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Caries Prevalence and Prevention in Young Children: A Community-Based Preventive Approach

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1. Introduction

In the past 15 years, the dental health status of children and adults has remarkably improved. Credits for this positive development can be traced to the epidemiological studies carried out on regular basis by health departments, monitored and documented by the German Association for Community Dental Health (Deutschen Arbeitsgemeinschaft für Jugendzahnpflege, DAJ) [DAJ 1995, 1996, 1998, 2001, 2005].

Starting the surveillance program in 1991, the DAJ had improved policies and regulations according to dental health needs. The outcome over these years was a decrease of caries prevalence among 12 year old children up to 90 % [OECD 2010]. Yet, the results were not that positive for 6-7-year-olds and younger children. In some German states like Berlin, Brandenburg and Thüringen there was even an increase in caries level of primary dentition in 6-7-yearolds for some time [Pieper and Jablonski-Momeni 2008]. Moreover, a lower degree of rehabilitation was documented as half of the carious deciduous teeth of new school children were not supplied with intact restorative material [Pieper 2005a]. Similar caries trends in primary dentition could be noticed also in other European countries such as England, Norway and Wales [Momeni et al. 2006].

Despite of the astonishingly caries decline in permanent dentition, caries levels of primary teeth has stagnated in Germany. The rapidly progressing decay at early childhood occurring shortly after eruption of teeth is the reason of this unsatisfactory situation. This phenomenon is known as early childhood caries (ECC). This disease that is also known as baby bottle tooth decay [Healthy mothers – Healthy babies coalition 1985], exhibits a trend of significant carious attacks mainly of the maxillary primary anterior teeth directly after eruption which may develop in severe cases throughout subsequent aggressive form of demineralization to cover all the set of teeth [Davies 1998, Wayne 1999]. The suspected cause of primary teeth decay as well as ECC were discussed in several studies and the variable risk factors includes the excessive use of baby bottle with cariogenic erosive drinks at night, early oral colonization with

Streptococcus Mutans bacteria and poor oral hygiene which are all generally associated with families of low socio-economic status [Harris et al. 2004].

Parents play a key role in evolving ECC, by influencing on their children's nutrition as well other potential risk factors that affects their overall dental health. Their attitude and behaviour towards oral health concepts can manipulate dramatically the efficiency of preventive measures as brushing, dietary control and fluoridation applied to control early decay.

A short overview for the incidence of ECC in Germany reveals an irregular figure of distribution due to the absence of a representative sample of the population. However, some studies tried to estimate the prevalence of early childhood caries, but still these values conceal the real values. For example, a study in Hannover showed that ECC in a group of 3 to 6 years kindergarten children was 12% and rises up to 35% in socially disadvantaged areas [Robke and Buitkamp 2002].

This brief outline shows that caries experience in primary dentition through different variables is an urgent point of view to be controlled and that intensive preventive acts are mandatory. Prerequisites for this are that data and information about ECC from various German states must be collected to determine the variables associated and the appropriate preventive programs.

Hence, is the aim of our current study to help to develop a preventive programme of early childhood caries (ECC) among young children in the state of Mecklenburg – Vorpommern (MV – North East Germany) in a community setting.

2. Literature Overview

2.1. Early Childhood Caries

2.1.1. Debate on the Name of ECC

For several decades, the aggressive form of dental caries in young ages was a subject of discussion and debate among researchers. Jacobi [1862] stated already in his manual on “Dentition and its derangements” that the enamel of anterior and lateral sides of the tooth in children are most affected, badly developed, cracked, or their enamel entirely absent**.** Fass [1962] estimated that caries in young toddlers is caused solely by putting a child to bed with a bottle of milk, and proposed a name of this phenomenon as “nursing bottle mouth” and considered it as a part of rampant caries where all primary maxillary anterior teeth, maxillary and mandibular first molars and mandibular canines are affected. He said “Nothing is shocking to a dentist as the examination of a child suffering from rampant caries” [Fass 1962]**.** In 1985, the Healthy mothers – Healthy babies coalition, proposed the term baby bottle tooth decay and suggested that it would be appropriate for patient acceptance and focus attention on the potential damage of using a nursing bottle.

Later on, several synonyms were deemed by different researchers as “nursing caries”, “baby bottle tooth decay” and “baby bottle caries” [Ripa 1988, Horowitz 1998, Reisine and Douglass 1998]. Similar names were available for ECC in the German literature along side with English terms such as “Milchzahnkaries”, “frühkindliche Karies”, “Babyflaschenkaries” and “Zuckerteekaries”. At some extent, all these terms are logic. However, they are not accurate as only referring to a unilateral more inclusive cause of the disease that is assumed to be breast feeding or any other condition of nursing practices. Hence, the term Early Childhood Caries has been prevailed revealing the truth that caries is a multifactorial disease [Wyne 1999].

Some researchers had objections on the term ECC, where it does not include the age of children affected, represent caries pattern as well as may be unclearly understood by the public [Davies 1998; Horowitz 1998]. But the upcoming studies have managed to overcome these obstacles, by setting a sort of criteria for defining the pattern of caries

in relation to age [National Institute of Dental and Craniofacial Research 2002], and subsequent community – based campaigns permitted the public to be more familiar with the term.

Eventually, a debate over the terminology is mandatory to get a clear vision about the disease. Recent studies have shown that caries in young children is multifactorial and various independent variables are associated with the disease rather than sugars alone. These variables are ranged among biological, psychological and behavioural factors; and may vary from population to population. But researchers have agreed that packing all information like etiology, signs, symptoms and prevention into one term is difficult to accomplish.

Therefore, researchers and dental professions found no term more perfect than ECC as long as continuous educational programs to the dental professions, medical colleagues and public regarding all aspects of ECC are implemented.

2.1.2. Definition and Classification of Early Childhood Caries

Early childhood caries is a specific form of devastating caries that affect the primary dentition and may begin as soon as the infant teeth erupt [Huntington et al., 2002; Ramos-Gomez et al. 1999]. ECC is neither self-limiting nor amenable to short term pharmacological management and remains a sizable and significant personal and public health problem [Jones et al. 2005].

Finding a single definition of the ECC pattern based on the number of lesions, teeth involved and age of the affected children is a controversial issue between authors. In 1999, a proposal for the classification of ECC and case definition for each type based on the observations of group of dental pediatric professionals around the world was submitted. Each definition contains the common clinical picture, most probable cause, and age at which children are mostly affected [Wyne 1999].

Type I – ECC (mild to moderate form)

It is the existence of isolated carious lesion(s) in primary dentition involving molars and/or incisors. The cause is usually a combination of cariogenic semi-solid or solid food and lack of oral hygiene. The number of affected teeth usually increases as the cariogenic challenge persists. This type of ECC is usually found in children who are 2 to 5 years old.

Type II – ECC (moderate to severe form)

It is the presence of labiolingual carious lesions affecting maxillary incisors, with or without molar caries depending on the age of the child and stage of the disease, and unaffected mandibular incisors. The cause usually is inappropriate use of feeding bottle or at-will breast-feeding or a combination of both, with or without poor oral hygiene. Poor oral hygiene most probably compounds the cariogenic challenge. This type of ECC could be found soon after the first teeth erupt. Unless controlled, it may proceed to become Type III ECC.

Type III – ECC (severe form)

It is when carious lesions are affecting almost all the teeth including the lower incisors. The cause is usually a combination of cariogenic food and poor oral hygiene. This condition is usually found between age 3 and 5 years. The condition is rampant and involves tooth surfaces which are usually unaffected by caries.

