THE PRETERM CHILD IN DENTISTRY

Behavioural aspects and oral health
THE PRETERM CHILD IN DENTISTRY – BEHAVIOURAL ASPECTS AND ORAL HEALTH
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Behavioural aspects and oral health

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Dedicated with gratitude to all the children, both preterm and full-term and their parents for their participation in the studies.
## CONTENTS

**PREFACE**........................................................................................................... 11

**ABSTRACT** .......................................................... 13  
  Background .................................................................................................. 13  
  Aims ............................................................................................................ 13  
  Materials and methods ................................................................................ 13  
  Results of the four papers ........................................................................ 14  
    Paper I ..................................................................................................... 14  
    Paper II .................................................................................................. 14  
    Paper III .................................................................................................. 14  
    Paper IV ................................................................................................ 14  
  Conclusions and clinical implications ....................................................... 15

**POPULÄRVETENSKAPLIG SAMMANFATTNING** ............... 17  
  Konklusion och klinisk betydelse ............................................................. 18

**LIST OF ABBREVIATIONS** ........................................... 19

**INTRODUCTION** .............................................................. 21  
  Prematurity ................................................................................................ 21  
  Definitions ................................................................................................. 21  
  Epidemiology ............................................................................................. 22  
  Aetiology ...................................................................................................... 23  
  Survival ........................................................................................................ 23  
  Outcomes of preterm birth ......................................................................... 24  
  Complications during the neonatal period ............................................ 24  
  Pain and stress .......................................................................................... 26
Health outcomes .............................................................. 27
Neurodevelopmental outcomes, cognitive functions,
and behavioural and social emotional problems ............... 27
Oral health outcome of preterm birth .................................. 29

AIMS ................................................................................. 35
  Paper I .............................................................................. 35
  Paper II ............................................................................. 35
  Paper III ........................................................................... 35
  Paper IV ............................................................................ 35

HYPOTHESES .................................................................. 37
  Paper I .............................................................................. 37
  Paper II ............................................................................. 37
  Paper III ........................................................................... 37
  Paper IV ............................................................................ 37

MATERIALS AND METHODS ........................................... 39
  Dental care system for children in Sweden ....................... 39
  Study area ......................................................................... 39
  Subjects and sampling procedures .................................. 40
    Papers I-III ..................................................................... 40
    Paper IV .......................................................................... 41
  Ethics ................................................................................ 42
    Ethical consideration in research involving children .......... 43
  Methods ........................................................................... 45
    Dental behaviour management problems (BMP) .............. 45
    Dental fear and anxiety (DFA) ........................................ 46
    Developmental defects in enamel (DDE) including .......... 46
    Molar-Incisor Hypomineralization (MIH) ......................... 46
    Oral health behaviour .................................................... 47
    Dental caries, dental plaque and gingivitis ...................... 47
    Medical health ................................................................ 47
  Statistical methods .......................................................... 48

RESULTS ............................................................................ 49
  Analyses of non respondents and dropouts ....................... 49
  Dental behaviour management problems (BMP) ............... 49
This thesis is based on the following papers, which are referred to in the text by their Roman numerals I-IV.


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ABSTRACT

Background
Advancements in medical care have enabled more children born preterm to survive and develop as healthy individuals alongside their full-term peers. However, a higher frequency of medical health problems, cognitive and behavioural disturbances, including problems in school, has been reported. There is limited knowledge about how this affects preterm children (PT) in dentistry, and few studies have evaluated behavioural problems related to dental treatments and oral health in PT as compared with full-term control children (C).

Aims
The overall objective was to investigate behavioural problems related to dental treatments and the oral health in PT born between 23 and 32 weeks of gestation as compared with full-term C. Specific aims were to analyze behaviour management problems (BMP), dental fear and anxiety (DFA), prevalence of Molar-Incisor Hypomineralization (MIH), oral hygiene, gingival health, and dental caries in PT and full-term C.

Materials and methods
The study group comprised all children born between 23 and 32 weeks of gestation in the catchment area of the University hospitals of Lund and Malmö in southern Sweden. The subjects in Papers I-III were PT and matched full-term C, followed from preschool years to adolescence. In Paper IV, a new group of children, living in the city of Malmö was identified, the subjects being 10-to-12-year old PT and matched full-term C.
Information about dental treatment, oral health and oral health related factors were obtained from dental records, interviews, questionnaires and clinical examinations.

**Results of the four papers**

**Paper I**
BMP and dental caries was studied in 187 PT and 187 C, based on notes in dental records at 3 and 6 years of age, and during the preschool period (3-6 years). At age 3, but not at age 6, the prevalence of BMP at dental examinations were more common in PT than in C. At various kinds of dental treatments during the preschool period, PT presented more frequently with BMP. No differences were found regarding dental caries.

**Paper II**
Parents of 153 PT and 153 C were interviewed on two occasions, two years apart (preschool period and early school years) regarding experience of their child’s dental care, oral health behaviour and medical health. BMP were reported more common in PT than in C during preschool period but not during the early school years. PT also reported more medical health problems than C.

**Paper III**
At 12-14 years of age, 109 PT and 108 C took part in a questionnaire study, including, the Children’s Fear Survey Schedule – Dental Subscale (CFSS-DS) to measure the level of DFA, oral health behaviour and medical health. Few PT and C reported DFA. PT reported more daily use of dental floss and use of extra fluoride supplements than C. Further, PT reported more medical health problems than C.

**Paper IV**
Eighty-two PT and 82 full-term C, aged 10 to 12 years, were clinically examined regarding the prevalence and severity of MIH as well as their levels of oral hygiene and gingival health. In addition, BMP and dental caries were recorded. MIH was more common in PT than in C. Low gestational age and low birth weight increased the risk of MIH. PT had more plaque and gingival inflammation
and presented more BMP than C. No difference in caries prevalence was found.

**Conclusions and clinical implications**

In 3-to-10-year-old PT and matched full-term C, and based on dental records and parental reports, it was concluded that BMP were more common in PT than in C during the preschool period. The difference decreased with increasing age and during the early school years there were no differences between the groups. However, at clinical examination at the age of 10-12 years, PT presented with BMP more frequently than C.

During adolescence, based on the youngsters’ own viewpoints, few PT and C reported DFA.

The clinical examination at 10-to-12 years of age showed that PT had a higher prevalence of Molar-Incisor Hypomineralization (MIH) than C, and low gestational age and low birth weight increased the risk of MIH. At this age, PT also had less favorable oral hygiene and gingival status than C.

Problems with toothbrushing were more commonly reported in PT than in C during the preschool period. During adolescence, PT reported more daily use of dental floss and extra fluoride supplements than C.

Regarding caries prevalence, there were no differences between the groups in either the primary or in the permanent dentition. In contrast, PT had more medical health problems, persisting from preschool period into adolescence than C.

The results in this thesis indicate more behavioural problems related to dental treatments and more oral health problems in PT than in C. Therefore, PT require special attention from the dental services, with treatment planning and prevention strategies from an early age. Collaboration between medical and dental health care professionals is advocated in order to ensure good oral health in PT.
Allt fler för tidigt födda barn överlever tack vare en avancerad intensivvård, vilket innebär att tandvården möter en ny grupp av patienter som är födda 3 till 4 månader för tidigt. Många av dessa barn riskerar att få bestående fysiska och psykiska problem.

Det finns mycket få studier som utvärderar oral hälsa hos för tidigt födda barn eller hur de klarar sin tandvård. Avhandlingens övergripande mål har varit att analysera olika aspekter av tandvårdsbeteende och oral hälsa hos för tidigt födda barn.

Samtliga barn födda före graviditetsvecka 32 i Malmö Lunds sjukvårdsdistrikt ingick i studierna. I delarbete I-III följdes en grupp för tidigt födda barn och matchade fullgångna kontrollbarn från förskoleålder till tonår. Delarbete IV inkluderade en ny grupp 10-12 år gamla för tidigt födda barn och kontrollbarn.

I delarbete 1 studerades tandvårdssjunker för 187 tidigt födda barn och 187 fullgångna kontrollbarn vid 3 och 6 år samt under förskoleperioden (3-6 år). Uppgifter om psykologiska behandlingsproblem och karies registrerades. Behandlingsproblem var vanligare bland de för tidigt födda barnen, medan det inte förelåg några skillnader mellan grupperna avseende karies.

I delarbete II intervjuades föräldrar till 153 för tidigt födda barn och 153 matchade fullgångna kontrollbarn vid två olika tillfällen med 2 års mellanrum (förskoleålder, tidig skolålder). Syftet var att studera
föräldrars syn på barnens tandvård, tandhälsa och tandvårdsvanor. Föräldrarna till de för tidigt födda barnen rapporterade mer behandlingsproblem i förskoleåldern, men inte i skolåldern. De rapporterade också mer medicinska problem än föräldrarna till kontrollbarnen.

I delarbete III, när barnen var 12-14 år gamla, deltog 109 för tidigt födda barn och 108 fullgångna kontrollbarn i en enkätstudie. Syftet var att studera upplevelser av tandvård samt förekomst av tandvårdsrådsla, tandvårdsvanor och allmän hälsa. Studien visade inga skillnader mellan grupperna avseende tandvårdsrådsla eller andra faktorer kopplade till tänder och tandvård. De för tidigt födda ungdomarna rapporterade mer flitig användning av tandtråd och extra fluor och hade mer allmänna hälsoproblem än kontrollerna.

