic foods will be given to their children.<sup>39</sup> Although smoking practices may also be linked to SES and controlling for the complex influence of SES can be difficult, two studies that have shown a positive relationship between passive smoking and caries. In one such study passive smoking was found to be an independent predictor for caries in 3-4.5 year old children after controlling for SES.<sup>39</sup> Whilst this was a large study it was not prospective rather, the data were derived from information collected for the UK National Diet and Nutrition Study.<sup>73</sup> Similarly analysis of data from the Iowa Fluoride Study has found smoking to be an important predictor of caries in infants but only in middle income families.<sup>74</sup> Further research, controlling for confounding variables such as SES is therefore required before firm conclusions can be drawn on the effect of passive smoking on ECC.

#### **New Zealand perspective**

There is no New Zealand based evidence available on the relationship between maternal general health/well being and infant caries experience. However in terms of epidemiology 46.6% of the New Zealand population may meet the criteria for a mental disorder at some time in their lives and the

prevalence is known to be higher in Maori and Pacific people. Further it has been reported that major depressive illnesses (as experienced in NZ in the past 12 months) are equally as common in the Maori and Pakeha populations (5.7% and 5.8% populations respectively) but lower in Pacific people (3.5%).<sup>75</sup> It is possible that the influence of poor maternal mental health may further exacerbate the inequalities in infant oral health that exist. Again whilst the evidence is not strong, promoting maternal health is likely to positively influence infant health (including oral health).

### **Summary Box 3**

**Highest level of available evidence:** Type IV Observational Study

**Strength of Evidence:** Low

- Parental smoking, particularly by mothers may increase the risk of dental caries in their offspring. In addition to the more general health benefits, smoking cessation strategies targeted towards parents may have beneficial effects on future oral health of their child.

#### **Question 4: What is the influence of maternal oral health on ECC experience in their offspring?**

Early childhood caries is a multi-factorial disease in which maternal characteristics undoubtedly play a significant role. This may be directly through bacterial transfer or indirectly through their family dietary patterns and social situation. A large number of studies have been published in the dental literature that have investigated the influence of parental attitudes and knowledge of appropriate tooth brushing, diet and use of toothpaste on the dental health of their children. However relatively little research has been conducted to investigate the link between parental oral health status (caries and periodontal disease) and ECC in their offspring. Table 4 summarises the studies that were identified through our search and included in this review that relate the caries status of children with their parent's oral health. Because of a lack of any high quality studies all retrieved studies have been included in the synthesis of evidence relating to this question.

A total of ten studies were identified that specifically aimed to investigate the relationship between parental oral health status and that of their children. The age range of the children in these studies was wide (6 months to 9 years) and there was a wide variety of settings, some with specific high risk groups and others with more general randomly selected samples. Measures of oral health status used also varied between studies. Six studies<sup>76, 77, 78, 79, 80, 81</sup> reported relationships using clinical measures for health outcomes (dmft/DMFT, proportion caries free, presence of anterior caries, or need for treatment) for both mother and child. Three studies<sup>82, 83, 84</sup> compared parent (one study also surveyed fathers) self-reported dental status with the findings from clinical examination of their child. A single study<sup>85</sup> used parent reported dental status for both mother and child. The majority of studies (n=7) were cross sectional, one used a prospective cohort and one used a case control approach. With one study the design was not clear from the published information although the families were part of a larger prospective cohort. As a result most of the studies only report correlations between mother and child oral health status and are not able to establish cause and effect.

Despite this variation in design and outcome variables all included studies except one<sup>77</sup> found that the oral status of parents (mostly mothers) was related to that of their children. One study found significant associations with univariate analysis but not with later multivariate logistic tests.<sup>76</sup> In a large, prospective study<sup>84</sup> a group of 1443 pregnant Finish mothers were followed up over five years. Although clinical oral examination of the parents was not conducted, complex, in depth questionnaires were completed by both parents during pregnancy and again when the child was 1.5, 3 and 5 years of age. At each of these time points, dental examinations were conducted on the children. Only 57% (n=823) of parents and children completed the five-year follow up. The average dmft for all children at 5 years of age was 0.995 with a large proportion of children caries free (72%). Many variables were examined but maternal oral health (described as having more than 2 carious teeth per year) and irregular flossing and brushing by the mothers were associated with the caries status of the infants. An interesting secondary finding was that by 5 years of age the fathers' oral status became just as important as that of the mothers.

The one study that failed to show any significant association between mother and child oral health status involved infants born with a cleft of the lip and/or palate.<sup>77</sup> It is possible that this subgroup of children is more likely to develop caries than an otherwise healthy population due to barriers to adequate oral hygiene such as crowding and difficulty of cleaning around the cleft area. As such this anomalous finding should be viewed with caution.

Comparison between the studies is difficult due to limitations in design and differences in study groups. This further limits the ability to draw strong conclusions beyond the observation that there is weak to moderate quality, but relatively consistent evidence to support the existence of a relationship between maternal and infant oral health status. The most common weakness in the published literature to date is that although direct clinical examination of the infant is reported, detailed clinical examination of their mothers (parents) is not. Rather written or verbal self-report questionnaires were used as the outcome measure. Self reported oral status is likely to be different from objective clinical oral health status and populations and individuals will invariably under or over report previous and/or current dental status. Furthermore the included studies were conducted in a wide range of countries and cultural settings and this could also affect participants' subjective interpretation of their own and their child's oral health status. Comparison of studies is also complicated by the fact that the definition of what constitutes a carious lesion in mothers and children differs between studies. Most studies report and analyse only cavitated lesions and ignore white spot and incipient lesions. The inclusion of white spot lesions in the analysis of the data is important as it may influence the strength of the relationship between with maternal and infant oral health.

### **New Zealand Perspective**

The only New Zealand study identified was by Schluter et al.<sup>85</sup> This study was undertaken in response to findings from previous work that had shown that Maori and Pacific children were more likely to have dental decay than Pakeha.<sup>52, 86</sup> Therefore as part of a prospective cohort study, Pacific mothers were verbally surveyed about both own and their child's oral health status. Results of multivariate analysis, showed Pacific mothers who reported brushing their own teeth less than twice a day (44% of mothers) were significantly more likely to report that their child had had either a filling or dental extraction. As only 53% of the 1048 surveyed children brushed their teeth twice a day, the authors suggest that a targeted health promotion message primarily aimed at this preventive strategy alone might considerably reduce caries in this population. Almost half (47%) of these four year old children never received assistance with tooth brushing despite general recommendation that parents should assist children until the age of eight years. Unfortunately this study did not ask direct questions regarding parental oral health, rather used surrogate measures such as tooth brushing behaviours, time since last dental visit and reason for last dental visit. Although it is likely that these factors are related to measures of oral health (subjectively experienced and objective clinical measures) no supporting evidence for this was presented. In addition, maternal self-report of their children's restoration and tooth extraction dental history and of oral health and dietary behaviours is subject to recall and social desirability biases.<sup>85</sup>

Although this study has significant limitations it does provide some insight into a population in New Zealand as well as identifying great variation in oral status, beliefs and practices between the different Pacific populations (Samoan, Cook Island Maori and Tongan). This highlights the heterogeneous nature of these population groups and supports caution in generalizing the findings from studies conducted in different countries or communities within New Zealand. It also emphasizes the need for significant preliminary community based consultation and engagement in order to identify group-specific beliefs, norms and practices. This information is important when developing culturally acceptable interventions and for establishing appropriate outcome measures and evaluation tools to assess the success of such interventions.