The American Academy of Pediatric Dentistry (AAPD) defines the disease early childhood caries as the presence of one or more decayed (noncavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child under the age of six [AAPD 2014]. Moreover, the term S-ECC which is designated for the severe pattern of early childhood caries has been used for children under the age of three years and exhibit any sign of smooth surface caries. Also from three to five years, one or more cavitated, missing (due to caries), or filled smooth surface in primary maxillary anterior teeth or a when the score of decayed, missing, or filled surfaces

(dmf-s) is greater than or equal to four, five, and six for ages three, four, and five respectively; constitutes S-ECC.

In an effort to facilitate the measurements of ECC, a work-shop in 1999 set age-related criteria that serve as a case definition of the disease [table 1]. The term severe early childhood caries (S-ECC) was first introduced. Any carious lesion, whether non cavitated (d1) or cavitated (d2-d4), tooth missing due to caries (m), or filled surface (f) of primary teeth are to be counted [Drury et al. 1999].

Table 1: Proposed case definitions of early childhood caries and severe early childhood caries [Drury et al. 1999]

Age in months	**Early childhood caries**	**Severe early childhood caries**
< 12	1 or more dmf surfaces	1 or more smooth dmf surfaces
12-23	1 or more dmf surfaces	1 or more smooth dmf surfaces
24-35	1 or more dmf surfaces	1 or more smooth dmf surfaces
36-47	1 or more dmf surfaces	1 or more cavitated, filled, or missing (due to caries) smooth surfaces in primary maxillary anterior teeth or dmfs ≥ 4
48-59	1 or more dmf surfaces	1 or more cavitated, filled, or missing (due to caries) smooth surfaces in primary maxillary anterior teeth or dmfs ≥ 5
60-71	1 or more dmf surfaces	1 or more cavitated, filled, or missing (due to caries) smooth surfaces in primary maxillary anterior teeth or dmfs ≥ 6

Another classification was used by Davies and his colleagues [2001] to assess the prevalence of ECC in Manchester, United Kingdom. They defined three types of nursing caries, which records carious attacks on the maxillary incisors as a fixed criterion and the involvement of canines and molars as the variable. The criteria of the following three types are summarized in table 2. Type 1 being the strictest criteria while type 3 the broadest definition.

Table 2: Criteria for three types of nursing caries [Davies et al. 2001]

	A child will be regarded as having nursing caries if:
Type 1	One or more upper primary incisors has a buccal or palatal surface affected by caries (with or without upper first molars being affected)
Type 2	One or more upper primary incisors has any surface affected By caries (with or without upper first molars being affected)
Type 3	One or more upper primary incisors has any surface affected By caries (with or without any other teeth being affected)

As a conclusion, all the different attempts for classifying the caries patterns in primary dentition agree on the following advantages: firstly, it would be easy to understand what an author or speaker actually means when he or she refers to a specific type. Secondly, it mentions the severity and seriousness of the problem for general public. Thirdly, a well-defined caries pattern would enhance the ability of an analysis to identify meaningful association between risk factors and ECC.

Therefore, knowledge of the distribution of ECC types and associated risk factors would assist in determining the seriousness of the ECC problem, and hence suitable preventive programs are designed and implemented for various populations with effective and precise monitoring of these programs.

2.1.3. Measurement of ECC

An index is defined as the numerical value that describes the relative status of a population, on a graduated scale with a definite upper and lower boarder. It is designed to permit and facilitate comparison among populations using same criteria and methods.

The most common index used for measuring the caries prevalence in primary teeth is the (dmf-t/-s) index, developed in 1938 by Klein and his colleagues [1938]. It has been extensively used for years and earned a worldwide acceptance to become the gold standard index for prevalence studies recommended by the World Health Organization [WHO 1979].

This index is based on the detection of present as well as past dentinal caries of individuals per tooth (t) and/or surface (s). The values between primary and permanent can be distinguished by capitalizing the letters for permanent teeth, i.e. DMF-T/-S.
The abbreviation of DMF/dmf index defines the following three categories:
D/d = Decayed; present untreated teeth
M/m = Missed; due to caries
F/f = Filled; evidence of past disease as teeth treated with filling.

DMF–T= Sum of the individual values of each tooth
DMF–S= Sum of the individual values of each tooth surface.

According to the WHO dmf-t modifications in 1986, the maximum score is 32 and 20 for permanent and primary dentition respectively. Moreover, when the dmf – s index is used then four surfaces (labial / lingual / mesial / distal) for anterior teeth are counted and five surfaces for posterior teeth (labial / lingual / mesial / distal / occlusal), making the total number of surfaces examined is 148 for permanent teeth and 88 for primary teeth.

Detection of dentinal caries has been considered as threshold criteria to be used in epidemiological studies [WHO 1997]. However, the reduction in caries prevalence made the dmf index is based on dentinal caries and it is less informative regarding the changes in caries values - especially in young children with rare dentinal caries - as enamel lesions are not considered and thus may lead to a vague overview of caries experience in such population groups [Drury et al.1999]. Some authors suggested that reliability of correctly diagnosing enamel lesions may vary [Ismail 1997], in contrary to others that evidenced some good reliability whenever a suitable training is provided [Pitts 1997]. The international caries detection and assessment system (ICDAS) was developed in 2002 and presented in a modified form as ICDAS-II in 2005. The system classified the carious status of each tooth surface using a seven-point ordinal scale ranging from sound to extensive cavitation [table 3]. It allows the detection of incipient

caries that aims for early remineralization of enamel lesions. Although the ICDAS-II system demonstrated a high reproducibility and diagnostic accuracy, yet shows some limitations for assessing caries in very young children [Momeni et al. 2008]

Table 3: Coronal primary caries detection criteria according to ICDAS-II [Criteria Manual 2005]

Code	Description
0	Sound
1	First visual change in enamel (seen only after prolonged air drying or restricted to within the confines of a pit or fissure)
2	Distinct visual change in enamel
3	Localized enamel breakdown (without visual clinical signs of dentinal involvement)
4	Underlying dark shadow from dentin
5	Distinct cavity with visible dentin
6	Extensive distinct cavity with visible dentin

Another criterion was set for diagnosing and recording ECC by two German researchers [Robke and Buitkamp 2002]. It is used in conjunction with the dmf recordings. It is modified in a way that allows the examiner to give a distinct value of the initial lesions that are usually not considered in recording the decayed category (d-t/-s). This modification assists the public health professionals to track the variation in caries pattern with an overall image of the oral health status of the individual (plaque and oral hygiene protocols) where preventive programs could be better evaluated and implemented. The measurements are divided into three categories:

- ECC 0: no caries
- ECC 1: initial lesions at smooth surfaces
- ECC 2: true carious lesion

The criterion for recording the individual with ECC is the presence of at least two maxillary anterior teeth with cavitated carious buccal and/or palatal surfaces.

2.1.4. Change Management in Relation to Governmental Policies

Regardless of the tremendous decline in general caries levels, early childhood caries continues to be a major public health problem. Most of the developing countries as well the minorities and disadvantaged groups in developed countries are widely affected [Ismail et al. 2008; Haujorden et al. 2002; Petti et al. 2000]. Children with early childhood caries may have a high risk to develop future carious lesions, and considered to be a good predictive for later caries experience [Peretz et al. 2003; Warren et al. 2002]. Hence the problem persists through lifelong but still the consequences of early childhood caries on individual basis are not fatal, although discomfort and reduced quality of daily life resulting from pain and suffering are considerable [Filstrup et al. 2003].