I delarbete IV undersökt kliniskt 82 10-12 år gamla för tidigt födda barn och 82 matchade kontroller avseende emaljavvikelser (MIH), förekomst av plack, gingivit, karies samt psykologiska behandlingsproblem. Studien visade att för tidigt födda barn hade högre förekomst av MIH, hade mer plack och gingivit samt uppvisade mer psykologiska behandlingsproblem jämfört med de fullgångna kontrollbarnen. Tidig födsel och låg födelsevikt ökade risken för MIH. När det gäller kariesförekomst sågs inga skillnader mellan grupperna.

**Konklusion och klinisk betydelse**

LIST OF ABBREVIATIONS

ADHD  attention deficit hyperactivity disorders
BMP   behaviour management problems
BPD   bronchopulmonary dysplasia
C     full-term control children (≥ 37 gestational weeks)
CNS   central nervous system
CP    cerebral palsy
CPAP  continuous positive airway pressure
CFSS-DS children’s fear survey schedule-dental subscale
DDE   developmental defects in enamel
DFA   dental fear and anxiety
dft   decayed filled teeth in the primary dentition
DFT   decayed filled teeth in the permanent dentition
EPT   extremely preterm children (gestational weeks 23-28)
ELBW  extremely low birth weight (< 1 000 grams)
FT    full-term born children (≥ 37 gestational weeks)
INT1  first interview covering preschool years
INT2  second interview covering the early school years
IVH   intraventricular haemorrhage
IQ    intelligence quotient
LBW   low birth weight (< 2 500 grams)
MIH   molar-incisor-hypomineralization
NEC   necrotizing enterocolitis
OR    odds ratio
PFM   permanent first molar
PPROM preterm premature rupture of membranes
PT    preterm children (gestational weeks 23-32)
PVL   periventricular leukomalacia
RDS  respiratory distress syndrome
ROP  retinopathy of prematurity
SGA  small for gestational age
UNICEF the United Nations Children’s Fund
VPI  visible plaque index
VPT  very preterm children (gestational weeks 29-32)
VLBW very low birth weight (< 1 500 grams)
WHO  World Health Organization
WHO-PT preterm children (gestational weeks 33-36)
INTRODUCTION

Prematurity
Definitions
According to the World Health Organisation (WHO), a full-term infant is a child born after at least gestational week 37, or with a birth weight of 2 500 g or more [1, 2]. Infants born between gestational weeks 33 and 36 are defined as preterm (WHO-PT), between gestational weeks 29 and 32 as very preterm (VPT) and born before gestational week 29 as extremely preterm (EPT) [1, 2].

In this thesis, the term preterm (PT) will be used to describe children born at 32 weeks of gestation or earlier, which is not in line with the WHO-PT definition given above. VPT as used here represents children born from 29 to 32 weeks of gestation, and EPT children born from 23 to 28 weeks of gestation.

Figure 1. Categorization of pregnancy lengths. EPT = extremely preterm; VPT = very preterm; PT = preterm; WHO-PT = born between gestational weeks 33 and 36; FT = full-term.
However, preterm is also defined in terms of birth weight, and classified as low birth weight (LBW), <2500g, very low birth weight (VLBW), <1500g and extremely low birth weight (ELBW), <1000g [1, 2]. It is routine in Sweden to estimate the gestational age by ultrasound examination, and considered to give a good description of the maturity of the preterm infants, better than birth weight, since a low birth weight infant can be mature but small for gestational age [3].

Epidemiology
Worldwide, the incidence of preterm birth varies. According to a recent review, preterm birth is estimated globally at 9.6%, with the highest rates in Africa (11.9%) and North America (10.6%), and the lowest in Europe (6.2%) [4]. In spite of modern technology, knowledge of the mechanisms underpinning preterm birth, and the development of assessment strategies, the rate of preterm birth has increased worldwide [5] and today the relatively high incidence of preterm birth is regarded as a public health problem across the globe [4].

The most recent statistics concerning Swedish infants born full-term, WHO-preterm (WHO-PT), very preterm (VPT) and extremely preterm (EPT), and the survival rates at 1 year of age are presented in Table 1.

Table 1. Data from Swedish Medical Birth Register for 2008 [6].

<table>
<thead>
<tr>
<th>Gestational age (in weeks)</th>
<th>Number of births (N)</th>
<th>Percentage of all births (%)</th>
<th>Survival 1-year (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FT</td>
<td>≥ 37</td>
<td>100 131</td>
<td>94.1</td>
</tr>
<tr>
<td>WHO-PT</td>
<td>33-36</td>
<td>4 989</td>
<td>4.7</td>
</tr>
<tr>
<td>VPT</td>
<td>29-32</td>
<td>851</td>
<td>0.8</td>
</tr>
<tr>
<td>EPT</td>
<td>&lt; 29</td>
<td>457</td>
<td>0.4</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>106 428</td>
<td>100</td>
</tr>
</tbody>
</table>
Aetiology
Preterm birth has been associated with several factors, either medically indicated, or spontaneous [4, 5]. Examples of preterm birth attributable to medical conditions include fetal or maternal illness such as infection or maternal pre-eclampsia leading to fetal distress and poor fetal growth. Most preterm births are caused by spontaneous preterm labour, either spontaneously triggered or following preterm premature rupture of the membranes (PPROM) [5]. The reasons for PPROM are multifactorial. Infection or inflammation, vascular disease, and uterine or cervical abnormalities have been suggested as aetiologies [5]. Epidemiological studies have identified a clear association between preterm birth and previous preterm delivery, ethnic factors, low maternal body mass index, and maternal smoking during pregnancy [5]. Periodontal disease during pregnancy has also been associated with preterm birth caused by pre-eclampsia [7].

Survival
Advances in medical care in recent decades have resulted in increasing numbers of preterm survivals. The one year survival rates of Swedish infants according to Swedish Medical Birth Register [6] are shown in Table 1. Such rates vary significantly among countries as well as within them, and are further, influenced by gestational age, birth weight, and sex [8, 9]. They also reflect variations in perinatal care management, such as decision making concerning initiation or withdrawal of treatment [9].

Today, the survival rate for the most immature infants has increased thanks to technological and pharmacological advances at neonatal intensive care units. Still, there are few survivors of birth at 22 weeks of gestation [9]. In Sweden, a recent study reported an overall one-year survival rate of 9.8% in infants born at 22 weeks of gestation, 53% survival at 23 weeks gestation and 67% survival at 24 weeks gestation. At 26 weeks of gestation the survival rate was 85% [9]. This may be compared with population-based studies in Europe with reports of 0% survival rate at 22 weeks of gestation, a variation from 6 to 26% at 23 weeks of gestation and 29% to 55% at 24 weeks of gestation [9-14]. It should also be noted that neurodevelopmental disabilities, according to some studies, have not decreased with increased survival rates [11, 15, 16].
Outcomes of preterm birth
The improved survival rates have, however, been accompanied by an increased incidence of a broad range of neurodevelopmental impairments [16-18]. Preterm birth is not a condition with a fixed set of outcomes. Instead, it increases the risk of adverse outcomes also seen in full-term infants. Nevertheless, the risk of impairments increases with decreasing gestational age and birth weight [15, 18], resulting in disabilities in multiple developmental domains [17, 18]. Complications in the premature infant may be of a short-term nature, occurring in the neonatal period (e.g. respiratory and cardiovascular complications) or long-term sequelae, e.g. neurodevelopmental disabilities.

Complications during the neonatal period
Complications are likely to arise in infants born <35 weeks of gestation since these infants have immature organ systems that are not yet prepared to support life in the extrauterine environment [19]. Therefore, preterm infants need basic additional support with nutrition, heat, and respiratory and circulatory monitoring [19]. The most fragile and vulnerable organ systems are the brain, the lungs, the intestines and the eyes [20].

Preterm infants primarily risk two lung-related injuries; one acute, respiratory distress syndrome (RDS) and one chronic progressive lung disease, bronchopulmonary dysplasia (BPD) [21]. RDS is a major cause of mortality and morbidity in preterm infants [20, 21]. The aetiology is lack of surface tension, reducing the surfactant that helps the lungs inflate air and keeps the alveoles from collapsing. The condition requires continuous respiratory support including oxygen, CPAP, (Continuous Positive Airway Pressure), surfactant administration and ventilator treatment [20, 21].

Preterm infants may experience dysfunctional autoregulation of blood vessels. For the preterm infant the circulation of the blood must be adjusted to a life with lungs and without the placenta. In the fetal period, the exchange of oxygen occurs in the placenta and the fetal blood flow bypasses the lungs through the ductus arteriosus [19]. Normally, ductus arteriosus closes after birth when the lungs expand. In the preterm infant it sometimes does not close properly, leading to heart failure and reduced blood flow to vital
body organs which may, in turn, increase the risk of IVH, BPD and NEC [19]. A patent ductus is closed by medication and in some cases by surgery [19].

Moreover, the preterm infant is at increased risk of infections, such as septicaemia, pneumonia and, in severe cases, meningitis. The immune system is immature, and the skin is not fully developed to serve as an effective barrier to infection [22].

Feeding difficulties are another common type of complication [23]. The immature gastrointestinal tract has difficulties in digesting food, which is necessary for ongoing growth and development. Preterm infants <32 weeks of post-conceptual age (related to the estimated day of fertilization) are neurologically immature and have difficulties in coordinating sucking, swallowing and breathing [23]. There is also a more general influence of the infant’s medical health status, and many preterm infants need naso-gastric tube feeding [23, 24]. The most preterm infants will also need parenteral nutrition for a long time [25].

Necrotizing enterocolitis (NEC) is an acute injury of the small and large intestines that lead to inflammation and injury to the bowels. It primarily affects infants born preterm [26]. The cause, like most other complications of preterm birth, is multifactorial, and associated with decreased intestinal blood flow and infections [26].