#### **Summary Box 4**

**Highest level of available evidence:** Type IV Observational Study

**Strength of Evidence:** Moderate

- Although there is no very strong evidence (ie RCTs) regarding the relationship between parental (especially maternal) oral health and that of their offspring, what evidence does exist is consistently supportive.
- Interventions which aim to improve the oral health of parents are likely to have beneficial effects on the oral health of their offspring.

## **Question 5. How effective are interventions involving mothers in reducing ECC in their infants?**

Improving the oral health status of mothers may benefit their children in two general ways. Firstly, interventions that increase maternal knowledge of their own oral health issues, such as limiting carbohydrate intake and improving oral hygiene habits are likely to impact on how they care for their infant's oral health. Secondly an improvement in maternal oral health may reduce the number of *S. mutans* present in their oral cavity thereby reducing the potential risk of transmission of these cariogenic bacteria to their children. It is probable that the majority of children acquire *S. mutans* eventually but the critical period for ECC development is the first few years of life.<sup>24</sup> Interventions that aim to prevent transmission of *S. mutans* by either reducing levels of the bacteria in the mother's oral cavity or by reducing behaviours that promote salivary transfer may be important in reducing the risk of ECC in early childhood. Interventions that focus on improving oral awareness more generally may have long lasting, ongoing positive influences on the whole family unit.

The literature related to this topic is not large but a number of studies have been conducted as seen in Tables 5A and 5B. Several approaches have been adopted 1) strategies aimed at improving the mother's oral health status with the intention of reducing the child's risk or primary-prevention; 2) oral health education; 3) use of fluorides; and 4) chemical suppression of bacteria in child's mouth. This review is limited by its a-priori scope which included only interventions that aim to influence the mothers oral health and her oral health practices (1 and 2) and the effects of this on the oral health of the infant/child. However comment will be made with respect to the other approaches (3 and 4) as evidence is available suggesting support for fluoride use and also failure of interventions using antibacterial chemicals in children.

Six studies were located that targeted mothers in an attempt to prevent or delay the transmission of cariogenic bacteria to their offspring. Of these six, four studies assessed the impact of a comprehensive treatment and/or preventive dental program for prenatal or new mothers and two assessed the effects of xylitol use. The quality of these studies was generally low with the exception of one of the xylitol studies. Most of the studies had small numbers of subjects and the interventions varied in extent, limiting the ability to aggregate the results or to draw conclusions on how beneficial interventions would be on a population basis. Despite these caveats the majority of studies (5 of 6) showed that improving the oral status of a mother does directly translate into less caries in their children. Most of the studies provided oral hygiene instruction and attempted to restore any carious lesions that were present in the mother's oral cavity to eliminate or reduce maternal *S. mutans* levels during or immediately after pregnancy. It is hypothesized that the approaches used in these six studies may have reduced maternal *S. mutans* levels and subsequently reduced colonization of the infant oral cavity and hence slowed the development of caries. This is highly likely with the two xylitol studies, although it is less clear in the others as they used multiple strategies which may have

affected *S. mutans* but also could have lead to behavioural changes in mothers with relation to their child's diet or oral hygiene practices.

Four studies included in our review evaluated the effects of dental health education provided to the mother on the ECC in their offspring. The first study, carried out by Kowash and co-workers (2000), tested the impact of home visits to mothers living in disadvantaged suburbs of Leeds in the UK.<sup>87</sup> Varying approaches were used in relation to content (Group A diet only, Group B oral hygiene only or Group C balanced oral hygiene and dietary advice) with home visits scheduled every 3 months for first two years then twice in the third year. A fourth group D was given diet and OH instruction during home visits conducted just once a year for the full 3 years. All children and mothers were examined for caries and oral hygiene and the outcomes compared with that of the fifth, control group E who received no home visits. The study found striking differences in the prevalence of ECC with only two children across all four (A-D) intervention groups compared to 18 (33%) in the control. There were also no significant differences within the intervention groups when the frequency of visits was assessed. It appears that once yearly home visits (Group D) were as effective as the more intensive schedules used in Groups A-C. An additional secondary effect was the significant improvement in the oral health as measured by gingival health, plaque and calculus displayed by mothers in the intervention groups despite the focus being on infant/child oral health.

The next two published reports presented results at two different time points from the same study.<sup>88, 89</sup> This study, again involving high risk families, used a novel approach known as motivational interviewing (MI). MI has been defined as a client-centred yet directive method for enhancing intrinsic motivation to change by exploring and resolving client ambivalence.<sup>90</sup> In a multi-centre study 240 healthy infants aged 6 to 18 months and their mothers were recruited from a high caries risk, Punjabi-speaking community in British Columbia, Canada. The parents and children were randomly assigned into one of two groups; either an MI counseling or a health education (control) group, after stratifying the children into two age groups (6 to 12 months and older than 12 months). At one and two year time points the children in the MI group had significantly less caries when compared to children in the control group. The authors suggested that the counseling increased dental visiting for fluoride varnish applications which was promoted to both groups through a pamphlet.

Another study utilising the home visiting approach was a randomised controlled field trial in Brazil by Feldens and co-workers.<sup>91</sup> Mothers of infants received advice about healthy breast feeding, weaning and infant diet from ten days up to six months and then again at eight, ten and twelve months. The advice was based on WHO recommendations for healthy diet for babies and although it did contain advice designed to deter cariogenic feeding practices was not specifically delivered as oral health advice. No information about oral hygiene of the child was included. Mothers with newborn babies of low SES living in an optimally fluoridated region of Brazil were recruited and randomly assigned to either an intervention or a standard care group. Mothers were surveyed and children examined by dental examiners blinded to the allocation process. The intervention group had significantly less dental caries at twelve months, and was exposed to sugar containing drinks and foods significantly later than the control group. Interestingly, although again consistent with the findings in other studies,

the intervention had no impact on the use of night time bottles despite inclusion of this advice in the overall program. This good quality study suggests that dental health can be enhanced through interventions that incorporate dental health advice as part of general nutritional advice for infants and toddlers.