After caries decline in adults, ECC became of great concern for public health authorities and professionals in the medical field. The standard of care for ECC has been primarily restorative and surgical treatment with little emphasis on the prevention and management of the disease [AAPD 2008]. In terms of cost to community, care of ECC consumes amount of health care budgets, due to the extent of the problem and the frequent need for the use of emergency and general anaesthetic facilities [Casamassimo et al. 2009]. A recent paper in the USA, investigated the cost involved in patients receiving dental treatment in hospital emergency room (ER), in Minneapolis-St. Paul metropolitan area. They found that over a 1-year period there were over 10,000 visits to ER for dental-related problems, the total charges reaches nearly $5 million and mainly charged to the public programs. The average cost of each patient is about $459 for those individuals less than 5 years of age [Davis et al. 2010]. Despite of receiving costly treatment under general anaesthesia, children often develop new and recurrent caries [Graves et al. 2004]. Moreover, surgical repair alone does not address the

underlying etiology of the disease [Fontana et al. 2011]. Therefore, a successful rebalance of risk and protective factors may slow down or halt the disease process resulting in caries arrest if not preventing the onset of new diseases [Ng et al. 2012]. In Europe, the dental treatment is in general costly averaging 5% of the total health expenditure and 16% of private health expenditure across Organization for Economic Co-operation and Development (OECD) countries in 2009 [OECD 2011]. In 2000, it was estimated that the total spend on all aspects of care and treatment provided by dentists in the 'old' European Union (EU) – 15 member states – was over EUR 54 billion per year [Widström and Eaton 2004]. The figure for the current EU with 27 member states is more likely to be closer to EUR 79 billion, and may reach up to EUR 93 billion in 2020 if it continues in the same trend.

In Germany, 0.8% of the Gross National Product (GNP) is spent on oral health services in 2010. This percentage varies between different European countries and ranges between 0.15 and 1.1. The German authorities spent the most between other countries on the oral health care services. In 2010, 2012 and 2015; the estimated numbers in billion EUR are 21.82, 22.70 and 24.09 respectively. And it is estimated to be EUR 26.60 billion by 2020. On the other hand, the authorities in Malta has spent the lowest on oral health services, with a value of EUR 0.03 billion in each year (2010/2012/2015) and estimations would be also EUR 0.03 billion by year 2020. Moreover, the structure of the oral health care system varies among countries. The services are either provided exclusively by private practitioners as in Spain where such system creates difficulties for the low – income groups. Other systems are totally dependent on the governmental expenses as in Denmark, while member states like Germany and France, the public health insurance covers treatment and prevention but a share of the cost is borne from the patient [State of Oral Health Report 2012].

In Germany, the public health authorities has managed to develop the system over years and set rules for better oral health of the community. Changes in the oral health care system including the implementation of population-based caries preventive programs and the introduction of fluoride containing tooth pastes offered a great opportunity to decline caries levels [Pieper and Momeni 2006].

The oral health status of Germany during the early 80's was considered as poor in comparison to other industrial countries. Up to the year 1989, In West Germany (formerly the Federal Republic of Germany): Only for children and young people with private insurance policies (approx. 10% of the population). These policies paid for oral hygiene checkups, oral hygiene instructions, topical fluoride application and fissure sealants carried out in a dentist´s office. No state supported prevention programs in kindergartens or schools. Whereas In East Germany (formerly the German Democratic Republic): Prevention and treatment provided for children and young people by state-supported school dental clinics which were also responsible for organising preventive programmes in kindergartens and schools. In some regions, the drinking water was fluoridated.

In 1989, finance of the group prophylactic actions by the public health insurance was stated by law [Sozialgesetzbuch V, §21] besides the individual prophylaxes [Sozialgesetzbuch V, §22], and the DAJ (Deutsche Arbeitsgemeinschaft für Jugendzahnpflege) committee was formed for the development of community dental health. This committee is responsible for the collection and documentation of data from the group prophylaxes actions. The examinations at schools were categorized according to age into 3 groups: 6-7-, 9- and 12-years-olds [DAJ 2010].

Between 1989 and 1991, the individual prophylaxes (IP 1-4) including oral hygiene checkups, oral hygiene instructions and topical fluoride application was first introduced in dental practices and covered by the statutory health insurances for patients between 12 and 18 years old. The costs of preventive programs for 6 to 12 years old in schools are also paid.

In 1993, these measures started to be covered also for children from the age of 6 to 11 years. At the same time, the spectrum was extended as preventive fissure sealants for permanent molars were enclosed for 6 to 18 years old as well. Data of the group prophylaxes programs in schools since 1994 were organized by the dental school of Marburg. The variables used in documenting the recordings are the school type; class level; sex; birth by month and year; and the date of examination. Whereas the following dental parameters were recorded: the DMF-T; D-T; F-T; M-T for permanent dentition

and for primary dentition dmf-t (d-t, f-t, m-t). Also the sealed teeth were recorded (ΣV). The examiners groups were either regular community dentists or central teams. It is a huge challenge to calibrate such a high number of dentists all over Germany. Thus a calibration record was designed for the examiners ranging between kappa 0.2 (low) and 1 (almost perfect). Out of 256 examiners, 52% had an almost perfect reliability (k= 0.8-1)/ 42.6% with substantial reliability (k=0.61-0.8) and 5.4% with moderate reliability (k=0.41-0.6). Regarding the sample number, it was agreed that in each federal state (Bundesland) there should be a representative sample of the state since not all schools are to be examined due to economic reasons.

Since 1997, prevention programs in schools were extended to cover children with increased risk of caries up to the age of 16 years [Pieper and Schulte 2004]. In the time frame from 1994 to 2004, the mean dmf-t in 6-7-year-olds was reduced from 2.89 to 2.16 and the DMF-T for 12-year-olds even dropped from 2.44 to 0.98 [RKI 2009; Pieper and Momeni 2006]. In 2009, the DMF-T values for 12-years-old German children dropped further to 0.3-1.1 depending on the federal county. Thus, the DMF-T has decreased in this particular age group by almost 90% from 1980 to 2006 [OECD 2010].

After the results in the year 2000, the oral health status for children at 12 years old was improved, and so was the question if this improvement was generalized to all children including those of high caries risk or just confined to children with good oral hygiene. Therefore, the significant caries index (SiC) was applied by the year 2000 in order to be linked with high caries risk children that constitute one third of the population with high DMF-T values.

On the other hand still until now not all German counties have obligatory group prevention and regular school check-ups as the laws differ within each county. The examination and prevention in kindergartens varies strongly from the region and even within, as tooth brushing doesn't necessarily belong in the daily routine, though recent studies have shown a clear benefit for oral health [Pieper et al. 2010]. This shows that despite improved oral health in children caries prevention for children younger than 6 years is still far from optimal. For children younger than 3 years no chair-side prevention is paid for, and for 3-6yrs-olds only once a year (FU) [BEMA 2004]. Besides the minimal

role of prevention in public institutions such as schools and kindergartens along with the polarized distribution of caries, the gap will even rise as these risk children/families barely visit dental practices for a regular check-up. The implemented preventive programs have improved oral health status in Germany and in terms of finance; the change management strategies saved money on the long term plans. For example, in the state of Mecklenburg-Vorpommern (North East Germany) €475 thousand was the amount of money saved from restorative treatments yearly performed in the permanent dentition of up to 12-years of age. Also there is €300 thousand saved from fillings in the primary dentition, not including general anaesthesia therapies [Splieth et al. 2013]. Regardless of the improvements, unfortunately not all age (<6yrs and >18yrs) and risk groups (e.g. low social status) are sufficiently reached yet, though working strategies are at hand [Pieper book 2010].