Injury to the CNS can occur during pregnancy, delivery, transition to the extrauterine life or be a result of later illness. In preterm infants the white matter around the ventricles and the highly vascular germinal matrix are especially vulnerable [20]. Since cerebral autoregulation is not fully developed in a preterm infant, the cerebral blood flow is not maintained adequately despite changes in blood pressure [20], and brain damage may result. One common sign of brain injury in preterm infants is haemorrhage from the immature vessels, in the mildest form confined to the subependymal layer or in a more severe form with free blood seen in the intraventricular cavity (IVH; intraventricular haemorrhage) [20]. The preterm infant is at special risk of cerebral white matter injury, which is a spectrum of CNS injuries, including periventricular leukomalacia (PVL) [27]. Today PVL is considered to be the most common form of injury to the preterm brain [27, 28]. A complex interplay of aetiological factors predispose, such as immature vascular system, ischaemia,
infection and inflammation, and poor autoregulation of cerebral blood flow, causing hypotension or hypertension [27, 28].

There is a risk of cerebral injury in the early neonatal period caused by the vulnerable vascular supply to the brain, and resulting in cerebral palsy (CP) [20]. The combination of both the bleeding and cysts created in the area of the ventricles and motor region may cause CP [20]. One Swedish study reported that 7.7% of infants born before 28 weeks of gestation and 4% of infants born between 28 and 31 weeks of gestation developed CP [29]. However, a recent study reported a steadily decreasing trend in the prevalence of CP in Swedish preterm children [30].

Retinopathy of prematurity (ROP) is the most common eye abnormality in preterm infants, and is a vascular disease that affects the immature retinal vessels. In the worst case it can result in subsequent blindness [31]. The most important risk factor for ROP is low gestational age at birth [31].

Pain and stress
An important area of pain research today concerns pain development in newborn infants, with the aim of better understanding the developmental neurobiology of the pain, in order to improve pain management in newborn infants [32]. It is also of interest to study clinical effects of early pain exposure on neurodevelopment and how such exposure possibly contributes to later attention, learning, and behavioural problems [33-35]. The definition of pain includes not only a physical sensation of noxious stimulus and disease, but also a conscious experience with both sensory and emotional components that permit recognition of a stimulus as unpleasant [36]. Consequently, the capacity for conscious perception of pain can arise only after the thalamocortical connections are established, which occurs from about 25 weeks of gestational age [37].

In the neonatal intensive care unit, preterm infants are exposed to multiple stressors. Furthermore, the impact of frequent pain, stress response and long-term consequences of pain on neurodevelopment is a complex relationship and varies with timing, type, and degree of the pain causing injury [34]. Frequent painful experiences in the neonatal care unit include exposure to light and noise, invasive procedures, intubations, repeated blood tests, and medication, some
or all of which may be needed for weeks or even months. This might lead to structural and functional alterations of the nervous system, and children born preterm are known to remain more sensitive to pain through childhood than full-terms [34]. Although the long-term outcome of neonatal pain is difficult to isolate in human infants, there is increased support for the viewpoint that early exposure to repeated procedural pain in neonatal intensive care contributes to functional changes in pain sensitivity which in turn, affects cognition, behaviour and learning in a long-term perspective [33-35]. One recent study revealed that pain-related stress in very preterm infants during neonatal intensive care was associated with poorer cognitive and motor development in the in first two years of life [35]. This finding indicates that the preterm children’s experience of pain during neonatal intensive care might influence later behaviour and pain sensitivity even in dental treatment, although this has not yet been studied.

Health outcomes
Medical health problems during childhood and adolescence are more commonly reported in VPT and EPT as well as in VLBW and ELBW than in full-term children [38-43]. These reported health problems include asthma, chronic lung disease, respiratory infections, retinopathy of prematurity, other ophthalmic problems, and hearing impairments [38-43]. Further, VPT used health care services more frequently both during their first year of life [42, 44] and later on [42, 45]. This reflects preterm children’s compromised health status during childhood.

Neurodevelopmental outcomes, cognitive functions, and behavioural and social emotional problems
Several studies have documented the prevalence and described the spectrum of neurodevelopmental impairments attributable to prematurity [15-18, 46-52]. Many of these complications imply lifelong consequences for health, growth and development [49-52]. The literature presents wide variations in prevalence of neurodevelopmental outcomes owing to methodological issues, length of follow-up, selection criteria, outcome measures, diagnostic criteria, differences in study populations, and in treatment strategies in the
Neurodevelopmental disabilities are a group of chronic interrelated disorders of the central nervous system function due to malformation of or injury to the developing brain [27, 28], and the risk of impairments increases with decreasing gestational age and birth weight [15, 17, 18, 48, 53]. Neonatal illnesses, such as BPD are considered risk factors for neurodevelopmental impairments [48]. The spectrum of neurodevelopmental disabilities observed during early years of life includes low developmental scores, cerebral palsy, visual and hearing deficits, feeding difficulties, and delayed language skills [39, 46]. A prevalence of approximately 60% disabilities in one or more different domains have been reported in preschool children born <30 weeks of gestation [17]. At the same time, over, 25% in that study had no disabilities or no school problems [17]. In schoolchildren born extremely preterm a recent study reported a disability prevalence of 45% when combining impairment across domains, compared with 1% in full-term peers [18].

Several follow-up studies focus on the cognitive outcome of prematurity, which includes school problems at an early age [17, 54]. In children born before 26 weeks of gestation, cognitive impairments and general behavioural problems at early ages are more common than neuromotor, neurosensory, hearing, or vision problems. During the school years these problems are even more pronounced [46].

Cognitive functions include e.g. intelligence, executive function, perceptual motor skills, and verbal list learning and memory. Preterm children are frequently reported to have impairments in these specifically neurocognitive functions [55-58]. In a 10-year follow-up of EPT, Stjernqvist and Svenningsen [55] found that 70% had an IQ below 100, as compared with 30% in full-term controls, and almost half of the children performed poorly at school. These findings were supported in another Swedish follow-up of 10-to-12-year-old EPT children [40].

School problems may contribute to special educational needs [46], and are associated in preterm children with poor academic achievement [49, 57-60], that persist into late adolescence and adulthood [48, 51, 52, 59, 60]. Furthermore, impaired motor development, commonly reported in preterm children, may contribute to later poor cognitive functioning and learning disabilities [53, 61], especially concerning processing speed and working memory [60, 61].
Cognitive processes are associated with executive functioning and have been identified as strongly influencing academic, social and behavioural functioning [49]. Executive functioning overlaps with domains such as attention, reasoning, planning, organizing, initiation of activity, flexibility, and working memory [62]. Mathematical difficulties in preterms have been demonstrated to result from deficits in executive functioning [63]. Furthermore, research has pointed out the importance of executive dysfunction in disorders such as ADHD, and autism [62]. EPT have been reported as being more than three times more likely to have neuropsychiatric disorders such as ADHD, emotional disorders or autism spectrum disorders than their classmates [64].

VPT/VLBW are at significant risk of behavioural and emotional problems and when cognitive or motor difficulties are present, and if their socio-economic backgrounds are weak the risk also increases [65]. Behavioural and social emotional problems in general are clinically defined through self-reports, parental or teachers report. The spectrum of behavioural problems reported in preterm children concerns e.g. problems with attention, hyperactivity and adaptive functioning [55, 66, 67]. Stjernqvist and Svenningsen [55] found in their 10-year follow-up study that Swedish EPT were more anxious and shy, or more troublesome and aggressive than the controls. In addition, preterm young adults were reported to have behavioural problems and social emotional problems like anxiety and depression more often [48, 67-69]. In spite of this, they were adapting well to society and functioned just as well as their counterparts [59, 66, 70].

Oral health outcome of preterm birth
Follow-up of preterm infants has focused primarily on medical and neurodevelopmental outcomes. However, oral health may also be affected as a result of medical problems in the neonatal period. A complicated delivery, brain injury, RDS, infections, feeding difficulties, etc., may well affect oral health outcomes.

Behaviour management problems (BMP)
Dental behaviour management problems (BMP), defined as uncooperative behaviour leading to delay of treatment or rendering treatment impossible [71], are based on the dentist’s observation
of child behaviour and acceptance during dental treatment. Dental examinations and treatments are demanding experiences for all young children. A visit to the dental clinic may include several stress evoking components like strange surroundings, meeting unfamiliar people, novel sounds and tastes, strong light, lack of control and an obvious risk of stress, discomfort or even pain. However, children have different experiences and levels of maturity. Although previous studies indicate that young children’s acceptance of dental treatment increases with mental development [72], some children are tolerant while others are more vulnerable in stressful situations. Besides age and maturity, basic personality traits, intellectual capacity, temperament and emotions, experience from dental treatments, and also parents’ experiences and attitudes as well as the dental team’s empathy and care have been suggested to strongly influence the child’s behaviour and ability to cooperate in the dental situation [71-73]. Population-based studies show that dental BMP is common, with prevalence figures of 8-18% in children aged 4 to 11 years of age [71, 73].

BMP are more commonly reported in children who have experienced painful treatments than in those limited or no exposure to such treatments [71, 74, 75]. As evident from the above, many of the PT been gone through numerous medical procedures that may have been painful, and studies have shown that this early exposure to repeated procedural pain in neonatal intensive care leads to changes in pain sensitivity that affect behaviour later in life [33-35]. In what way this may have consequences for dental treatment has not been studied, but it is reasonable to assume that early pain related stress also contributes to greater sensitivity to dental treatments and could also result in more dental BMP in preterm children. On the other hand, if the children have positive experiences from different treatments this can promote stability and reduce stress, i.e. function as a vaccination against fear and anxiety, also referred to as latent inhibition [76, 77]. Great efforts have been made in recent years to reduce or prevent pain in medical care for children. This could have positive effects on the dental treatment situation and, indirectly, on the oral health.
**Dental fear and anxiety (DFA)**

Dental fear and anxiety (DFA) is related to behaviour management problems (BMP) but the terms are not synonymous. While BMP represents what the dentist observes, DFA refers to the patient’s perceptions and experiences. Several factors are related to the occurrence of BMP and DFA (Figure 2).