Fluoride has long been the cornerstone of caries prevention and is supported by strong and consistent evidence.<sup>92-94</sup> The daily use of fluoridated toothpaste has been shown to be the most cost effective way to prevent caries. In terms of prevention of ECC only fluoride use (both daily brushing and to a lesser extent varnish applications) can be supported conclusively by current evidence.<sup>22, 95</sup> However, when considering the use of fluoride the benefits should be considered alongside the risk of fluorosis. Parents and health care providers require education and support to be able to use fluoride optimally (ie greatest benefit with lowest risk) with young children.<sup>22, 96</sup> The use of other chemicals applied topically to children's teeth is not currently supported by evidence. A number of recent moderate quality studies using agents such as povidone iodine and chlorhexidine show no significant reduction in dental caries when tested through RCTs.<sup>97, 98, 99</sup>

### **New Zealand perspective**

No published studies from New Zealand were identified in the search of electronic databases. Some oral health promotion programs were identified by searching the grey literature and by contact with health professionals and personal networks. None of the programs have published formal evaluations although various data have been collected to provide feedback on important indicators of process and impact. Little quantitative data relating to oral health outcomes has been collected but important qualitative data on acceptability and appropriateness is available. This information should prove valuable to the development of future programs. At least two of the studies plan to assess dental caries outcomes using routinely collected school dental data although this is yet to be completed. Information regarding these programs was available through personal communication only and is discussed below.

The Tipu Ora Charitable Trust, a Maori health provider in the Te Arawa district, has for many years, recruited non-smoking Maori grandmothers to help pregnant women and subsequently mothers and their children in accessing basic health care. These women provide support and basic health information, as well as facilitating the mothers' and children's ability to access appropriate health care (including oral health). Although evaluation of the program has not been published anecdotal accounts suggest that the program has been successful in increasing access to services for mothers and their children and in reducing dental caries (Raewyn Bourne, Personal Communication). The program is also reported to be highly acceptable as the facilitators are trusted members of the Maori community. Similar use of community workers was also found to be successful in an evaluated health promotion program to reduce meningococcal disease (see below) reinforcing the advantages of this approach. Success of the program has also been attributed to the Maori health providers involved who have overcome barriers through the establishment of relationships within both the health sector

and the Maori community; and also through their passion and commitment to *oranga niho mo te iwi Maori* (oral health for all Maori).<sup>100</sup>

“Teeth 4 Keeps” was a Regional Public Health program of home visits to first time mothers residing in low SES areas of Wellington operating from 2000-2003. Home visits were made by Well-Child Nurses and three local Maori Health Providers where oral health education and printed resources were provided. Enrolment in school dental services was also promoted. Process evaluation in the form of monthly reports by the visiting educators and small number of focus group discussion with families and providers showed high acceptance and improvements in knowledge and reported practices. Children are being tracked through school dental services via a unique identifier to assess impact on dental caries. Data collected from a small proportion (~33%) of participating children show trends towards lower dmft at 2-3 years of age when compared to non-participant averages. However longer term information is required to determine the true impact.

Various programs providing training to health care (Practice Nurses, GPs and School nurses) and early childhood professionals to allow them to incorporate oral health promotion into their services have been undertaken. One program implemented as a pilot study in high-needs Kohanga Reo and Pacific Early Childhood Centres in Porirua, Strathmore, Newtown and Hutt Valley aimed to develop settings which supported oral health enhancing behaviors such as healthy eating and organized tooth brushing with fluoride toothpaste. The project was implemented for a twelve month period and process evaluation indicated good acceptance and also a number of important barriers to full adoption of the program in some centres. Other programs operated through medical practices and health care centres rely on strategies such as opportunistic one-on-one education or facilitated referral to school dental services. No outcome evaluation was available for any of these programs.

Examination of general health promotion initiatives in New Zealand concerning mothers and preschool children again found very few programs that had any form of evaluation available. In New Zealand as in other parts of the world, mass media campaigns have been shown to increase knowledge but have little effect on health related behavioural change.<sup>101, 102</sup> One study which focused on Maori and Pacific children living in low SES areas and which included health outcome measures as part of its evaluation is worthy of mention. It was an evaluation of a public awareness campaign in Auckland in 1998. It arose in response to a dramatic increase in meningococcal B disease with Maori and Pacific five year olds being at particularly high risk. The campaign involved door-to-door visiting by lay Maori and Pacific educators in the four city suburbs with the highest rates of disease. The educators were selected from these communities using criteria such as having good standing in the community, the absence of a criminal record, and a commitment to be involved for eight weeks. Handouts and educational aids were provided to the lay educators and participants. Analysis of the success was determined through focus group discussions and measuring the number of new meningococcal cases within the community over the 6 month period after the start of the education. Significantly greater awareness of the early clinical features of meningococcal disease and appropriate action to take was found in people visited by lay educators compared to those not visited.

Furthermore for the first time in 5 years, there were no meningococcal deaths among the target population for the 6 months from the start of the campaign.

#### **Summary Box 5**

**Highest level of evidence available:** Type II Randomised controlled trials

**Strength of Evidence:** Moderate

- Primary-primary prevention programs which aim to reduce dental caries in children by improving the oral health of mothers are supported by available evidence.
- Programs which provide one on one education and support to mothers are also likely to result in significant benefit particularly where they involve outreach into family homes.
- The use of lay community members in interventions is supported by a limited number of local New Zealand studies identified in the grey literature but remains to be tested in the area of child dental health.

## Conclusions

ECC appears to be an ongoing and significant problem for children in New Zealand. Available data on disease experience suggests that:

- Maori and Pacific children are less likely to be caries free at 5 years
- Maori and Pacific children experience more dental caries at 5 years
- Water fluoridation and area of residence have moderating effects on the relationship between ethnicity and caries experience

Little information is available on the disease levels of children under the age of five and even less about the impact of dental disease on the functioning of families and the quality of life of children and families.

In relation to periodontal disease (PD), there appears to be some evidence of a relationship between PD and poor birth outcomes (low birth weight/pre-term births). The way in which PD is causally related to birth outcomes is not clear and it is possible that there are complex confounding variables. The low quality of available studies means that the hypothesis that treating PD reduces the risk of poor birth outcomes has yet to be adequately tested. Given the invasive nature of periodontal therapy and its associated costs, interventions aimed at reducing poor birth outcomes through treatment of PD cannot, at this stage, be supported. However lack of evidence does not indicate a lack of effect. Given the additional benefits of adequate plaque control (caries prevention and *S. mutans* reduction) and the broader general benefits to child health and well being that would result from even a small reduction in preterm or low birth weight, interventions involving maternal oral health should include a significant focus on plaque control and the promotion of periodontal health.

Developmental Defects of Enamel (DDE) are associated with an increased risk of ECC. It appears that preterm birth and a history of neonatal intubation (proxy for poor neonatal health), poor maternal nutrition and exposure to infections do increase the risk of DDE in the primary dentition. Despite evidence to support these two relationships, there is little strong evidence to link poor maternal health during pregnancy directly with ECC in their offspring. Again this may be related more to the paucity of high quality studies than an actual lack of relationship. At this point in time, there is insufficient evidence to inform the development of an intervention that focuses on the general health of pregnant women in order to improve the oral health of their offspring. However the promotion of health during pregnancy, including oral health, should be supported in the broadest sense.

There is some evidence to support interventions targeting maternal oral health directly or the child's oral health through the mother in an effort to reduce ECC. Improvements in maternal oral health are associated with some reductions in dental caries experience in their children. However the quality of the primary studies is not high and in many cases the results are trends which do not achieve statistical significance. Of those studies that did demonstrate statistical significance most did not elaborate on the clinical significance of such outcomes. Motivational interviewing has shown promise

however the acceptability and effectiveness of this approach when used with population groups such as Maori and Pacific families needs to be established.