Therefore, the German academic dentistry and the dental profession - based on the World Dental Federation (FDI) goals - have jointly drawn up new national goals 'Goals for oral health in Germany 2020' [Ziller et al. 2006]. The goals are summarized as follows:

a) Promotion of oral health and reduction of the impact of oral and maxillofacial diseases on general health and psychological development especially in risk groups;

b) Reduction of the impact of oral and maxillofacial diseases on general health at both individual and population level by means of early detection, prevention and effective treatment of oral diseases.

Some of the targets, related to our topic, are to be achieved in 2020:

a) An increase in the proportion of 6-years old with caries free primary dentition to not less than 80%, and reduction of the DMF-T index in 12- years old to less than 1;

b) Increased provision of dietary advice by dentists with view to significant reduction of (concealed) sugar consumption by babies and children and hence also of the prevalence of early-onset caries and subsequent tooth hard tissue erosion, involving

increased interdisciplinary collaboration with pediatricians, gynaecologists and midwives (pregnancy counselling);

c) In the field of prophylactic measures, thus increasing the usage of fluoridated table salt to 70% as a semi- prophylactic measure to combat caries, targeted at a wide range of social and medical at-risk groups, and there should be no more than one form of systemic fluoride supplementation;

d) Increasing the percentage of children and adolescents between age 3 and 16 targeted by group prophylactic measures to 80%;

e) Ongoing of oral health information, together with the help of academic bodies, to the population with a view to achieving an all-around improvement in oral health.

2.1.5. Prevalence of ECC Worldwide

ECC is a public health problem that continues to affect babies, toddlers and preschool children worldwide. A comprehensive review of the epidemiology of ECC showed that its prevalence varies from population to population. However, most studies agreed that disadvantaged children, regardless of race, ethnicity or culture are the most vulnerable ones and making them at high risk for continued tooth decay as they grow older.

As early as the 1996, Milnes found in a review of the occurrence of caries on maxillary anterior teeth; including numerous studies from Europe, Africa, Asia, the Middle East and North America; that the highest caries prevalence is in Africa and South East Asia [Milnes 1996].

In a review of the literature regarding the prevalence of caries in each continent by itself, the following examples of some countries could draw a picture for the whole region. In Europe, recently several investigations from different countries have reported the prevalence of ECC in those about three years old. In England and in the city of Manchester, children from three distinct districts were randomly selected. 32% of

children experienced general caries with a mean dmf-t value of 1.4; where 19% had caries in the upper primary incisors [Davies et al. 2001]. In Sweden, 31% of three year old children had caries [Hugoson et al. 2007] and may reach up to 85% among low socio-economic children living in urban disadvantaged areas [Wennhall et al. 2002]**.** In a recent cross sectional study in Italy, the total caries prevalence was 15.99% among preschool children living in northern Italy [Congiu et al. 2013]. Lower values could be observed in Denmark, where 8% of children examined had caries [Barfod et al. 2011], whereas in some Eastern European countries the prevalence reach up to 56% of 3-year-old children with a mean dmf-t of 2.9 [Szatko et al. 2004].

Douglass reported that 25% of US preschool children had caries [Douglass et al. 2001]; however, the prevalence of ECC in high risk population including Hispanic and Native American ranges from 11% to 72% [Berkowitz et al. 2003]. Similar values of 67% of native Canadians had ECC [Peressini et al. 2004].

In Latin America, specifically in Brazil; the prevalence of early childhood caries among preschool children aged up to 36 months attending daycare centers with different fluoride level in the water supply of municipalities was 33.8% [Tiano et al. 2009].

In central and east Asia, the prevalence of ECC varies between nations. For example in Pakistan 29.1% of children between 3 and 5 years old had caries [Charania et al. 2011]. Also in India, a study conducted and 1500 children were selected in the city of Bangalore [Prakash et al. 2012]. 27.5% of preschool children in this urban area experienced caries. Results are much higher in the east, where a Thai study on children aged 6 – 19 months shows that 82.8% of 520 children had ECC [Vachirarojpisan et al. 2004] and in china reaches up to 55% of 2014 preschool children in 2 Chinese provinces [Du et al. 2007].

In the Middle East, the prevalence of caries in three-year-olds has been reported as between 22% and 61% [Rajab and Hamdan 2002; Al-Malik et al. 2001; Al-Hosani and Rugg-Gunn 1998] and in Africa between 38% and 45% [Kiwanuka et al. 2004; Masiga

and Holt 1993]. For more specificity, several studies showed the prevalence of s-ECC in different Arab countries. For example the prevalence in Ajman (UAE) was 31.3 % [Hashim et al. 2011]. More recent studies in the middle east showed similar results, where in Jeddah (Saudi Arabia), the prevalence of s-ECC was around 34% [Al-Malik et al. 2001] while, in Amman (Jordan), the prevalence of s-ECC was 31% [Sayegh et al. 2005]. This may indicate common determinants of disease in countries with similar cultures.

Another study for examining Early Childhood Caries among children aged 12–36 months in the community of the Bedouin tribe of Al-Jahalin, settled in the eastern outskirts of Jerusalem. In such communities with extreme poverty and minimal living standards it had been assumed that dental caries could be high, but results were as not as several native North American communities; where only 18% showed to have early childhood caries. This might be referred to their changing daily life [Livny et al; 2007].

2.1.6. Prevalence of ECC in Germany

In spite of its worldwide prevalence, there were very few representative reports on early childhood caries trying to estimate its prevalence in Germany. In the late 80's, a study in Giessen to approximate the percentage of caries distribution among young children aged between 6 and 48 months. It indicates that 5% of children between 6 and 12 months already had carious teeth, and this percentage increased with age to 26% in children of 24 to 48 months [Buhl et al. 1989]

With better understanding of the disease, recent studies throughout various states were dedicated to report the occurrence of early childhood caries in Germany. In an epidemiological study to provide a basic and representative data on oral health of preschool children aged 2 to 6 years old in North Western Germany, caries prevalence was about 39% where 20.3% manifest the pattern of nursing bottle caries (Type II) [Robke 2008]. Another study conducted in the middle of Hessen, among children aged 37 to 84 months. The results were as following: 41.7% of children had carious teeth with

a dmf-t value of 1.8, with 7.8% assigned to nursing bottle caries (ECC Type II) [Nies et al. 2008].

On the other side of Germany, in the federal state of Brandenburg, the prevalence of caries among infants of 13 – 36 months old was 12.7% where 7.4% and 5.3% are designated for enamel and dentine level respectively [Deichsel et al. 2012].

Therefore, the values of early childhood caries in Germany vary between almost 5% and 20% with an average range of 10% to 15% [Splieth et al. 2009].