**Figure 2. Different factors related to behaviour management problems (BMP) and dental fear and anxiety (DFA) [78].**

![Diagram showing different factors related to behaviour management problems (BMP) and dental fear and anxiety (DFA)]

- **Personal**
  - Maturity (age)
  - Temperament
  - Psychiatric problems
  - “Present fitness”

- **Child**

- **BMP**

- **DFA**

- **Parents/family**
  - Knowledge, attitudes
  - Family and social factors

- **Dental team**
  - Painful treatment
  - Lack of control

DFA is also more common in young children [71], reflecting the influence of a child’s normal psychological development on the coping ability [72]. A fearful reaction is a natural feeling for a young child and must be distinguished from anxiety that develops later in childhood. According to Klingberg and Broberg [72] the definition of dental fear (DF) is a normal emotional reaction to one or more specific threatening stimuli in the dental situation. Dental anxiety
(DA) denotes a state of apprehension that something dreadful is going to happen in relation to dental treatment, coupled with a sense of losing control. DFA combine these entities [72]. The most commonly used questionnaire to measure DFA in children and adolescents is the Dental Subscale of Children’s Fear Survey Schedule (CFSS-DS) [79]. This instrument is available in two versions, one to be answered by parents and one to be answered by children and young people. A score $\geq 38$ has been suggested to define DFA [80]. In a systematic review [72], a pooled prevalence of DFA was approximately 9% in children and adolescents but the figures varied from 6 to 20% in the 12 studies from the different countries included. The correlation between children’s and parents’ ratings of the children’s DFA has been debated, and a recent study showed that there was not a perfect match [81].

**Developmental enamel defects (DDE) including Molar-Incisor Hypomineralization (MIH)**

Clinical studies have revealed a higher prevalence of enamel hypomineralization in both primary [82-84], and permanent dentitions [84, 85] in preterm children as compared with full-term children. The clinical findings have been confirmed in histological studies [86, 87].

The term Molar-Incisor Hypomineralization (MIH) was introduced as a specific entity in 2001, and describes a disturbance in the early phase of enamel maturation in one or more permanent first molars (PFM), with or without the permanent incisors involved [88]. The prevalence of MIH is reported to vary between 2.4% and 40.2% in normal child populations [89]. There is as yet no information on the prevalence of MIH in preterm children. Enamel is a hard tissue which, once formed, unlike bone, does not remodel. For that reason, insults during enamel development are permanently imprinted. The first permanent molar starts its matrix formation during the fourth month of gestation and the first signs of the mineralization process are seen on the highest point of the crown at or soon after birth. It then progresses downwards [90-92]. Around six months of age the four cusps are united [91, 92]. The deposition of the enamel matrix is completed in the occlusal half of the crown at the end of the first year, and the crown is completed at around 3 years of age [93, 94].
The aetiology of MIH as a specific entity is not fully understood but it is likely that several factors act simultaneously [95]. Potential factors involved are high fever, hypoxia, hypocalcaemia, exposure to antibiotics and dioxins [95], respiratory diseases during infancy [96-98], feeding difficulties and infection [96, 99]. It is not known whether there is a relationship between MIH and preterm birth, or if there is a correlation between the severity of the developmental enamel defects and gestational age at birth.

**Dental caries**
The few studies available on dental caries prevalence in LBW and preterm children have not revealed a higher prevalence of caries in the primary [83, 100-103] or permanent [104] dentitions. However, it is reasonable to assume that enamel defects, commonly reported in preterm children, may predispose for dental caries [83, 101, 102]. In addition, the reported higher frequency of feeding problems in preterm children [105, 106], might comprise a caries risk.

**Dental plaque and gingival health**
Gingivitis is the most common form of periodontal disease in children and adolescents. Bacterial plaque accumulation is the primary aetiological factor; its severity and manifestation is considered to be multifactorial [107, 108]. The presence of plaque retention areas on tooth surfaces such as cavities or enamel defects makes oral hygiene difficult and influences the gingival condition, especially if the defective enamel gives rise to pain during toothbrushing. Toothbrushing is the primary contributor to oral hygiene, and remains the most reliable method of controlling supragingival bacterial plaque. Furthermore, daily toothbrushing with fluoridated toothpaste is considered to be the primary reason for the caries decline observed since the 1970s [109].

Because of possible deficits in fine and gross motor development and manual dexterity [53], preterm children may have reduced or limited plaque removal abilities. In addition, owing to possible cognitive and behavioural problems, preterm children may not have the endurance to manage toothbrushing with the necessary diligence. Neither the level of oral hygiene nor gingival conditions have been assessed in this group of children.
Orthodontic treatment need and craniofacial morphology
Several studies have shown that different malocclusion traits occur more often among preterm born children than in full-term born children [110-112]. A series of studies of orthodontic treatment, craniofacial morphology and function have reported a higher prevalence of malocclusion traits as well as greater need for orthodontic treatment in preterm children as compared with full-term children [112, 113]. Deep bite was the most common malocclusion trait in EPT and VPT [112]. It was also found that EPT had significantly shorter anterior cranial base and less convex skeletal profile, and both VPT and EPT to have shorter maxillary length than full-term children [113].

Tooth-crown dimensions
LBW and prematurity have also been associated with a reduction of the tooth crown size in the primary dentition [114, 115], while there are conflicting results in the permanent dentition [116, 117]. Variation in tooth-crown size of the teeth is claimed to be of multifactorial origin, but strongly influenced by genetics as well as by environmental factors including nutritional factors and developmental disturbances during the prenatal and postnatal periods [117, 118]. Maternal smoking during pregnancy has been pointed out as a possible cause in both primary and permanent dentitions [119, 120].
AIMS

The overall aims of this thesis were to analyse behavioural aspects related to dental treatment and to investigate oral health and related factors in PT born between 23 and 32 weeks of gestation. Comparisons were made with full-term C.

The specific aims were to study:

**Paper I**
- the prevalence of BMP at clinical examination and treatments during preschool years.
- the prevalence of dental caries.

**Paper II**
- the prevalence of BMP, oral health behaviour, and experiences from dental care at preschool and school ages, using the parents as informants.

**Paper III**
- the prevalence of DFA and factors related to oral health in 12-to-14-year-olds.

**Paper IV**
- the prevalence and severity of MIH in 10-to-12-year-olds.
- the relationship between MIH and various health related variables during the pre-, peri-, and postnatal periods.
- the status of oral hygiene and gingival health.
- the prevalence of dental caries and BMP.
HYPOTHESES

When PT (born from 23 to 32 weeks of gestation) are compared with FT it will be found that:

**Paper I**
- PT display BMP more frequently.

**Paper II**
- PT display more BMP and have less favourable oral health behaviour as reported by parents.

**Paper III**
- PT aged 12-14 years more often report DFA than FT.
- No differences in oral health behaviour are seen between PT and FT.

**Paper IV**
- PT aged 10-12 years present a higher prevalence of MIH.
- PT presents higher levels of plaque scores and gingival inflammation.
MATERIALS AND METHODS

Dental care system for children in Sweden
In Sweden regular dental care, including specialist dental care if needed, is free of charge and offered to all children and adolescents up to the age of 19. In the present catchment area, approximately 85% of all children, aged 3-19 years attend the Public Dental Service. Further, about 90% have regular dental check-ups. The intervals between checkups are decided on an individual basis and vary between 12 and 24 months depending on risk assessments.

Study area
The studies were carried out in the southwest part of the County of Skåne in southern Sweden. This is an area of about 4 000 km² with approximately 730 000 inhabitants, representing almost 8% of the total Swedish population [121]. According to the study design, all PT included in the studies were born at the University hospitals of Lund and Malmö, where their births are recorded.

The two main cities in the catchment area are Malmö and Lund. Malmö is the third largest city in Sweden with about 290 000 inhabitants, of whom 30% were born abroad [121]. Lund is a smaller city with almost 110 000 inhabitants, of whom 17% were born abroad [121].

In papers I-III, all participating children were from Malmö or Lund, or in the surrounding smaller towns or villages. In paper IV, all children were from the city of Malmö.
Subjects and sampling procedures
In this thesis the term preterm (PT) is used to describe children born at 32 weeks of gestation or earlier. VPT is used to describe children born from 29 to 32 weeks of gestation, and EPT to describe children born from 23 to 28 weeks of gestation.

Papers I-III
Preterm children
All children born between 23 and 32 weeks of gestation between 1 January 1994 and 31 December 1996 in the catchment area were invited to participate. The Swedish Medical Birth Register provided information on gestational age, birth weight, and number of siblings. A total of 192 eligible PT were identified and invited for participation for Paper I (Figure 3). Participating PT were regular patients at 53 public and 11 private dental clinics. In Paper II the original study groups from Paper I were again invited, and 154 PT entered the study. The first interview (INT1) was conducted in 2004, and 2 years later, the parents were interviewed a second time (INT2). Out of 187 PT, 153 participated in INT1 and 150 in INT2. In Paper III, 109 PT out of 154 eligible PT participated.