Although not a specific focus of the review questions and search strategies, the role of fluoride in maternal and child oral health remains important. It is also one of the oral health promotion strategies that has been consistently been shown to provide benefit and is supported by strong high quality evidence. Fluoride has been used in studies which aim to reduce dental caries in mothers (usually in conjunction with therapy and/or health education) or used to reduce *S. mutans*. It has also been shown to reduce the incidence of ECC when used in toothpaste form or as professionally applied varnishes.

## **Recommendations**

Given the evidence reviewed in this report the following recommendations are put forward for the Ministry to further consider:

- Evidence.

Good quality well funded research is required in the New Zealand environment to fill the identified information gaps in the current evidence base.

- Routine surveillance.

Available data indicates that by age five years nearly half of children in NZ have experienced dental caries. However nothing is known about the natural history of dental caries leading up to this age nor, more specifically, the epidemiology of the disease in disadvantaged groups. Given the well recognised long term benefits of early intervention in the first five years of life across the broadest range of health outcomes, it would be beneficial to establish some routine oral health surveillance for this age group in NZ. Such data would provide not only baseline data against which effectiveness of interventions could be compared but would also facilitate monitoring of trends across the population.

- Addressing inequalities.

Within the broad public health sector there is debate regarding the most appropriate, equitable and ethical approach to addressing health inequalities through health promotion; a population based or targeted approach. When an entire population is exposed to a health promotion intervention there should be an overall improvement in health across all sectors of the community whilst a targeted approach specifically focuses on the most disadvantaged communities. Whilst the strength of the evidence surrounding the extent of oral health disadvantage experienced by specific communities in NZ is incomplete there is no reason to believe that similar inequalities do not exist in NZ as elsewhere. A community focussed, targeted intervention could provide an opportunity to improve the

oral health outcomes of the more disadvantaged thus reducing inequalities whilst optimising cost effectiveness and not succumbing to the pressures of victim blaming and stigmatisation.

All expectant mothers should be targeted generally for oral health promotion, but additional resources should be made available to develop supportive health promoting programs for socially disadvantaged women and those from high risk populations.

- Health promotion.

Whilst the evidence surrounding the relationship between maternal oral and general health and the oral health of their offspring is currently not strong, there are many oral and general health benefits to be gained, especially by women in disadvantaged communities, from being exposed to oral health promotion. These benefits are likely to be optimised by adopting a broader 'determinants of health' approach and integrating oral health in to general health promotion. Opportunities for oral health promotion should be delivered in an integrated way within existing services already accessed by women from disadvantaged groups such as the Well Child/Tamariki Ora services or primary health services. The potential benefits of mothers improving their own oral health should be promoted in relation to general child health and wellbeing as well as the oral health outcomes for the individuals themselves and their broader communities.

Given that women in the target group are likely to have significant levels of untreated dental disease, the effectiveness of such strategies in isolation from access to primary dental care is likely to be diminished. In the New Zealand context therefore access to primary dental care, particularly for women most at risk of oral disease should be considered.

- Evaluation.

Any proposed oral health promotion programme aimed at improving infant oral health must include a comprehensive evaluation plan which takes in to account process, impact, outcome and economic aspects of evaluation.

- Cultural competency

Programmes should incorporate significant community involvement from the planning, through implementation to the evaluation phase. Based upon the evidence, the involvement of community educators together with child and health care workers, is likely to be beneficial. Furthermore if deemed culturally appropriate and acceptable to the community within the NZ context, home visits can be additionally supportive.

Any planned oral health interventions or programs should be preceded by careful and comprehensive needs assessment using techniques that engage community groups. Mothers and other community members from socially disadvantaged and high risk groups should be encouraged to participate in the development and delivery of innovative programs. Program development and evaluation should be based on a robust model or framework for health program/promotion planning.

- Content

Primary - primary prevention approaches that focus on low technology strategies such as plaque control through tooth brushing with fluoride toothpaste and the provision of primary dental care services should be core to any intervention.

Any program that uses screening or dental treatment strategies must be part of a comprehensive prevention and health promotion approach. If the identification of dental treatment needs is to be part of a program, then direct pathways to such care should be established and closely linked with the screening process.

## Appendix 1 – Search Strategies

### Question 1.

What is the influence of maternal oral health on gestational and perinatal events?

- 1 exp periodontal diseases/ or exp alveolar bone loss/ or exp furcation defects/ or exp gingival diseases/ or exp gingival hemorrhage/ or exp gingival neoplasms/ or exp gingival overgrowth/ or exp gingival recession/ or exp gingivitis/ or exp granuloma, giant cell/ or exp pericoronitis/ or exp periodontal attachment loss/ or exp periodontal cyst/ or exp periodontitis/ or exp tooth loss/ or exp tooth migration/ or exp "mesial movement of teeth"/ or exp tooth mobility/
- 2 exp Gingival Hemorrhage/
- 3 1 or 2
- 4 exp Pregnancy/
- 5 exp pregnancy complications/ or exp abortion, spontaneous/ or exp chorea gravidarum/ or exp diabetes, gestational/ or exp fetal death/ or exp fetal diseases/ or exp hypertension, pregnancy-induced/ or exp morning sickness/ or exp placenta diseases/ or exp pregnancy complications, cardiovascular/ or exp pregnancy complications, hematologic/ or exp pregnancy complications, infectious/ or exp pregnancy complications, neoplastic/ or exp pregnancy in diabetics/ or exp pregnancy, ectopic/ or exp prenatal injuries/ or exp puerperal disorders/
- 6 4 or 5
- 7 exp infant/ or exp infant, newborn/ or exp infant, low birth weight/ or exp infant, premature/
- 8 3 and 6 and 7
- 9 3 and 6
- 10 limit 9 to english language
- 11 limit 10 to ("review articles" and yr="1997 - 2008")

## Question 2.

What is the impact of maternal health and peri-natal events on the development of developmental defects of enamel?

1. tooth abnormalities/
2. dental enamel hypoplasia/
3. tooth discoloration/
4. dental enamel/
5. molar/
6. tooth calcification/
7. (enamel adj2 defect\$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
8. (enamel adj2 hypo\$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
9. (MIH or "molar incisor hypominerali#ation" or "molar incisor hypo-minerali#ation").mp. [mp=title, original title, abstract, name of substance word, subject heading word]
10. idiopathic enamel.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
11. "cheese molar\$".mp. [mp=title, original title, abstract, name of substance word, subject heading word]
12. enamel opacit\$.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
13. or/1-12
14. limit 13 to (english language and "etiology (optimized)" and "all child (0 to 18 years)")
15. tooth abnormalities/et, ab
16. dental enamel hypoplasia/et, ab
17. tooth discoloration/et, ab
18. molar/ab
19. dental enamel/ab
20. tooth calcification/ab
21. \*tooth abnormalities/et, ab or \*dental enamel hypoplasia/et, ab or \*tooth discoloration/et, ab or \*molar/ab or \*dental enamel/ab or \*tooth calcification/ab
22. limit 21 to (english language and "all child (0 to 18 years)")
23. 14 or 22
24. \*tooth abnormalities/ or \*dental enamel hypoplasia/ or \*tooth discoloration/ or \*dental enamel/ or \*molar/ or \*tooth calcification/ or 7 or 8 or 9 or 10 or 11 or 12
25. limit 24 to (english language and "etiology (optimized)" and "all child (0 to 18 years)")
26. 22 or 25

### Question 3

What is the influence of maternal general health on the ECC experience of their offspring?