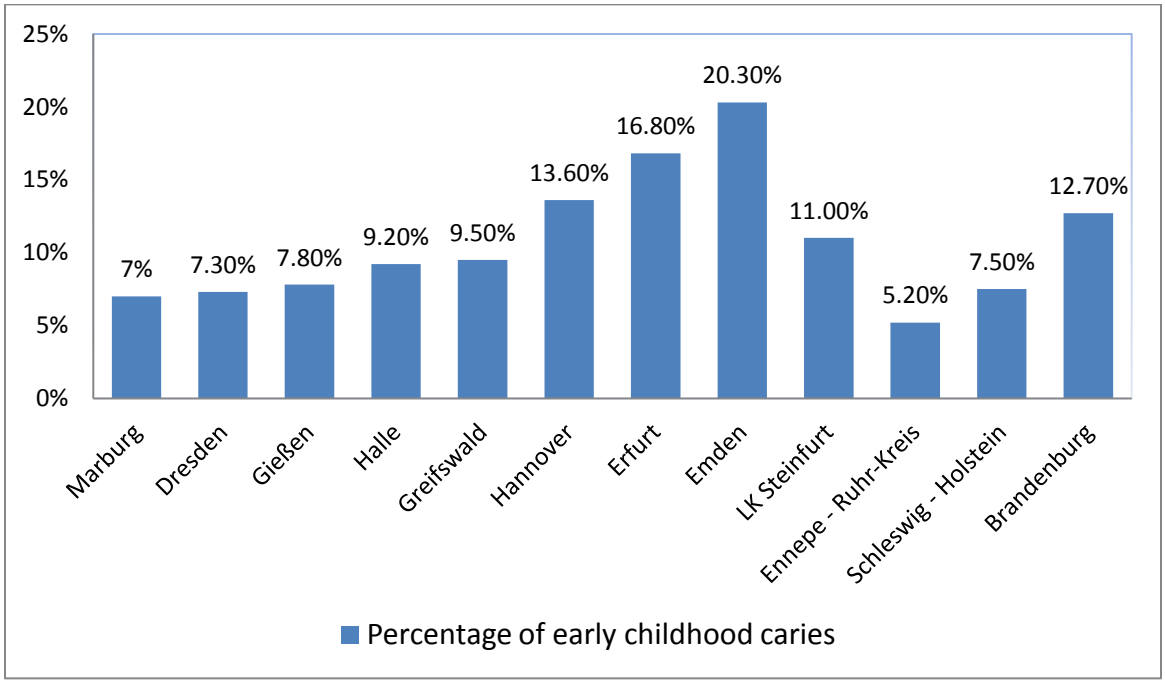

Fig.1: Regional studies for the prevalence of early childhood caries in Germany [Treuner and Splieth 2013]

2.1.7. Socio-behavioural Aspects and ECC

In general, dental caries recently has been considered as a social and life style disease in addition to the four etiologic factors:

a) fermentable carbohydrates,

b) cariogenic bacteria,

c) susceptible tooth and

d) long time exposure [Colak et al. 2013; Reisine and Douglass 1998; Seow 1998].

Several studies have urged to investigate the cause of caries in early childhood. It was thought that the presence of bacteria besides the immaturity of host defense system and the feeding bottle as being the unique risk factors for caries in infants and young children [Soew 1998]. In addition to the main standard known etiologic factors; oral hygiene, type of diet, enamel hypoplasia, beliefs and attitudes about tooth brushing and sugary snacking, socio-economic background and ethnicity are to be considered to help determine which young children develop dental caries [Harris et al. 2004].

2.1.7.1. Demographic Characteristics

Two important factors included in the demographic characteristics of specific community could be attributed to early childhood caries; the socio-economic status (SES) and race or ethnicity. Burt and Eklund [2005] defined the socio-economic status, which is known also as the social class, as a broad recording of an individual's attitude and values as measured by such factors as education, income, occupation and place of residence.

The relationship between SES and the incidence and prevalence of a disease is inversely proportional. That is, as the socio-economic status increases, diseases, illness and their impacts decrease [Marmot et al. 1999]. This could be explained by the proposal that social class may influence caries risk in the following ways: Individuals from lower SES groups experience financial, social, and material disadvantages that compromise their ability to care for themselves, obtain professional health care

services, and live in a healthy environment [Reisine and Douglass 1998]. Moreover, this influence may be as a consequence of differences in dietary habits and the role of sugar in the diet [Ismail et al. 1997]. In a review on inequalities in oral health, Sheiham and Watt [2000] indicated that the main causes of inequalities in oral health are differences in patterns of consumption of non-milk sugars and fluoride toothpaste.

Studies suggested that ECC is more commonly found in poverty or poor economic conditions, and for those born to single mothers. These children are at high risk for early development of caries [Rajab et al. 2002; Hallett et al. 2002; Ramos-Gomez et al. 1999]. Another factor that has a strong impact on the prevalence of caries is the educational level of parents, especially when the mothers have low educational level or illiterate [Dini et al. 2000; Wendt et al. 1996].

In addition to the SES, caries experience was found among ethnic subgroups with the highest risk for tooth decay in the primary dentition and specifically in the early childhood age [Shiboski et al. 2003; Kaste et al. 1996]. On the contrary, other studies when analyzed the race/ethnicity variable found no significant difference on dmfs scores or in the prevalence of defects [Montero et al. 2003]. Also the immigrant background is associated with the prevalence of caries [Stecksen-Blicks et al. 2004]. However, it is difficult to separate the cultural influences of ethnicity from the effects of low socio-economic status on the prevalence of dental caries [Reisine and Douglass 1998]. Thus the SES differences – that is, the differences in education, self care practices, attitudes, values, available income, and access to health care – appear to be far important [Burt and Eklund 2005].

2.1.7.2. Behavioural Issues in ECC

Feeding Practices

Historically, when the term nursing caries [Rippa 1988] had been used, then early childhood caries was linked to baby bottle or breast feeding. Thus the inappropriate way of feeding has a central role in the etiology and severity of ECC. Bottle feeding and sleeping with a bottle, are being strongly correlated to early childhood caries. In a

Brazilian study to analyze the association between feeding practices and the presence or absence of severe early childhood caries (S-ECC) among preschool children, found that the use of bottle at night as a substitute to the pacifier is associated with the etiology of S-ECC [Azevedo et al. 2005]. In another cross sectional study, sweetened bottle contents was shown to be a significant determinant for the presence of ECC among four to six years old Australian children [Hallett and O'Rourke 2002]. Although a Greek study assumed that the bottle feeding is not the only for the development of nursing caries where 85% of their control group used the bottle and none of them developed caries [Oulis CJ et al.1999]; but on the other hand a more recent study showed that the use of bottle on demand during the day is correlated to severe early childhood caries [Azevedo et al. 2005]. Since both studies agreed on the night – time use of bottle, then we may conclude that prolonged bedtime use of bottles with sweet contents is the rational key determinants of caries development.

Moreover, milk-based formulas for infant feeding, even those without sucrose in their formulation, proved to be cariogenic in some studies [Erickson et al. 1998; Sheikh and Erickson 1996]. Studies performed on cow's milk showed that:

a) it contains calcium, phosphorus and casein,

b) does not produce caries,

c) fall of plaque PH is negligible and

d) has a cariostatic action instead [Bowen and Pearson 1993; Ribeiro and Ribeiro 2004].

Breast feeding provides the perfect nutrition for the infant, and there are numerous of health benefits to the breastfed child. This includes a reduced risk of gastrointestinal and respiratory infections [Kramer and Kakuma 2002]. However, frequent and prolonged contact of enamel with human milk as result of on-demand breast feeding has been shown to result in acidogenic conditions and softening of enamel [Prakash et al. 2012; Valaitis et al. 2000]. Other reports found no clear and significant relationship between breast feeding and the prevalence of tooth decay [Rosenblatt and Zarzar 2004;

Roberts et al. 1994]. Even for a prolonged or at night, breast feeding is not correlated to ECC [Mohebbi et al. 2008].

Although there is no objective evidence of the weanling's dilemma [Kramer and Kakuma 2002], but weaning from the breast has been recommended by dental professionals soon after the child's first birthday [American Dental Association 2007] since different studies reported that nocturnal breast feeding after the age of 12 months poses a risk of developing ECC [van Palenstein Helderman et al. 2006].

After weaning, the variety and the amount of food that a child ingests are increased. Snacks between the meals in addition to sweetened food and beverages including fruit juices and yogurt showed a significant association with ECC. Increasing the time per day that fermentable carbohydrates are available is the most significant factor in shifting the re-mineralization equilibrium toward tooth de-mineralization by subsequent lowering of plaque PH and thus affecting the so-called "caries balance" between factors [Ramos-Gomez et al. 2010].