Control children
Each PT entering Paper I was matched with a FT control by age, sex, immigrant background (defined as at least one parent born outside the Nordic countries), dental clinic and dental operator. Providing the criteria were satisfied, the child directly following the PT in the patient register at the same dental clinic was chosen as a control (C) (Figure 3). In Paper II, 187 matched controls who had participated in Paper I were eligible for participation. The parents of all C were contacted at both INT1 and INT2, and 153 C were reachable and included at both INT1 and INT2. This corresponded to 152 matched pairs at INT1 and 149 at INT2. In Paper III, 108 C out of 154 eligible C agreed to participate and corresponded to 76 matched pairs.
Figure 3. Flow chart describing the study population of PT, VPT, EPT and C participating in Papers I-III.

<table>
<thead>
<tr>
<th>Eligible</th>
<th>PT</th>
<th>EPT</th>
<th>VPT</th>
<th>Full-term</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=192</td>
<td>N=45</td>
<td>N=147</td>
<td></td>
<td>N=187</td>
</tr>
</tbody>
</table>

**PAPER I**

Study group

| N=187 | N=43 | N=144 | N=187 |

<table>
<thead>
<tr>
<th>Eligible</th>
<th>INT1</th>
<th>INT2</th>
<th>INT3</th>
<th>INT4</th>
<th>INT5</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=135 (152)</td>
<td>N=37</td>
<td>N=116</td>
<td>N=153 (152)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eligible</th>
<th>PT</th>
<th>EPT</th>
<th>VPT</th>
<th>Full-term</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=154</td>
<td>N=37</td>
<td>N=117</td>
<td>N=154</td>
<td></td>
</tr>
</tbody>
</table>

**PAPER II**

Study group

| N=109 (76) | N=27 | N=82 | N=108 (76) |

| *Identified through the Swedish Medical Birth Register | 5 Identified through dental clinics |
| Declined = declined participation. Not retrievable = could not be reached. |
| Excluded = excluded owing to learning disability. ( ) = matched pairs. |

**Paper IV**

*Preterm children*

All children born between 23 and 32 weeks of gestation between 1 January 1997 and 31 December 1999 and living in the city of Malmö in 2009 were eligible. The Swedish Medical Birth Register provided information on gestational age, birth weight, and number of siblings. Ninety-eight PT satisfied the inclusion criteria and were identified. No PT were born in gestational week 23. Parents of 14
PT declined participation, and another 2 were not reachable. The target group thus, consisted of 82 PT and comprised 62 VPT and 20 EPT (Figure 4). The children were 10-12 years of age when the study was conducted.

**Control children**
Matched control children were recruited from the Children’s Dental Clinic at the School of Dentistry, Malmö University. This clinic functions in a way equivalent to a Public Dental Service clinic. The controls were born after at least 37 weeks of gestation and matched for age, sex and immigrant background (defined as at least one parent born outside the Nordic countries). All C agreed to participate. A total of 82 C were included consecutively from the patient list.

**Figure 4. Flow chart describing the study population of PT, VPT, EPT and C participating in Paper IV.**

<table>
<thead>
<tr>
<th></th>
<th>PRETERM CHILDREN</th>
<th>CONTROL CHILDREN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PT</td>
<td>EPT</td>
</tr>
<tr>
<td>Eligible</td>
<td>N=98</td>
<td>N=25</td>
</tr>
<tr>
<td>PAPER IV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study group</td>
<td>N=82</td>
<td>N=20</td>
</tr>
<tr>
<td></td>
<td>14 declined</td>
<td>5 declined</td>
</tr>
<tr>
<td></td>
<td>2 not retrievable</td>
<td></td>
</tr>
</tbody>
</table>

*Identified through the Swedish Medical Birth Register
† Identified through the Children's Dental Clinic at the School of Dentistry, Malmö University
Declined = declined participation. Not retrievable = could not be reached.
* Matched pairs

**Ethics**
The Ethics Committee of the Medical Faculty of Lund University approved the study plans (Papers I-II, Dnr LU 362-01, Paper III, Dnr 618/2007, Paper IV, Dnr 449/2008).
After the Swedish National Board of Health and Welfare granted the authors access to the Swedish Medical Birth Register, all PT who satisfied the study’s inclusion criteria were identified as were C, consecutively.

Written information about the studies, including information on full confidentiality and the right to discontinue participation at any time, was posted to all the parents and the children. A written informed consent form was obtained from parents in the studies presented in Papers I-IV and from children in Papers III and IV. Reminders were sent out twice. After that, no further attempt was made to reach the families.

**Ethical consideration in research involving children**

Involving children in research is problematic from an ethical point of view. Research involving human beings is very much founded on the informed consent procedure, which requires a competent person able to decide for him/herself. This implies a person able to understand the full consequences of the study, aspects of possible risks and benefits, as well as aspects of integrity. Children cannot be presumed to satisfy this requirement. The same applies to other groups with impaired autonomy, e.g. in case of severe illness, learning disability, unconsciousness or communication problems. Thus research on human beings should primarily be research on competent individuals able to give their consent.

However, restricting research to this group would also be problematic, as this would exclude so many people, and research must also be conducted in order to explore and improve health and living conditions for groups other than fully competent adults. This is a delicate ethical dilemma, which requires consideration and reflection from everyone involved.

These aspects of involving children and adolescents in research are expressed in declarations of rights and formulations of laws and proclaimed by UNICEF, and approved in the United Nations Convention on the Rights of the Child from 1989 [122]. This convention deals with the whole spectrum of needs and rights of the child and has set up principles to ensure human rights and legal safeguards for children. It defines a child as below eighteen years of age, implying that not every child has the maturity and development
to participate in the same way children’s age, maturity, physical, and psychological status must be taken into account before involving them as participants in research.

The researcher’s awareness of the balance between the benefits, risks and discomfort of involving children, is another point of view. Participation must imply that adults respect children’s opinions rather than having relationships based on adults’ power over children. The very first consideration must be that the child understands what the project is about, its intentions, and her/his role in it. All children should be treated with equal respect irrespective of their age, ethnicity, disability, views and experience or other factors. Their participation must be voluntary, and children should be allowed to discontinue participation at any stage. Thus, participation should be based on informed consent from each child’s legal guardian (usually the parent), as well as informed consent from the child beginning at an appropriate age, and preferably verbal assent from younger children. The Swedish Ethical Review Act states that children age fifteen or older should themselves give consent to participation [123]. Further, even if the legal guardian gives consent to the child’s participation, the research should not be conducted if the child (regardless of age) understands the research objectives and objects to participation.

It is of vital importance that the quality of research involving patient populations such as children with impairments or special needs is ensured, especially as there are many difficulties and barriers associated with conducting research in these groups of children. Children with disabilities may be vulnerable in the research process owing to diminished communication and understanding ability. It is important to explore all children’s viewpoints, as a contribution to gaining new knowledge and insights to improve rather than to prove the health conditions of patients with different needs.

Regarding PT, advanced medical care have saved many children’s lives. However, survival rate is one thing and ensuring the overall well being of the child and family throughout their lives is another, and an obligation for society. As being PT implies risks of deficits and potential functional consequences, society has an obligation to identify these needs and to help the child have as good health status as possible. Extended follow-up studies are required for assessing the different approaches.
**Methods**

The analyses on which this thesis is based on include data from:

- **Dental records – Paper I.** Notes on behaviour management problems (BMP) collected for the specific ages 3 and 6, as well as for the entire preschool period (3-6 years), plus notes on dental caries (dft).

- **Interviews – Paper II.** Parents were interviewed twice, two years apart, the questions covering the preschool period, and the early school years, respectively. A structured interview protocol was used. Information about BMP, oral health behaviour and medical health were included in both interviews. At the second interview (INT2), questions about sociodemographic characteristics were also included.

- **Questionnaires – Papers III-IV.** In paper III, the 12-to-14-year-old children were asked to fill out the CFSS-DS scale (Children’s Fear Survey Schedule – Dental Subscale) [79]. The questionnaire also included items such as oral health behaviour and medical health. In Paper IV, the parents filled in a structured questionnaire covering possible aetiological factors influencing the prevalence of MIH and oral health.

- **Clinical examination – Paper IV.** Clinical examinations were performed in children ages 10-12, and registrations were made concerning developmental defects in enamel (DDE), including Molar-Incisor Hypomineralization (MIH), and for dental plaque, gingivitis, dental caries (DFT), and BMP. Standardized intra-oral photographs were taken in order to document DDE, including MIH.

**Dental behaviour management problems (BMP)**

*Papers I-II, IV*

The definition of BMP used in Paper I was: disruptive behaviour during dental appointment resulting in delay of dental examination/treatment or rendering dental examination/treatment impossible [71]. In this paper BMP were studied retrospectively from dental records at the target ages of 3 and 6 and for the overall preschool period (3–6 years).

In Paper II, BMP were reported by parents, the definition of BMP was based on a question modified from Holst 1988 [124]: *Have
there been any cooperation problems when seeing a dentist between the ages 3 and 6/7 and 10? Answers were: not at all; just a little, yes rather much, or yes very much. BMP were defined as answers yes rather much, or yes very much.

In Paper IV the children’s abilities to cooperate during clinical examination and intra-oral photography were evaluated. Acceptance was assessed according to Rud & Kisling [125], modified by Holst & Crossner [73] (Appendix A). Negative or no acceptance was defined as BMP [73].

Dental fear and anxiety (DFA)

Paper III
Dental fear and anxiety (DFA) was measured using the Children’s Fear Survey Schedule – Dental Subscale (CFSS-DS) (Appendix B). All children filled in the Swedish version of the scale [79, 80]. CFSS-DS is a self or parental report of 15 items. Total scores range from 15 to 75, and adolescents with a score equal to or exceeding 38 were categorized as having DFA according to Klingberg [80] (Appendix B).