Search Strategy:

- 1 exp health/ or exp family health/ or exp holistic health/ or exp mental health/ or exp minority health/ or exp occupational health/ or exp physical fitness/ or exp public health/ or exp rural health/ or exp suburban health/ or exp urban health/ or exp women's health/ or exp population/ or exp socioeconomic factors/
- 2 exp mental health/ or exp mental disorders/
- 3 exp infant/ or exp infant, newborn/
- 4 exp child/ or exp child, preschool/
- 5 exp tooth diseases/ or exp dental deposits/ or exp dental leakage/ or exp dental pulp diseases/ or exp dentin sensitivity/ or exp focal infection, dental/ or exp tooth abnormalities/ or exp tooth abrasion/ or exp tooth demineralization/ or exp dental caries/ or exp tooth erosion/ or exp tooth loss/ or exp toothache/
- 6 dental decay.mp. or exp Dental Caries/
- 7 exp Maternal Exposure/ or exp Maternal Nutrition Physiology/ or exp Maternal-Fetal Exchange/ or exp Maternal Health Services/ or exp Maternal Welfare/ or exp Maternal Behavior/ or maternal.mp. or exp Maternal-Fetal Relations/ or exp Maternal Age/ or exp Maternal Mortality/ or exp Maternal Deprivation/
- 8 maternal welfare.mp. or exp Maternal Welfare/
- 9 exp Surrogate Mothers/ or exp Mothers/ or mothers.mp.
- 10 1 or 2 (2356611)
- 11 3 or 4 (569998)
- 12 5 or 6 (36622)
- 13 7 or 8 or 9 (95285)
- 14 10 and 13 (59735)
- 15 11 and 12 (10117)
- 16 14 and 15 (298)
- 17 limit 16 to english language

#### Question 4.

What is the influence of maternal oral health on ECC experience in their offspring?

Search Strategy:

- 1 exp Oral Health/
- 2 exp periodontal diseases/ or exp alveolar bone loss/ or exp furcation defects/ or exp gingival diseases/ or exp gingival hemorrhage/ or exp gingival neoplasms/ or exp gingival overgrowth/ or exp gingival recession/ or exp gingivitis/ or exp gingival pocket/ or exp gingivitis, necrotizing ulcerative/ or exp granuloma, giant cell/ or exp pericoronitis/ or exp periodontal attachment loss/ or exp periodontitis/ or exp periodontal abscess/ or exp periodontal pocket/ or exp periodontitis, juvenile/ or exp tooth loss/ or exp tooth mobility/ or exp salivary gland diseases/
- 3 exp tooth demineralization/ or exp dental caries/ or exp dental fissures/ or exp "root caries"/ or exp tooth discoloration/ or exp tooth erosion/ or exp tooth eruption, ectopic/
- 4 exp dental caries/ or exp toothache/
- 5 1 or 2 or 3 or 4
- 6 exp health status/ or exp geriatric assessment/ or exp health status disparities/
- 7 exp Smoking/ or exp Marijuana Smoking/ or exp Smoking Cessation/
- 8 exp birth order/ or exp family relations/ or exp maternal behavior/ or exp maternal-fetal relations/ or exp maternal deprivation/ or exp parent-child relations/ or exp parenting/ or exp paternal behavior/ or exp paternal deprivation/ or exp sibling relations/
- 9 exp Health Behavior/
- 10 exp Maternal Welfare/
- 11 6 or 7 or 8 or 9 or 10
- 12 exp parents/ or exp fathers/ or exp mothers/ or exp single parent/ or exp surrogate mothers
- 13 Female/
- 14 12 or 13
- 15 11 and 14
- 16 exp child/ or exp child, preschool/ or exp infant/
- 17 5 and 16
- 18 15 and 17
- 19 limit 18 to english language

### Question 5.

How effective are interventions involving mothers in reducing ECC in their infants?

Search Strategy:

- 1 exp fathers/ or exp mothers/ or exp single-parent family/
- 2 maternal.mp.
- 3 exp stomatognathic diseases/ or exp tooth diseases/ or exp dental deposits/ or exp dental leakage/ or exp dental pulp diseases/ or exp focal infection, dental/ or exp mouth, edentulous/ or exp tooth abnormalities/ or exp tooth demineralization/ or exp dental caries/ or exp dental fissures/ or exp "root caries"/ or exp tooth discoloration/ or exp tooth loss/ or exp tooth resorption/ or exp toothache/
- 4 exp Dental Caries/
- 5 exp periodontal diseases/ or exp alveolar bone loss/ or exp furcation defects/ or exp gingival diseases/ or exp gingival hemorrhage/ or exp gingival neoplasms/ or exp gingival overgrowth/ or exp gingival recession/ or exp gingivitis/ or exp gingival pocket/ or exp gingivitis, necrotizing ulcerative/ or exp periodontal attachment loss/ or exp periodontal cyst/ or exp periodontitis/ or exp tooth loss/ or exp tooth migration/ or exp tooth mobility/
- 6 1 or 2
- 7 3 or 4 or 5
- 8 therapeutics/ or surgical procedures, operative/ or investigative techniques/ or exp dentistry/ or exp air abrasion, dental/ or exp anesthesia, dental/ or exp dental bonding/ or exp dental care/ or exp dental debonding/ or exp dental equipment/ or exp dental health surveys/ or exp dental high-speed technique/ or exp dental occlusion/ or exp dental pins/ or exp dental polishing/ or exp dentistry, operative/ or exp endodontics/ or exp esthetics, dental/ or exp infection control, dental/ or exp mouth rehabilitation/ or exp oral medicine/ or exp oral surgical procedures/ or exp orthodontics/ or exp pathology, oral/ or exp periodontics/ or exp preventive dentistry/ or exp prosthodontics/ or exp surgery, oral/ or exp technology, dental/ or exp tooth preparation/ or exp tooth remineralization/
- 9 treatment.mp.
- 10 exp "Early Intervention (Education)"/ or intervention.mp. or exp Intervention Studies/
- 11 8 or 9 or 10
- 12 6 and 7 and 11
- 13 limit 12 to english language

## **Appendix 2 – Expert Review Panel**

1. Professor A Blinkhorn (NSW Health Chair-Population Oral health, Faculty of Dentistry, University of Sydney) has extensive experience in research, management and clinical care. His research has encompassed clinical trials, health services research and new ways of educating oral healthcare professionals. He is also heavily involved in oral health promotion and editor of the Health Education Journal.
2. Ms E Riggs (Research fellow, The McCaughey Centre, School of Population Health, University of Melbourne) is currently completing her PhD on the barriers to promoting oral health in young children in new and emerging communities in Australia. As part of her project she has been evaluating the international evidence base to cultural competency within oral health promotion.
3. Professor B Chadwick, (Professor Paediatric Dentistry, School Dentistry, University of Cardiff) is a paediatric dentist who has broad experience in the prevention of dental disease in children. She has been involved in several systematic reviews including the management of dental caries. She also co-ordinates several large scale public health interventions in both Wales and elsewhere.