Sugar intake

Diet has a clear influence on caries development; in particular the strong association between the intake of refined carbohydrates, especially sugars, and the prevalence and severity of caries. Thus sugars are clearly a major etiologic factor in the causation of caries. In the late nineteenth century, Miller put his theory on the development of caries. It was based on the action of microorganisms on the fermentable carbohydrates that adheres to the tooth surface [Miller 1883]. Modern research shows that Miller's view of the overall picture was reasonably correct. There is overwhelming evidence that sugar (such as sucrose, fructose and glucose) and other fermentable carbohydrates (such as highly refined flour) play a role in the initiation and development of dental caries [Tinanoff and Palmer 2000]. Sucrose is the most common sugar and is the only one that, when metabolized, produces dextrans which promotes superior adhesion to the teeth. Because of this, it is considered the most important substrate in the establishment of cariogenic bacteria [Mikkelsen 1996]. The linear relationship between sugar consumption and caries in high-income countries has come into question. Regardless of

the high sugar intake, caries levels declined. This is influenced by the exposure to fluorides [Burt and Pai 2001]. In developing countries where there is a rise in the sugar consumption rates and with an absence of public health preventive programs, has a direct influence on the deterioration of oral health status [Ismail et al. 1997].

There is an evidence that sugar use was increasing in many developing countries, to be equivalent (Middle East region) or even higher than that of developed countries. The consumption of sugar-containing carbonated beverages in a number of developing countries in East and Southeast Asia became of a great concern [Ismail et al. 1997]. A report accomplished between WHO (World Health Organization) and FAO (Food and Agriculture Organization indicates that the level of dental caries is low in countries where the consumption of free sugars is below 40–55 g per person per day [United Nation, 2003]. Regardless of the accurate amount to be consumed, frequent consumption makes preschool children more vulnerable to early childhood caries [Sayegh et al. 2002; Chan et al. 2002; Tinanoff and Palmer 2000]. Others found no significant correlation between sugar intake and caries prevalence [Yabao et al. 2005; Kiwanuka et al. 2004].

In a trial to focus on the behavioural attitude of Europeans regarding food intake, it revealed that European – on average – eat or drink on five occasions per day. For example, people in Germany besides United Kingdom and Sweden eat/drink approximately 6 times. While in Denmark they eat up to 8 times per day, and on the other hand 3 – 4 times in south-eastern countries like Romania and Greece. The European who eat and drink most often during the day (5.7 times) are mainly young aged between 15 and 24, where the least those of least frequently (5.2 times) are the respondents of 55 years and over. Moreover, 9 out of 10 investigated individuals often eat fresh fruits (65% of German respondents), and more than half natural sweets including jam or honey at least from time to time (Germany with highest score of 36%). Regarding the intake of sweet drinks (like lemonade, cola, or other soft drinks), it seemed that young people aged between 15 and 24 are the most frequent drinkers of this type of drinks. The scores range between 8% and 58%, where Germany's score is 16%. Only 15% of Germans eat biscuits, cake and sweets where 4% chew gums

containing sugars [Special Eurobarometer 330, Oral Health Report 2010]. German scores in comparison to other European countries are most likely being low to average; this might be due to the influence of their cultural habits on the dietary habits.

For a very long time, sugar has been blamed as a primary etiologic factor in the development of dental caries. However, carbohydrates had a less important role. Sugar consumption alone does not affect caries prevalence as much as it was. Additional factors like SES, education and motivation, use of fluorides, and oral hygiene are to be presented [Harel-Raviv et al. 1996].

Dental plaque

Visible plaque on children with early childhood caries is recorded as a proxy for oral hygiene habits. Its presence and accumulation on the labial surface of maxillary anterior teeth has been related to caries among these children [Kiwanuka et al. 2004] as well to the daily eating and drinking episodes [Habibian et al. 2001]. In comparison to other variables, a study showed that 91% of children were correctly classified as a high caries risk group depending on the presence or absence of visible plaque [Alaluusua and Malmivirta 1994].

The caries process is initiated in dental plaque, which resembles a community of microorganisms found on the tooth surface as a biofilm [Marsh 2004]. Some bacteria – mainly Mutans Streptococci and Lactobacilli - had a potential cariogenic effect in advanced lesions. These bacteria are capable of metabolizing dietary sugars to acid rapidly, creating a low pH locally, and loss of mineral leading to dissolution of dental hard tissue resulting in a caries lesion that can be seen clinically [Marsh 2009; Kidd and Fejerskov 2004; Becker et al. 2002].

Early acquisition of S. mutans is a key event in the natural history of the disease. Acquisition may occur via vertical or horizontal transmission. Primary oral colonization by S. mutans coupled with caries-promoting feeding behaviours results in accumulation of these organisms to levels exceeding 30% of the total cultivable plaque flora. These bacterial masses are often associated with carious lesions, white spot lesions and sound tooth surfaces near the lesion [Berkowitz 2003]**.** Conversely, S. mutans typically

constitute less than 0.1% of the plaque flora in children with negligible to no caries activity [Loesche 1985].

Therefore, caries prevention strategies that target specific bacteria will be only partially successful, whereas approaches that reduce acid production, maintain plaque pH around neutrality and good oral hygiene measures will be more generally applicable [Marsh 2009].

Oral hygiene

Good oral health is dependent on the establishment of the key behaviours of tooth brushing with fluoride tooth paste and controlling sugar intake. Newly erupted teeth may be at high risk of developing caries, thus supervised tooth brushing twice a day with fluoridated dentifrice is recommended as a measure of the caries preventive strategies applied onto preschool children [Tinanoff et al. 2002]. Weighing the risk – benefit ratio of fluoride, mild fluorosis is versus preventing devastating dental disease. So a “smear” or “rice-size” amount of fluoridated tooth paste should be used for children less than three years of age, while a “pea – size” amount is appropriate for children aged three to six [Wright et al. 2014]. For maximum beneficial, rinsing should be discouraged to keep the residual fluoride toothpaste on teeth where the excess paste should be spit out [Chestnutt et al. 1998].

Tooth brushing on daily basis seems to be of valuable effect in ECC reduction compared to non-brushing habit. Other factors like frequency of tooth brushing more than once a day, age at which brushing was started, parental supervision of tooth brushing, not having teeth brushed at bedtime, and use of fluoridated as opposed to non-fluoridated toothpaste are to be considered too [Harris et al. 2004]. One systemic review [Reisine and Psoter 2001], suggests that when brushing teeth, it is uncertain whether the effects of tooth-brushing are due to use of a fluoride dentifrice or from mechanical removal of plaque. But in general, tooth brushing should continue to be recommended as a measure to prevent dental caries particularly when using a fluoridated paste, in regard to evidence in many other reports [Gussy et al. 2006;

Marinho et al. 2003]. In Europe, the Health Behaviour School-Aged Children (HSBC) survey report for the year 2009/2010 investigating tooth brushing, found that the habit of brushing regularly at 11 years old is associated with higher income families [The state of oral health in Europe report, 2012]. The good parent-child communication has been illustrated to be associated with more regular tooth brushing among adolescents, thus familial factors exhibited by the European family may have a protective effect on oral health behaviours [Levin and Currie 2010].

2.1.8. Prevention of ECC

The dynamic balance between pathologic factors that lead to demineralization and protective factors that lead to remineralisation determines the end result of the disease. This is accomplished by reducing the availability of refined carbohydrates, reducing the microbial burden and on the other side increasing the resistance of the teeth [Featherstone 2004].

There are two distinct groups regarding prevention strategies for a certain disease: strategies aimed at the whole population which seeks to control the incidence of disease, and the 'high-risk' approach which seeks to protect susceptible individuals [Rose 2001]. Others divided them into population – based public health approaches and individual private practice – based approaches, where former approaches are more likely to reach the target population group at risk of developing ECC [Weintraub 1998].