Developmental defects in enamel (DDE) including Molar-Incisor Hypomineralization (MIH)

Paper IV
Clinical registrations were made for developmental defects in enamel (DDE), including Molar-Incisor Hypomineralization (MIH). Hypomineralization (MIH) was defined as demarcated opacity with a diameter exceeding 2 mm, or posteruptive enamel breakdown/atypical restoration/extraction owing to MIH in permanent first molars [126, 127]. Hypomineralized enamel was characterized as enamel of normal thickness with a distinct boundary to the adjacent normal enamel, and could appear as white, creamy, yellow or brown. MIH was classified as mild, moderate or severe according to Jälevik et al. [126] and Weerheijm et al. [127] (Appendix C).

For registration of DDE, an adapted index classifying the enamel defects as demarcated opacities, diffuse opacities and enamel hypoplasia was used [128]. This registration included all permanent teeth.
Standardized intra-oral photographs were taken in order to document DDE and MIH. Calibration was performed regarding diagnoses, and intra- and interexaminer agreement was calculated.

Oral health behaviour
*Papers II-IV*
Items concerning oral health behaviour were answered by the parents in Papers II and IV and by the youngsters for Paper III. The following items were covered: frequencies of intake of food or beverages per day, frequency of eating sweets, or soft drinks (non-diet), toothbrushing habits, dental floss, fluoridated toothpaste, and use of extra fluoride supplements and electric toothbrush [129-131]. In Paper II the items also covered parental assistance with toothbrushing.

Dental caries, dental plaque and gingivitis
*Papers I, IV*
Data on dental caries in the primary dentition (dft) were collected from dental records at ages 3 and 6 in Paper I. Dental caries in the permanent dentition (DFT) were registered clinically in Paper IV. Clinical dental caries (manifest caries) was recorded as decayed or filled teeth (DFT). Decay was defined as visible tooth substance loss without the characteristics of a developmental defect, or, in pits and fissures, when the point of the probe ‘caught’ on gentle pressure. No X-rays were taken.

The children in Paper IV were instructed to abstain from toothbrushing for 2 hours and from eating for 1 hour prior to examination. After staining with Diaplaque®, dental plaque was registered and the Visible Plaque Index (VPI) was calculated [132]. Gingival inflammation was defined according to Ramfjord [133], and the gingival bleeding index was calculated [134, 135].

Medical health
*Papers II-III*
Medical health was divided into chronic illness, general health problems, hospitalization, and frequent medication according to Westbom and Kornfält [136]. General health problems were defined as having medical problems but of minor severity or duration, e.g. allergies or minor respiratory disorders.
**Statistical methods**
The Statistical Package for the Social Sciences (SPSS), version 13.0, 16.0 and 18.0 was used for the analyses. Differences at the 5% level of probability were considered statistically significant. The following statistical methods were used: McNemar’s test, Chi-square test, Fisher’s exact test, Student’s t-test, Mann Whitney test, Sign test, Univariate logistic regression and Kappa statistics. For details see Papers I-IV.
RESULTS

Analyses of non respondents and dropouts
Out of 192 eligible PT, 187 participated in the studies presented in Paper I, 153 in the studies presented in Paper II, and 109 in the studies presented in Paper III. For C, the corresponding figures were 187 in Paper I, 153 in Paper II, and 108 in Paper III. Furthermore, 76 matched pairs were available for the paired analyses presented in Paper III (Figure 3). There were no statistically significant differences in mother’s educational level or immigrant background between participants and non-participants in the PT and C groups in Papers I-III. Neither were there any statistically significant differences in BMP and dft between participants and non-participants in the PT and C groups in Paper II. However, non-participant PT in Paper III had higher dft at the age of 6 (data from Paper I) as compared with participating PT (1.87 vs. 0.97; \( p = 0.028 \)). This difference was not seen in C.

Dental behaviour management problems (BMP)
Prevalence of BMP in Papers I-III is presented together with prevalence of DFA in Table 2.
**Table 2. Prevalence of BMP and DFA for PT and C in Papers I-IV.**

**Paper I:** BMP at clinical examinations; data from dental records.

**Paper II:** BMP at clinical examinations and treatments; data from parental interviews at two occasions (INT1, INT2). Paper III: DFA; defined as CFSS-DS $\geq 38$. Paper IV: BMP at clinical examinations; data from observations.

<table>
<thead>
<tr>
<th></th>
<th>BMP - Paper I</th>
<th>BMP - Paper II</th>
<th>DFA - Paper III</th>
<th>BMP - Paper IV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age 3 N=163*</td>
<td>Age 6 N=186*</td>
<td>INT1 N=152*</td>
<td>INT2 N=149*</td>
</tr>
<tr>
<td></td>
<td>36 (22%)</td>
<td>30 (20%)</td>
<td>16 (11%)</td>
<td>3 (3%)</td>
</tr>
<tr>
<td></td>
<td>4 (2%)</td>
<td>3 (2%)</td>
<td>2 (2%)</td>
<td>12 (15%)</td>
</tr>
</tbody>
</table>

**Sign.** $p=0.005^*$ $p=0.375^*$ $p=0.028^*$ $p=0.189^*$ $p=0.658^*$ $p=0.035^*$

<table>
<thead>
<tr>
<th></th>
<th>Aged 12-14 years N=109 PT**</th>
<th>Aged 10-12 years N=82*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 (3%)</td>
<td>2 (2%)</td>
</tr>
<tr>
<td></td>
<td>9 (6%)</td>
<td>3 (4%)</td>
</tr>
</tbody>
</table>

* Matched pairs  ** Not matched pairs  * McNemar’s test  $^5$ Chi-square test

**Papers I-II**

At 3 years of age, BMP at dental examination were more common in PT than in C (22% vs. 10%; $p=0.005$) (Paper I). From the PT group, a higher frequency of children with BMP were found in the subgroups of VPT and EPT, the difference between VPT and matched C being significant ($p=0.017$). At 6 years of age, BMP at the dental examination had decreased, and no significant differences were noted between the groups. PT in Paper I also showed more BMP at various kinds of dental treatments during the preschool period as compared with C (32% vs. 15%; $p<0.001$). Besides dental examinations, these treatments included local anaesthesia, polishing, cavity preparation, and extraction. Parental reports of BMP in Paper II showed that BMP were more common in PT than in C during the preschool period (INT1) (20% vs. 10%; $p=0.028$), but the difference decreased with increasing age and by the early school years (INT2), there was no statistically significant differences between the groups.
Within the PT group, there were no statistically significant differences between EPT and VPT at either INT1 or INT2. BMP in FT boys was more common than in girls (14% vs. 5%; \( p=0.054 \)) in Paper I, and PT girls reported more BMP than boys at INT2 in Paper II (17% vs. 5%; \( p=0.032 \)).

**Paper IV**

At ages 10-12, more PT presented with BMP than C at clinical examination, intra-oral photography, as well as at global assessment of the total session (BMP total 25.6% vs. 7.3%; \( p=0.006 \)). There were no statistically significant differences between VPT and EPT, twins and singletons, or between the sexes within the groups.

**Dental fear and anxiety (DFA)**

**Paper III**

At ages 12-14, no differences in mean scores of CFSS-DS between PT and C were noted, either when analyzing matched pairs, or all respondents, as in independent samples (Table 2).

**Developmental defects in enamel (DDE) including Molar-Incisor Hypomineralization (MIH)**

**Paper IV**

The clinical examination revealed a higher prevalence of developmental defects in enamel (DDE) in PT than C (69.5% vs. 51%; \( p=0.024 \)). When assessing DDE on intra-oral photographs a similar difference were noted (68% vs. 52%; \( p=0.047 \)). In addition, a higher prevalence of MIH was found in PT than C (38% vs. 16%; \( p=0.002 \)). Concerning MIH a similar difference was noted in the photographic analysis (38% vs. 17%; \( p=0.003 \)). Only results from the clinical examination were subjected to further statistical analyses.

There were no differences in severity of MIH between PT and C (Table 3).
Table 3. Severity of MIH in PT and C. Number and frequency (%) of affected first permanent molars and children according to severity of defects. Fisher’s exact test.

<table>
<thead>
<tr>
<th></th>
<th>Permanent first molars</th>
<th>SIgnificance</th>
<th>Children</th>
<th>SIgnificance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PT</td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>53 (59.6%)</td>
<td>24 (75%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>24 (27.0%)</td>
<td>4 (12.5%)</td>
<td>p=0.226</td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>12 (13.5%)</td>
<td>4 (12.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>89 (100%)</td>
<td>32 (100%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|                | PT                     | C            |          |              |
| Mild           | 17 (55%)               | 9 (69%)      |          |              |
| Moderate       | 10 (32%)               | 3 (23%)      | p=0.802  |              |
| Severe         | 4 (13%)                | 1 (8%)       |          |              |
| Total          | 31 (100%)              | 13 (100%)    |          |              |

Examples of MIH classified as mild, moderate and severe defects are shown in Appendix C.

The univariate logistic regression analyses revealed that both low birth weight and low gestational age had an impact on MIH. An increase of 100 g in birth weight reduced the occurrence of MIH by 4.5%, while increasing the gestational age by one week reduced the occurrence by 9.6%. Other perinatal factors or diseases during pregnancy and the first year of life did not have an impact on MIH.

**Dental caries, dental plaque and gingivitis**

**Papers I, IV**

No significant differences in caries prevalence were noted between PT and C in the primary dentition at 3-6 years of age (Paper I), or in the permanent dentition at 10-12 years of age (Paper IV). Twelve percent of PT and 9% of C had dental caries (dft >0) at 3 years of age, and 30% of PT and 27% of C children at 6 years of age. Further, 31% of PT and 38% of C presented dental caries (DFT >0) at 10-12 years of age.