### Appendix 3 – Evidence Tables

Evidence Table 1 – Question One. What is the influence of maternal oral health on gestational and peri natal events?

Study	Type of Study	Included studies	Oral Health /Obstetric variables used	Outcomes and conclusions	Quality Rating
Xiong et al., 2007	Systematic review  (meta-analysis of 5 clinical trials)	1966-2006  26 case studies  13 cohort studies  5 clinical trials	OH: At least one of several clinical periodontal indexes.  Ob: Identified birth outcomes	Moderately well conducted review. Authors did not formally assess the quality of included studies because of heterogeneity of PD variables and potential biases  44 studies identified of which 29 suggested an association between periodontal disease and increased risk of increased risk of adverse pregnancy outcomes and 15 found no association.  Strong association in economically disadvantaged populations  Concluded that periodontal disease may be associated with increased risk of adverse pregnancy outcomes. Insufficient evidence to support treatment of PD to reduce adverse birth outcomes	Medium
Clothier et al., 2007	Critical review	1998 - 2006  3 cross sectional  14 case control  12 cohort  1 clinical trial  3 RCT	OH: Probing depths and/or measure of clinical attachment loss.  Ob: PT and/or LBW  *Also surrogate blood markers for both condition	Fair quality review. Not systematic. Authors did not formally assess the quality of included studies beyond general comments re total body of studies  36 studies restricted to those who provided parameters related to probing depths and/or clinical attachment loss and PT and/or LBW  16 studies that examined relationship between the presence of surrogate blood markers and PT and/or LBW  Conclusion was that the studies examined support a relationship between periodontal health and adverse pregnancy outcomes	Low

Xiong et al., 2006	Systematic review (meta-analysis 2 clinical trials)	1966-2005 13 case-control 9 cohort 3 clinical trials	OH: At least one of several clinical periodontal indexes.  Ob: PT, LBW, gestational age, small for gestational age, birth weight, pregnancy loss or pre-eclampsia.	Moderate quality review. Authors did not formally assess quality of included studies.  25 studies selected from defined inclusion and exclusion criteria of which 18 suggested that PD is a risk factor for preterm and LBW and 7 studies did not find a relationship.  There is evidence of an association between PD and an increased risk of PT and LBW, especially in economically disadvantaged populations, but no associations in European and Canadian studies.	Medium
Vettore et al	Systematic Review	Up to Dec 2005 27 case control 6 cohort 3 clinical trials	OH: clinical, microbiological, or immunological aspects and measurements of destructive periodontal disease and adverse  Ob: PT and/or LBW	Good quality systematic review. Authors did not assess quality of included studies but used stricter inclusion criteria.  Most studies found some association between periodontal conditions and PT and/or LBW. But quality of included studies and high potential for bias mean no confident conclusions can be made.	High
Khander & Ta'ani 2005	Meta-analysis	1966- August 2002 3 cohort 2 case control	OH: PD  Ob: PT and/or LBW	Moderate to good quality review and meta-analysis. Formal quality assessment of studies using composite scores was conducted. Most included studies were of fair to poor quality.  Analysis indicates that periodontal diseases in pregnant mothers significantly raise the risk of PTB or PLBW. No convincing evidence that the treatment of periodontal disease in pregnant women reduces the risk of adverse birth outcomes	Medium
Scannapieco et al 2003	Systematic Review	Up to October 2002 6 Case control	OH: gingival inflammation, probing depth, clinical attachment level and or radiographic bone loss,	Fair quality review. Limited number of studies and the 3 intervention studies were of poor to low quality. Concluded that there was some evidence of association between PD and PT/LBW but no evidence of causal role of PD.	Low

		3 intervention studies 3 other study types	immunological markers Ob: Prematurity and restricted fetal growth	Some suggestion that periodontal intervention may reduce adverse birth outcomes	
Madianos et al 2002		Up to Oct 2001 1 cohort 4 case control	OH: PD by clinical, microbial or immunological measures Ob: PT and/or LBW	Good quality review but quality of included studies poor to fair. Included all study types as at time very limited amount of research.  Concluded that there was limited evidence linking PD with increased risk of adverse birth outcomes.	High

**OH - oral health, Ob – Obstetric, PD - periodontal disease, PT – preterm, LBW – low birth weight,**

Evidence Table 1A

Study	Type of study	Population	Treatment or intervention	Outcomes and conclusions	Quality Rating
Gazolla et al., 2007	Case control with Brazilian pregnant women aged 18-30 attending public prenatal program	G1: healthy: 122 G2: PD: 328	G1: no treatment G2a: treatment provided including SRP, OHI, CHX: (266) G2b: no treatment (62)	Proportion of PT/LBW:  G1: 4.1% G2a: 7.5% G2b: 79%  Education level, previous preterm birth and periodontal disease were related to PT delivery	Low
Michalowicz et al., 2006 <sup>103</sup>	RCT which enrolled women > 16 years from Kentucky and Harlem, USA	Control: 410 Treatment: 413	Control: treatment after delivery  Treatment group: SRP, OHI and monthly polish	Proportion of PT:  Control: 12.8% Treatment: 12%  Concluded that treatment of periodontal disease did not alter the rates of preterm birth, LBW or fetal growth restriction.	High
Offenbacher et al., 2006	RCT pilot study recruited from high risk prenatal clinic in Raleigh, North Carolina, USA	Control: 32 Intervention: 35  Most women had had previous preterm	SRP and/or supragingival polish and use of sonic powered toothbrush	Proportion of PT:  Control: 43.8% Intervention: 25.7%  OR of preterm birth without treatment was 0.26	Medium

		deliveries			
Lopez et al., 2005	RCT Chilean women from prenatal public health clinic with gingivitis aged 18-42	Control: 290 Treatment: 580	Control: no treatment until delivered  Treatment: scaling, plaque control and CHX 0.12% plus maintenance treatment every 2-3 weeks	Proportion of LBW or PTB:  Control: 6.71%  Treatment: 2.14%  Periodontal treatment significantly reduced the PT/LBW in these women with pregnancy associated gingivitis	Medium
Jeffcoat et al., 2003	Randomised clinical trial of African American	G1: n=123 G2: n=123 G3: n=120 Control n=723	G1: prophy and placebo capsule  G2: SRP plus placebo capsule  G3: SRP plus metronidazole	Proportion of PTB:  G1: 4.9%  G2: 0.8%  G3: 3.3%  Control: 6.3%  That performing SRP in pregnant women with periodontitis <i>may</i> reduce PT in this population. Adjunctive metronidazole therapy did not improve pregnancy outcome.	Low
Lopez et al., 2002	Randomised clinical trial of low SES Chilean women	Control: 200 Treatment: 200	Controls: no treatment  Treatment: standard periodontal treatment with or without the use of LA	Proportion of PTLBW:  Control: 10.11%  Treatment: 1.84% (SS to 0.001)  Multivariate logistic regression analysis showed that periodontal disease was the strongest factor related to PLBW	Medium