The use of effective population – based interventions can reduce the morbidity, mortality, and economic burden associated with oral health conditions [Truman et al. 2002]. Thus it is feasible in populations with high prevalence of oral diseases, where efforts are focused on shifting the risk distribution of the population into a more favorable level. In the Scandinavian countries, the prime community based strategies are the regular use of fluoridated tooth paste and public dental education that emphasizes oral hygiene [Burt 1998]. In northern America, water fluoridation has been recognized as one of 10 great public health achievements of the 20th century. In 2012,

74.6% of the U.S. population on public water systems had access to fluoridated water. The 2020 objective on community water fluoridation; that 79.6% of people on public water systems will receive water that has the optimum level of fluoride recommended for preventing tooth decay [CDC 2013].

Facilitated access to dental in some communities allowed performing the individual clinical – based interventions. Along with the group prophylactic measures on population level, caries prevalence is reduced and polarization in caries trends increased. Thus targeting individuals at high – risk for developing ECC is recommended in such countries [Twetman et al. 2000]. Though in some reviews, the effectiveness of the high risk approach has been criticized. Identifying the individuals at risk is inaccurate and such strategies would fail to deal with the majority of new lesions. So even in countries where the caries rate has far been low, population – based measures continues to be important [Batchelor and Sheiham 2002; Seppä 2001].

Nevertheless also cultural beliefs and family experience has an influence on the preventive oral health care of young children leading to certain barriers like failure to prevent transmission of the bacteria that cause tooth decay from caregivers and siblings to infants and young children, frequent and high intake of sugar, and less than optimal exposure to fluorides [Hilton et al. 2007].

2.1.8.1. Measures for Preventing ECC

In general, controlling dental caries is achieved by arresting the disease onset, prevent progression and repair on lost tooth structure by surgical interventions [Winston and Bhaskar 1998]. ECC prevention has evolved more than just being an immediate fixes like restorative care, educational programs targeted to parents or caregivers would manipulate the behaviours of infants and young children hoping to decrease the incidence of ECC. Such programs would focus on diet, oral hygiene instructions, use of fluorides and a combination of all measures [Kowash et al. 2000].

Dietary modification and oral hygiene

Unquestionably, sugar plays a huge role in the development and progression of ECC. After all, it acts as the substrate for the bacteria to begin its decay process. For this reason many professional reviews and researches have urged to evaluate the effectiveness of educating the parents on their children's feeding habits and oral hygiene practices [Gussy et al. 2006; Kowash et al. 2000]. Yet the behavioural modification issue is still yet controversial. A longitudinal community based study implementing oral health education for teachers in kindergartens – mainly focusing on tooth brushing – have showed a reduction in dmfs increments by 30% in comparison to control group who received no actions [Rong et al. 2003]. Another study focusing on dietary modification, showed an overall reduction of 25% in the prevalence of ECC among children [Ismail 1998]. While others have found that parents still add refined sugars to their children's bottles despite their knowledge of the link between sweet fluids in the bottles and dental caries [Gussy et al. 2006].

Moreover, some qualitative researches show that there are multiple sociocultural barriers including perceptions that milk is a food rather than a between meal drink and that forcing a child to drink water is cruel or a sign of poverty [Chestnutt et al. 2002]. And advertising of food and drinks also confuses parents who find it difficult to differentiate the cariogenic potential of many products [Chestnutt et al. 2003].

Fluoride

The introduction of fluorides decreased the incidence of caries during the past decades. Fluoride is either used systemically through water system, or even topically mainly via tooth pastes. Fluoride prevents and slows the progression of tooth decay and can even reverse very early tooth decay. Topical fluoride results in a small, elevated and prolonged fluoride level in saliva and dental plaque, bringing fluoride in contact with tooth surfaces. This prevents tooth decay by:

(a) Facilitating the hardening of the tooth surface (remineralization);

(b) Improving the ability of the tooth surface to resist acid attack that breaks down tooth structure (demineralization);

(c) Inhibiting bacterial enzymes, which reduce the ability of the bacteria to grow, metabolize sugar and produce acid [Lynch et al. 2004].

Sources of fluoride include drinking water with optimal levels of fluoride and use of products such as fluoride varnishes, gels, toothpastes, mouth rinses, and supplements. Other sources that used in several public health programs are added fluoride into salt and milk [Marthaler and Petersen 2005; Ketley et al. 2003].

The first community program depending on water fluoridation was initiated at Grand Rapids in the United States of America in 1945. After wards, several other countries have used fluoridated water programs like Australia, Brazil, Canada and many others. Systemic reviews showed that water fluoridation reduces the prevalence of dental caries — % of the population with decayed missing and filled primary teeth (dmf-t)/decayed missing and filled permanent teeth (DMF-T) > 0 — by an average of 15%, and reduces the incidence of caries by an average of 2.3 dmf-t/DMF-T in children aged 5 –14 years [Medical Research Council 2002]. Water fluoridation has been seen to have benefits in reduction of caries, where there is no credible evidence of other potential adverse health effects. The use of fluoridated water should be considered for the risk of fluorosis. It is estimated that 1mg/l of fluoride is associated with an increase of 13% in the risk of unaesthetic dental fluorosis [McDonagh et al. 2000]. Thus some analysis suggested that the risk might be substantially higher in areas in which the water is naturally fluoridated and lower in areas in which the concentration of fluoride in water has been adjusted [Medical Research Council 2002].

Salt fluoridation is a widely practised alternative of water fluoridation that the advantage of allowing consumer choice. It may be consumed through several channels, including domestic salt, meals at schools, large kitchens and in bread. In France and Germany the focus is on fluoridated domestic salt while other countries used almost all of these channels [Jones et al. 2005]. When first used between 1965 and 1985, the effects on prevalence and incidence of caries in applied countries (Colombia, Hungary, and

Switzerland) were similar to those observed after the introduction of water fluoridation [Marthaler and Petersen 2005]. The optimal concentration of fluoride in salt is around 250 mg/kg, whereas the concentration worldwide ranges between 90 mg/kg to 350 mg/kg. The debating concern was about side effects of salt on health (particularly causing hypertension), but it is agreed that there is no need for people to change their usual behaviour of consuming more salt for benefit of fluoride, rather the concentration of fluoride in salt could be appropriately increased [Marthaler and Petersen 2005].

The potential of milk as an alternative vehicle for fluoride was first reported in Switzerland in 1962 [Ziegler 1962]. Starting a program on early childhood ensure an optimal effect on deciduous teeth, where a significant reduction of 72% in the dmfs indices were reported among group of preschool children of 3 to 6 years old; and the proportion of caries-free children after 4 years of implementing the program increased by almost 26% [Mariño et al. 2001]. A systemic review showed that fluoridated milk can be recommended as caries preventive measure where the concentration in drinking water is suboptimal, caries experience in children is significant and there is an existing school milk program. The program should aim to provide fluoridated milk for at least 200 days per year and should commence before the children are four years of age [Bánóczy and Rugg-Gunn 2007].

Fluoride mouth rinses and tooth pastes have been extensively used as caries preventive intervention in school based programs and individually. A systemic review suggests that mouth rinses is associated with a clear reduction in caries increments in children with almost 24% [Marinho et al. 2003]. However, there is a great risk of swallowing the solution by very young children who have not matured enough developmentally to be able to spit [AAPD 2008]. Also the fluoridated tooth pastes have shown a reduction in caries increment by 23% [Marinho et al. 2004].