At 10-12 years of age, PT had higher Visible Plaque Index (VPI) than C (64.4% vs. 54.8%; p=0.001) as well as more gingivitis than C (32.7% vs. 24.5%; p<0.001) (Paper IV). Within the PT group,
EPT was found to have higher VPI than VPT (72.2% vs. 61.9%; \( p=0.016 \)), and PT twins higher VPI than singletons (67.4% vs. 59.2%; \( p=0.029 \)). Higher VPI was also found in PT boys than in PT girls (67.9% vs. 60.7%; \( p=0.050 \)). Regarding gingivitis, no such differences were noted.

**Oral health behaviour**

**Papers II-IV**

During the preschool years (INT1), parents of PT reported more problems with toothbrushing than parents of C (21% vs. 11%; \( p=0.036 \)) (Paper II). No such significant difference was noted during the early school years (INT2).

In Paper III, more PT reported daily use of dental floss (12% vs. 4%; \( p=0.024 \)) and use of extra fluoride supplements (15% vs. 6.5%; \( p=0.050 \)) than C. Further, the use of dental floss was more common in twins/triplets than in singletons (\( p=0.002 \)), as was daily use of an electric toothbrush (\( p=0.036 \)). C girls reported more frequent use of dental floss than C boys (\( p=0.045 \)).

In Paper IV, PT girls more commonly used fluoridated toothpaste than PT boys (90% vs. 71%; \( p=0.034 \)). No other statistically significant differences were found between PT and C regarding any of the investigated oral health behaviours or dietary habits.

**Medical health**

**Papers II-III**

Medical health in PT and C group are shown in Table 4 (Papers II-III).

In Paper II chronic illness was reported for a higher proportion of EPT than VPT at INT1 (24% vs. 11%; \( p=0.048 \)) but not at INT2. Within the PT group, twins/triplets revealed more general health problems than singletons at INT2 (41% vs. 22%; \( p=0.028 \)), while no differences were reported at INT1.

In Paper III, in both PT and C groups, boys reported more chronic illness, general health problems and daily medication than girls. General health problems were more common in PT boys than in PT girls (61% vs. 38%; \( p=0.017 \)). Daily medication was more common in C boys than in C girls (11% vs. 2%; \( p=0.045 \)).
Table 4. Medical health in PT and C as reported by parents at interview 1 (INT1) and follow-up interview (INT2) in Paper II, and as reported by the adolescents in Paper III.

<table>
<thead>
<tr>
<th></th>
<th>Paper II – preschool years</th>
<th>Paper II – early school years</th>
<th>Paper III – adolescence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PT</td>
<td>C</td>
<td>Sign.#</td>
</tr>
<tr>
<td></td>
<td>N=152*</td>
<td>N=152*</td>
<td></td>
</tr>
<tr>
<td>General health problems</td>
<td>58 (38%)</td>
<td>25 (17%)</td>
<td>*p=0.000</td>
</tr>
<tr>
<td>Chronic illness</td>
<td>22 (14%)</td>
<td>7 (4%)</td>
<td>*p=0.040</td>
</tr>
<tr>
<td>Hospitalization for shorter periods***</td>
<td>57 (38%)</td>
<td>35 (23%)</td>
<td>*p=0.070</td>
</tr>
<tr>
<td>Hospitalization for longer periods****</td>
<td>10 (5%)</td>
<td>3 (2%)</td>
<td>*p=0.065</td>
</tr>
<tr>
<td>Daily medication</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Matched pairs  ** Not matched pairs  # McNemar’s test  § Chi-square test  
*** Hospital treatment < 1 month  **** Hospital treatment ≥ 1 month or three times during a one-year period
DISCUSSION

This thesis shows how preterm birth impacts on behaviour related to dental treatment, oral health and oral health behaviour from the ages of 3 to 14 years in PT. The main findings are that children born preterm (PT) presented more behaviour management problems (BMP) than full-term controls (C), and had higher prevalence of developmental defects in enamel (DDE), including Molar-Incisor Hypomineralization (MIH). The risk of developing MIH decreased with increased gestational age and birth weight. Furthermore, PT showed less favourable oral hygiene and gingival status and had more medical health problems than C. No differences in caries prevalence were noted between PT and C in the primary or the permanent dentition.

Methodological aspects
Information about dental treatment, oral health and oral health related factors was obtained from dental records, interviews and questionnaires and was based on information collected from a combination of dental health care professionals, parents and the children themselves. In addition, clinical examinations contributed to giving a full picture of the PT child in dentistry, covering both behavioural aspects and oral health.

All studies were population based and had a cross-sectional and case-control study design. The study design stipulated matched controls in order to avoid bias as far as possible. The C were matched and recruited with the intention of being as identical to the PT as possible, except for the preterm birth. In Papers I-III the children were followed from 3 to 14 years of age, and the studies were
conducted as repeated cross-sectional studies where the individuals included were chosen from the same original sample. Paper IV comprised new study groups, and the cross-sectional data collection was performed once.

The strengths of the studies were high rates of participation, from 97% in Paper I to 82% in the first interview (INT1), 80% in the second follow-up interview (INT2) in Paper II, and 84% in Paper IV. This probably reflects a high general interest among parents concerning oral health in their children. The response rate of 71% participation in Paper III was lower, but may be considered appropriate since this was a follow-up, four years after the first interview and the children had participated in two previous studies, and repeated requests for participation might be tiring for the families. It should also be noted that parents of the children who declined participation in Paper II were not considered eligible for Paper III.

Other strengths of the studies were that all registrations and interviews were carried out by one examiner and based on a well defined and standardized method, previously used in various national and international studies. In Paper IV, the diagnosing of MIH was checked for, with high intra and inter-examiner agreement in the analysis of photos.

One limitation of the studies was the small number of EPT, which made statistical comparisons between EPT and VPT within the PT group difficult. Still, the frequency of EPT corresponds well with official statistics from Sweden, as relatively few children are born at 28 weeks of gestation or earlier [6], and to achieve a relevant number of EPT, a larger total sample of PT would have been needed. Another possible methodological limitation was that the interviews in Paper II were retrospective and the outcome data reflected a period a few years back. However, the parents were thoroughly informed that the questions concerned a specific past period of time. In addition, the interview protocol used comprised specific questions with yes or no answers, which restricted some of the possible recall bias. In Paper IV, information regarding gestational age and birth weight were valid data, collected from the Swedish Medical Birth Register and were not influenced by the parent's ability to recall.
Dental behaviour management problems (BMP)

There are no previous reports of BMP in PT with which to compare, but the prevalence of BMP in the group of C in Papers I-II and IV corresponds well with previous reports from Sweden of 8-18% in preschool children [71-73].

In Papers I-III, BMP decreased with increasing age in both PT and C, which is in line with previous findings [72, 73], suggesting that problems with dental treatment are transient and probably more common in younger, less mature children [72]. In Paper II, the parents confirmed the difference in BMP during the preschool years, although a discrepancy in the frequency of BMP as reported by parents or found in the dental records in Paper I was noted. One possible explanation might be different measures of BMP. At INT2, a decrease in BMP was reported by the parents. This is also in line with the findings in Paper I.

In Paper IV, at 10-12 years of age, almost 30% of PT presented with BMP at the clinical examination, which may be interpreted as PT differing in BMP expression from C, where BMP prevalence was in line with previous population based data [72]. Plausible explanations for the high frequency of BMP might be that the examinations were carried out by a dentist previously unfamiliar to the child and that the examinations included uncomfortable intra-oral photography. Possible explanation might be the known long-term effect of prematurity on developmental outcomes, cognitive profiles and perceptual abilities [39, 50, 55, 58], which could influence the preterm child’s behaviour and ability to cooperate in stressful situations, e.g. dental examinations and treatment.

Dental fear and anxiety (DFA)

The questionnaire study in Paper III was specifically designed to explore the viewpoints of PT and C themselves, and their personal experiences of dental care situations. The informants were 12-14 years old at that time and thus were expected to be able to provide reliable answers. No differences were found between PT and C in CFSS-DS scores or in prevalence of DFA (CFSS-DS score ≥ 38). However, the cut-off score used may be questioned. One recent study has discussed the need for different cut-off scores on CFSS-DS for different age groups, sexes and type of informants [81].
Few children in Paper III reported DFA with the present cut-off score of $\geq 38$, 3% in PT and 2% in C. These prevalence rates are lower than most of the previously reported rates in children and adolescents [72, 80]. The low prevalence of DFA in Paper III indicates that PT seem to have adjusted to the dental care situation just as well as C over time, which is a positive finding. It should, however, be borne in mind that PT might underestimate their problems owing to cognitive deficits including difficulties with memory recall [67, 137], and e.g. Dahl et al. [138] found that adolescents with VLBW self-reported fewer behavioural problems than their parents reported.

Another point of view is the participant/non-participant analysis, revealing that PT who chose not to participate had had more dental caries than the participants during the preschool period. As treatment for dental caries increases the risk of pain experience, it cannot be excluded that the present results underestimate the prevalence of DFA, since the non-participants as a group may have had more negative dental experiences of early invasive treatment. Negative dental experiences have been reported to be an important factor for the development of DFA [74]. With this in mind, it is possible to make the assumption that the participating PT and C only had limited experience of invasive dental treatment, which also influenced the prevalence of DFA.

**Molar-Incisor Hypomineralization (MIH)**

MIH was found in 38% of PT as compared with 16% in C. There are no previous reports on MIH in PT, but the prevalence of MIH in C is in line with previous Swedish reports [89, 126]. The difference in prevalence of MIH between PT and C is also in line with Seow [85], who reported enamel defects in first permanent molars to be approximately twice as frequent in preterm children with LBW as in controls (21% vs. 11%), but did not use the definition of MIH.