Mitchell-Lewis et al., 2001	Majority African American and Hispanic  All low SES 12-19 years old	Controls: 90  Treatment: 74	Control group postpartum examined  Prophy group enrolled during pregnancy	Proportion of PLBW  Control: 18.9%  Treatment: 13.5%  Achieved a 28% reduction of PLBW but not SS	Medium
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**OH - oral health, Ob – Obstetric, PD - periodontal disease, PT – preterm. LBW – low birth weight, SRP – scaling/root planing, OHI – oral hygiene instruction, OR – odds ration, RCT – randomized controlled trial, CHX- chlorhexidine, SS – statistically significant**

Evidence Table- Question 2: What is the impact of maternal health and perinatal events on the development of developmental defects of enamel

<b>Authors</b>	<b>Type of Study</b>	<b>Population</b>	<b>Maternal or Child Health/Tooth defect variables used</b>	<b>Findings</b>	<b>Quality Rating</b>
Naidoo et al	Case control	Case: 90  Controls: 90 mean age 8.9-9.1 years	MCH: Fetal alcohol syndrome  TD: DDE	Prevalence of ~15% for both groups, exact data not given, no breakdown of categories or analysis	Low
Chaves et al	Cohort	228  Birth to 36 months old	MCH: Medical and nutritional  TD: DDE	Multivariate analysis: Intrauterine nutritional status, infection during pregnancy, post-natal nutritional status, infection 2-6 months and infection 7-12months significantly related to defects as a whole	Low
Lunardelli & Peres	Case control	Case: 102  Control: 113  3-5 years old	MCH: "Mother-child" conditions  TD: DDE	Illness in pregnancy SS, gestation duration SS.  Maternal illness during pregnancy, prematurity and absence of breast-feeding significantly related to defects as a whole	Medium
Aine et al	Case control	Case: 32  Control: 64  1-2 years old  Primary teeth	MCH: Prematurity  Vitamin D and Calcium & phosphorus supplementation  TD:Hypoplasia or	Primary teeth: significantly more defects in premature group for all defects, SS but not for opacities alone  Prematurity, duration of ventilation and parenteral nutrition significantly related to defects, Vit D and mineral supplementation no effect  Permanent teeth:	Low

		9-13 years old Permanent incisors and first molars	opacity	significantly more defects in premature group for all, P<0.001, and opacities, P=0.031  No influence from any of the above factors	
Lai et al	Case control	Case: 25 Control: 25 Examined at approx. 30, 44 & 52 months old  All primary teeth	MCH: VLBW  TD: DDE	VLBW significantly more defects (combined) SS at all exams,	Low
Fearne et al	Case control	Case: 110 Control: 93  5 year olds  All primary teeth, buccal and lingual surfaces	MCH: LBW and associated medical care  TD: DDE	SS differences in overall enamel defects (P<0.001) and for hypoplasia but not for opacities alone  Multivariate analysis:  Strong association between defects and ventilation small additional effect of gestation but little influence of birth weight	Medium
Drummond et al	Case control	Case: 28 Control: 21	MCH: PT or BMC  TD: Other, based on extent	SS more hypoplasia and hypomineralisation defects in premature babies, severity related to BMC but does not correspond exactly	Low

**MCH – maternal or child health, TD – tooth defect, DDE – developmental defect of enamel, SS – statistical significant, LBW – low birth weight, VLBW – very low birth weight, PT – preterm, BMC – bone mineral content**

Evidence table - Question 4: What is the influence of maternal oral health on ECC experience in their offspring?

Study	Type of Study	Population	Comparison Variables	Findings	Quality Rating
Schluter et al 2007	Cross sectional survey of Pacific Islands families in Auckland, New Zealand	1048 Tongan, Samoan & Cook Island Maori families with children aged 4 years	Mother: Self Reported OH  Child: Parent reported OH	Surrogates for mother's oral health were used (Tooth brushing frequency, time and reason for last dental visit).  Only tooth brushing of mother significantly related to reported child health measure of having had fillings or extractions	Low
Livny et al 2007	Cross sectional study of Al-Jahalin Bedouins in Jerusalem, Israel	102 mother-child dyads. Children aged 1-3 years	Mother: interviewed and anterior teeth examined and subjectively rated 'fairly good- no visual caries' or 'fairly bad- visually carious'  Child: clinical examination	Univariate analysis showed significant association between 'fairly bad' mother rating and caries prevalence.  In multiple regression although children of mothers with 'fairly good' rating were four times more likely to be caries free this was not statistically significant	Low
de Castilho et al 2006	Cross sectional study children with cleft palate and their mothers in Sao Paulo, Brazil	300 mother-child dyads. Children aged 3 to 5.5 years	Mother: dichotomised groups following clinical exam. Needing treatment or dentally fit  Child: clinical examination dmft score	No SS differences in dmft (5.6 vs 6.0) between M with treatment needs and those who were dentally fit	Low

Ersin et al 2006	Cross sectional study of families in Turkey	101 dyads Children aged 15-35 months.	Mother: clinical examination DMFS score  Child: clinical exam caries prevalence and saliva sampling for micro-flora	Mean DMFS of mothers was strong risk factor for ECC and the colonization of cariogenic bacteria (odds ratio 1.07)	Medium
Bedos et al 2005	Cross sectional study of families in Quebec, Canada	6303 randomly selected mother-child dyads. Children aged 5-9 years	Mother: dichotomised according to self report as either dentate or edentulous.  Child: clinical examination	Multiple logistic regression adjusting for confounders including SES and child's oral health behaviours significant association found. Children of edentulous mothers were 1.7 times likely to have caries in primary dentition	Medium
Vachirarojpisan et al 2004	Cross sectional survey of families in high ECC population in Thailand	502 mother-child. Children aged 6-19 months	Mother: clinical examination  Child: clinical examination	In older age group (15-19 months) mothers DT (DT =0 vs DT>0) was significantly associated with ECC	Low
Smith et al 2002	Case control study with mostly Hispanic or African American families conducted in low SES area in New York, USA	60 mother child dyads. 29 in ECC case group and 31 in caries free control group. Children aged 3-5 years	Mother: Clinical examination, plaque and saliva samples  Child: ECC	Mothers of children with ECC had significantly poorer oral health (48% vs 19% had active caries). Levels of Mutans streptococci ( $\geq 50$ cfu) were also significantly associated (69% vs 16%) and was the strongest maternal predictor	Medium
Clarke et al 2001	Study conducted in Canada. Design	314 mother-child dyads who had		Maternal dental status was statistically	Low

	not clear	previously participated in larger study. Children aged 6 years		related to their child's caries status.	
Mattila et al 2000	Prospective cohort in Finland	828 children and their parents (mother and Father)	Mother: telephone questionnaire Child: clinical examination	Mother reported caries was significantly related to caries prevalence in their children.	Medium
Sasahara et al 1998.	Cross sectional study conducted in Japan	1471 mother and child dyads. Children were aged 3 years	Mother: clinical examination of gingival health Child: clinical examination	Concluded that mothers' gingival condition was associated with the prevalence and severity of dental decay	Low