The risk of developing MIH decreased with increasing gestational age and birth weight. This association is a new finding and adds to the understanding of the aetiology of MIH. These results also accentuate the importance of a child being born as close to term as possible, even for reasons of oral health. MIH is of important clinical relevance since the condition may result in severe caries problems, plaque accumulation, discomfort and even dental pain. In addition,
experiences of pain and discomfort are associated with BMP and DFA in children with MIH [139].

The assumption that tooth development is affected by special conditions at birth, such as in preterm newborns, is a reasonable one. Preterm birth is often related to medical problems, complicated delivery and immature body functions requiring specialist neonatal care early in life. These problems increase the risk of hypoxia, which affects the normal function of the ameloblasts [84, 95, 99, 140]. The severity of these enamel defects depends on the duration of the disturbance, for example hypoxia [95, 140, 141].

In Paper IV it was found that diseases during first year of life did not impact on the occurrence of MIH. Previous studies have also failed to identify the relative importance of these medical health problems in the pathogenesis of developmental enamel defects [99] since they are based on retrospective information obtained from questionnaires or interviews. One possible explanation might be the problem of discovering and isolating one specific factor in these early medical health problems. Another might be the fact that many studies base their information on parental recall. However, it is likely that many factors are involved in the aetiology of MIH [95]. Information based on medical records is probably more appropriate for finding evidence of new and assumed factors. This information should preferably be collected in prospective studies involving a large number of PT.

The examinations of MIH were performed both clinically and with intra-oral photography. As the agreement between clinical and photographic evaluations of MIH was excellent, it is reasonable to suggest that standardized intra-oral photographs can be used to diagnose mineralization disturbances. This method could facilitate future studies and enable better comparisons between different populations and surveys. Standardized intra-oral photography has previously been pointed out as useful in epidemiological studies of enamel defects [142].

**Dental caries, plaque formation and gingivitis**

Although MIH was twice as common in PT as in C, no differences were noted in caries prevalence in the primary or the permanent dentitions between the groups. The lack of differences in caries
prevalence reported in Papers I and IV is in line with previous reports in primary dentition [83, 100-103] and permanent dentition [104]. MIH affected teeth may predispose for dental caries by the macroscopic loss of enamel and increased plaque retention [88, 98], but still, there were no differences in caries prevalence between PT and C.

PT had significantly higher mean plaque scores and more gingival inflammation than C at the ages of 10-12 years (Paper IV). Severe MIH defects are known to cause increased sensitivity in the affected teeth which, in turn, may interfere with toothbrushing and therefore result in poorer oral hygiene [127]. In addition, possible deficits in fine and gross motor development and manual dexterity, as shown by de Kieviet et al. [53] may predispose for oral hygiene problems.

The cause of high VPI and gingivitis appears to be related to factors indirectly related to preterm birth. This viewpoint is supported by the fact that EPT had statistically significantly more plaque than VPT. High mean plaque scores found, especially in PT, but also in C, together with common reports of medical health problems in PT, illustrate the need for improvements and strengthening of oral hygiene training in all children and in PT in particular.

Oral health behaviour

Oral health behaviour in PT and C was evaluated from preschool years to adolescence. The main finding was problems with toothbrushing, more commonly reported in PT than in C during the preschool years (Paper II). Interestingly, however, PT reported significantly more daily use of dental floss and use of extra fluoride supplements during adolescence (Paper III).

Concerning problems with toothbrushing, parents described how their children sometimes refused or were uncooperative, but they still usually brushed their teeth, though sometimes under duress. One speculation is that these problems might be linked to hyper-sensitivity in the orofacial region related to feeding problems [24], which has been reported in PT [105, 106]. During the neonatal intensive care premature infants may need naso-gastric tube feeding because of feeding difficulties and medical complications. Oral stimulation may then be reduced for a prolonged period, with consequences for the developmental outcome concerning oral sensory and motor function.
[24, 106]. Additionally, a high incidence of ADHD in children born preterm, with hyperactivity as one of the main symptoms during the preschool period [55], might have aggravated the toothbrushing problems found at INT1 in Paper II. Fortunately, these were temporary problems, and not reported at INT2, which may reflect increased maturity.

The number of parents who helped their children with toothbrushing and the use of extra fluoride supplements increased from INT1 to INT2 in both PT and C, which is a positive finding from an oral health perspective. Moreover, parental assistance with toothbrushing in early school years has been pointed out as a recommendation and health promotion strategy for all children in this age group [143]. The parents’ greater concern and more supportive attitude might also have influenced the more frequent use of dental floss and extra fluoride supplements in Paper III, although this was more commonly reported in the PT than in C. One speculation about this group difference might be different parenting styles, where overprotective parenting have been reported as more common in families where a child was born with extremely low birth weight (ELBW) [144].

**Medical health**

General health problems and chronic illness were more common in PT than C during the whole period from the preschool period in to adolescence, which is in accordance with other studies [39-43]. A high frequency of medical health problems together with less favourable oral health, as demonstrated in Papers I-III, indicates that PT require special attention from the dental services from the preschool period to adolescence.
CONCLUSIONS AND CLINICAL IMPLICATIONS

Based on four cross-sectional studies on 3-to-14-year-old preterm children (PT, born from 23 to 32 weeks of gestation) and matched full-term control children (C, born ≥ 37 weeks of gestation) with information obtained from dental records, interviews, questionnaires and clinical examinations, the following conclusions can be drawn:

• Based on dental records and parental reports, dental behaviour management problems (BMP) were more common in PT than in C during the preschool period. This difference decreased with increasing age, and by the early school years there were no significant differences between the groups. However, at clinical examination at the age of 10-12, PT presented with BMP more frequently than C.

• Based on the youngsters’ reports at 12-14 years of age, few PT and C reported DFA.

• At the clinical examination at 10-12 years of age, PT had a higher prevalence of Molar-Incisor Hypomineralization (MIH) than C. Low gestational age and low birth weight increased the risk of MIH.

• At the clinical examination at 10-12 years of age, PT had more plaque as well as more gingival inflammation than C.

• Problems with toothbrushing were more commonly reported in PT than in C during the preschool years. During adolescence, PT reported more daily use of dental floss and use of extra fluoride supplements than C.
• No differences between the groups were noted regarding caries prevalence in the primary or the permanent dentitions.
• PT had more medical health problems than C, persisting from the preschool period into adolescence.

A new and emerging population of children with a history of being born very or extremely preterm is growing up in our society. For the preterm child in dentistry, this thesis contributes new knowledge and important aspects of providing dental care.

The results, based on information collected from a combination of dental health care professionals, parents and the children themselves, indicate that PT require special attention from the dental service in terms of treatment planning and prevention strategies from an early age. Early identification of PT in the dental care system is essential in order to individually tailor dental care and prevention for them. Because many PT exhibit medical health problems in addition to problems related to cognitive function and gross and fine motor development, collaboration between medical and dental health care professionals is advocated in order to ensure good oral health in PT.

The thesis showed clearly that BMP and oral health problems were more common in PT than in C, and PT continued to require special attention from the dental care services during adolescence. Moreover, these studies evaluated behavioural aspects related to dental treatments and oral health up to 14 years of age. There is a need for future studies of older adolescents and young adults born preterm, with long-term follow-up into adulthood.
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REFERENCES


Appendix A

Different categories of behaviour at different levels of acceptance and influence on treatment. Ratings of acceptance according to Rud & Kisling (1973), modified by Holst & Crossner (1987).

| Rating | Categories of behaviour                                                                 | Level of acceptance          | Influence on treatment                                                   |
|--------|----------------------------------------------------------------------------------------|------------------------------|-------------------------------|-------------------------------------------------|
| 0      | Active physical resistance, protests, screaming.                                        | No acceptance.               | Treatment cannot be carried out without physical control.                |
| 1      | Crying. No cooperation.                                                                 | Negative acceptance.         | Treatment cannot be carried out without undue delay. Raised hands interfering with the treatment. |
| 2      | Sign of resistance such as strained muscles. Reserved attitude. No answers but following directions with poor cooperation. | Reluctant acceptance.       | Treatment can be carried out without undue delay. Raised hands but no interference with the treatment. |
| 3      | Relaxed calm eyes, talking and showing interest in the procedure. Good cooperation.     | Positive acceptance.         | Treatment can be carried out immediately (after proper information).     |
Appendix B

The Children's Fear Survey Schedule – Dental Subscale (CFSS-DS)

Estimate the level of fear you would perceive in the situations described below. Mark your answer with X.

How afraid are you of ......

<table>
<thead>
<tr>
<th></th>
<th>Not afraid at all</th>
<th>A little afraid</th>
<th>A fair amount</th>
<th>Pretty much afraid</th>
<th>Very afraid</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. dentists</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. doctors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. injections (shots)</td>
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<td></td>
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<tr>
<td>4. having somebody examine your mouth</td>
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<tr>
<td>5. having to open your mouth</td>
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<tr>
<td>6. having a stranger touch you</td>
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<tr>
<td>7. having somebody look at you</td>
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<tr>
<td>8. the dentist drilling</td>
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<tr>
<td>9. the sight of the dentist drilling</td>
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<td>10. the noise of the dentist drilling</td>
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<tr>
<td>11. having somebody put instruments in your mouth</td>
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<tr>
<td>12. choking</td>
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<td>13. having to go to the hospital</td>
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<tr>
<td>14. people in white uniforms</td>
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<tr>
<td>15. having the nurse clean your mouth</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
a) A permanent first molar with no signs of hypomineralization of the enamel
b) A permanent first molar with mild hypomineralization of the enamel
c) A permanent first molar with moderate hypomineralization of the enamel
d) A permanent first molar with severe hypomineralization of the enamel
THE PRETERM CHILD IN DENTISTRY

Behavioural aspects and oral health