**OH – oral health, SS – statically significant, dmfs – decayed, missing or filled surfaces (deciduous teeth), DMFS - decayed, missing or filled surfaces (permanent teeth), SES – socio-economic status, DT – decayed teeth, ECC – early childhood caries**

Question 5 How effective are interventions involving mothers in reducing ECC in their infants

Table 5A Primary-Primary Prevention Interventions targeting mother's oral health

Study	Type of Study	Population	Interventions	Findings and conclusions	Quality Rating
Ercan et al., 2007 )	Non randomised trial conducted in Turkey	Test group: 8 tribal women and their 11 children in early primary dentition  Control: 9 mothers chosen at end of study (4 years) for comparison- different tribe, same village with their 9 children	Test: mothers had OHI, SRP, ART treatment of carious lesions, sealing, CHX rinses  Control: no treatment	Test group: starting point DMFT= 4.5 ± 3.7  At end of four years:  1. control children: 9 had caries vs only 2 children in test group 2. numbers of teeth affected: control had 21 total teeth affected vs only 2 in test group	Low
Thorild et al 2006	RCT conducted in Sweden	173 mothers of newborn babies with high salivary counts of MS	Group 1: chewed gum with xylitol  Group 2: chewed gum with CHX  Group 3: chewed gum with sodium fluoride  Control: reference group of mothers with low /medium MS counts who did not chew gum	At 18 months significantly lower MS colonisation of children whose mothers chewed xylitol and CHX compared to fluoride gum.  At three years lower MS levels and caries were found in the children whose mothers chewed the xylitol and CHX gum but this was not statistically significant.  This intervention in low caries populations may not be efficient.	Low

Türksel Dülgergil et al., 2004	Non-randomised trial (pilot study) conducted in rural Turkey	27 infant-mother pairs  Control: 12  Test group: 15	Control group: mothers simple care and advice (simple OHI, ART of cavitated lesions)  Test group: preventive and operative regimen (detailed OHI, sealing 6's, ART, twice daily CHX rinse for 10 days and then 2 times per year)	Annual incremental occurrence of caries determined for mother and child  New carious lesion (dfs) at 2 years:  1. control group: $3.17 \pm 1.70$ 2. test group: $0.20 \pm 0.56$ Concluded that preventive and operative regimen designed to reduce oral bacteria levels was 'remarkably' effective in reducing the incidence of caries in infants in rural Turkey	Low
Zanata et al., 2003	RCT in Brazil	100 pregnant women in 2 <sup>nd</sup> or 3 <sup>rd</sup> trimester with three or more active carious lesions in smooth surfaces  Control: 50 women  Experimental: 50 women	All patients had through initial oral examination  Control group: oral education including OHI via an instructive video and diet advice and all cavities filled  Test group: preventive advice as above but also included extractions, endodontic, SRP, carious lesions restored, NaF application  Education message repeated for both groups 6, 12 and 24 months after delivery,	34 experimental and 30 control patients completed all 30 months  At 24 months:  1. No significant difference in control and experimental mothers had caries increment (white spot and cavitated lesions) $6.2 \pm 5.7$ and $5.2 \pm 4.5$ 2. 66.7% and 85.3% of children from experimental and control mothers respectively were caries free but this was not statistically significant	Low
Gomez and Webber	Non-randomised	Test group: 930 women enrolled at navel hospital and 1-3.5 years	Test group: mothers had examination, education, OHI, CHX, SRP, dietary	Overall:  1. Test group % caries free was 97% 2. Control group % caries free was 77%	Low

2001	trial in Chile	later 180 of their children were examined  74% drop out.  Control group: 180 mother child pairs who did not participate	counselling every 6 months  Results determined from examination of children	Children who were aged 3.5 years  1. test group % caries free was 94% vs 2. control group % caries free was 58%  Concluded that preventive dental program targeting pregnant women and continued after birth of their children was highly effective in preventing and delaying the development of dental caries	
Isokangas et al 2000	RCT conducted in Finland		Group 1: chewed xylitol gum  Group2: CHX varnish  Group 3: fluoride varnish	At the age of five years the children of mothers who chewed xylitol gum had 71% reduction in caries when compared to the fluoride or CHX groups	Medium
Günay et al., 1998	Non-randomised trial conducted in Germany	Phase 1: 86 pregnant mothers  Phase 2: 60 mothers and their babies (children 0-3 years)  Phase 3: 47 mothers (children 4-6 years)  Controls: 65 three year old children and 45 four year old children	Phase 1: examination, OHI, SRP, diet counselling, F varnish application, CHX mouthwashes, referral to dentist for restorative treatment and advice on aetiology of caries  Phase 2: mothers preventive care every 6 months until children were 3 years	At Phase 2, all test children were caries free  At phase 2- control children only 81.5% were caries free  At phase 3, 91.5% of test children were caries free  At phase 3, 42.3% of control children were caries free  Throughout study mothers oral health improved markedly	Low

**CHX- chlorhexidine, OHI- oral hygiene instruction, ART- atraumatic restorative treatment, SRP- scaling and root planing, F- fluoride, MS - mutans streptococci**

Table 5B: Health Education Interventions targeting mothers

Study	Type of Study	Population	Interventions	Findings and conclusions	Quality Rating
Feldens et al 2007	RCT in Sao Leopoldo, Brazil	Intervention group: 200 mothers  Control group: 300 mothers	Intervention group received home visits to educate on breast feeding and healthy weaning (9 visits over 12 months)  Control: standard care	At twelve months of age intervention group had significantly less caries than control (10% vs 18%).  Intervention group also had longer duration breastfeeding, later introduction of sugar and better dietary habits.	Medium
Wenstein et al 2004 & 2006	RCT, High risk population in Canada	240 Punjabi infants and mothers	Intervention: pamphlet and video and 45 minute MI counselling session and 6 follow up phone calls  Control: Pamphlet and video only	Results at one year and at year two children of mothers receiving MI had significantly lower caries.  MI shows promise in high risk groups	Medium
Kowash 2000	RCT high risk population in UK?	228 Mother-Child dyads living in low SES are of Leeds	Intervention groups: A) DHE focused on diet; B) DHE focused on oral hygiene instruction (OHI) using fluoride	Significantly lower dental caries experience (prevalence) and risk factors than children in the control group.  Another benefit was a significant improvement in the mothers oral health as measured by gingivitis, plaque and calculus by the end of the study	Medium

			<p>toothpaste; and C)</p> <p>DHE by a combined diet and OHI message.</p> <p>D) was given diet and OHI, at home, once a year only.</p> <p>E) received no DHE and were never visited but examined at 3 years of age only.</p>		
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**RCT – randomised controlled trial , MI – motivational counselling DHE – dental health education**

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