Fluoride varnish has been increasingly used by dental professionals to deliver fluoride for young children to prevent from ECC. The premeasured dose and reduced risk of ingestion, makes the varnish safe and better accepted by young children [Weintraub et al. 2006]. A systemic review on preventive measures, found that fluoride varnish reduces the caries incidence in high risk children younger than 5 years old in a range

between 18% and 59% [Chou et al. 2014]. In comparing to other community – based measures, the varnish use is preferred over the acidulated phosphate fluoride gel (APF) and may be preferable to 0.2% sodium fluoride (NaF) mouth rinses [Weintraub 2003]. The frequency of applying varnish affects the results, where twice/year has significant protective effect on caries incidence than once/year [Weintraub et al. 2006]. Fluoride varnish has caries – inhibiting effect on both permanent and primary dentition, with the ability to reverse early tooth decay [Marinho et al. 2002]. In addition to varnish, fluoride gel applications are also mostly delivered in the dental office by dental professionals generally at intervals of 3 to 12 months. Although the gel had caries – inhibiting effect of 21%, some reported adverse side effects [Marinho et al. 2003]. Moreover, oral fluoride supplements (tablets, drops or lozenges) are available on prescriptions and recommended for children living in non – fluoridated area [ADA 2009]. They have been found to be effective at reducing caries incidence in children younger than five years old, however the use of supplements – as any other systemic approach – may be associated with increasing risk of enamel fluorosis [Chou 2014].

Oral health education

Early childhood disease is a lifestyle disease with biologic, behavioural, and social determinants. The possibilities of its prevention increased greatly with early detection of the decay helping in identifying risk factors on individual base and the 'high risk groups' on population scale. This must be accompanied by educating of prospective and new parents for appropriate home and professional measures [Twetman et al. 2000]. The educating programs give a counsel to parents or caregivers regarding diet modification particularly decreasing sugar from children's daily practice, and following oral hygiene instructions. All health education messages should be simple, consistent and evidence – based. Even though the message of prevention is delivered correctly and easily, but still the success of such programs is dependent on parent's knowledge levels, cultural norms, values, beliefs, attitudes, opinions, psychological factors and commitments towards what has been taught to them [Twetman et al. 2000].

When focusing on fluoride and caries, oral health promotion is effective in reducing caries. Chair side promotion is more effective than other methods of promotion, and

mass media programs have not been shown to be effective [Kay and Locker 1998]. Oral health education for children is needed in rural areas where knowledge and attitudes are low and the dental care habits influenced by dental attendance and education level of mothers [Wierzbicka et al. 2002].

Addressing information via regular visits to mothers with infants, commencing at or soon after the time of the eruption of the first deciduous teeth, was shown to be effective in preventing the occurrence of nursing caries [Kowash et al. 2000]. Also the primary care providers including pediatricians, who have contact with children before their first dental visit, may deliver oral health instructions and this may help in reducing the incidence of ECC [Gussy et al. 2006]

At the early 90's, there was insufficient information regarding oral health education programs that had been rarely studied and evaluated in a randomised way [Kay and Locker 1996]. Although it has been attempted on community – based approaches, but none has achieved any long-term effect [Weinstein 1996]. So the need is to follow the effect of dental health education over a long period of time [Kowash et al. 2000]. Later on, the effectiveness of oral health education programs on long period of time as a preventive measure has been tested in several reports. When oral health education is provided over 2 years to teachers in kindergartens (every 3 months), three year old children in kindergartens (monthly) and their parents as well (every 6 months); then there was a reduction in dmfs increment by 30%. Parent's knowledge and attitudes towards oral health was improved and an overall better oral health habits were acquired among preschool children [Rong et al. 2003]. In an another longitudinal study over 3 years for assessing a school – based oral health education program on preschool children, their mothers and the school teachers; the program had positive effects on oral health behaviours of children such as tooth brushing / use of fluoridated tooth pastes and less frequent consumption of cakes or biscuits. Also oral health knowledge and attitudes of mothers and teachers was significantly developed, especially when training workshops and involvements with children were used [Petersen et al. 2004].

3. Aim of the Study

3.1. General Aim

The general aim of the study was to determine the prevalence of ECC in children 6 to 36 months of age living in the federal state Mecklenburg-Vorpommern and to structure an intervention on ECC prevention in a community with polarized caries trends.

3.2. Specific Aims

a) To target the young children especially with underprivileged conditions at an early age.
b) To evaluate the effect of fluoride varnish applications on young children with ECC.
c) To set a structural program that can be adopted by the dental public health authorities to prevent ECC in kindergartens and nurseries.

4. Materials and Methods

4.1. General Description of the Study

Due to the severity of early childhood caries among young toddlers, all kinds of access channels must be developed to control the disease. Measures that are scientifically evaluated with positive impact on the prevention of ECC must be used only. Such measures are the regular fluoride applications, maintaining good oral hygiene via training of children as well parents and teachers on teeth cleaning. The oral health instructions alone are often not enough effective in prevention. Beneficiaries' episode of group prophylactic impulses performed in kindergartens should be expanded to include children from the age of the first year instead of the 3–year–old children. As well, in the professional dental practice, the appropriate period of early examination is at 6 months – by the time of first tooth emerging – rather than to be at 2 ½ years old as the current legislation in Germany implies. Most children diagnosed with ECC at age of 3 years have to be treated under general anaesthesia. For these reasons, a coordination of efforts between the health insurances and dental offices in Mecklenburg-Vorpommern are being developed. In addition, the dental public health officers in the federal state of Mecklenburg-Vorpommern have designed and proposed a program named "Healthy Teeth for a Life Time" as an effective approach to prevent ECC in nurseries.

The data of this study is part of the group prophylaxis program organized and formulated by the Department for Preventive and Pediatric Dentistry at the University of Greifswald. This is to evaluate ECC throughout the academic years 2011 – 2012 and 2012 – 2013 alongside an interventional approach for Mecklenburg-Vorpommern in general and Greifswald in particular.

4.2. Study Background

Since September the 4th of 2011, Mecklenburg-Vorpommern is divided into six rural districts (Landkreis Rostock, Ludwigslust-Parchim, Mecklenburgische Seenplatte, Nordwestmecklenburg, Vorpommern-Greifswald, Vorpommern-Rügen) and the two independent cities of Rostock and Schwerin.

According to the data of the Statistisches Landesamt [2011], Mecklenburg Vorpommern (MV) is the sixth largest German states by territory, with a population count by the end of year 2010 of 1,642,200 residents and an area of 23 191 km². In each kilometer square, 71 persons are recorded, thus making MV the most sparsely populated counties in Germany.

In both population counts in 1990 and 2009, a decrease of 15% (290,000) and of 0.5% (9000) residents was evident, respectively. In addition to this decrease in the growth rate, the mortality rate is still increasing and accompanied by a decrease in the immigrants (1.8%) residing in MV. The value of immigrants in MV is less than the 8.2% average value of total immigrants in German counties [Statistisches Landesamt 2011].

Regarding the family structure, a total of 226 700 families in MV could be divided into three main categories: married couples (61.5%), couples with no marriage (13.4%) and single parents (25% with 89.4% as single mothers) [Statistisches Landesamt 2011]. The average number of children per family was 1.40 ranging between 1.33 (single parents) and 1.44 (married couples). Data compared to 1991 showed a tremendous decrease in the number of families as well as children in each family, where the total population number in MV is around 1,732,000.

The first national caries survey within the community dental health programs started in 1994/95 and was followed by structured examinations in 2000, 2004 and 2009 [DAJ 2010]. In MV, there are 17 health departments with 21 dentists are available. For the DAJ surveys, 20 examiners were calibrated and recalibrated for each examination.

Greifswald is situated in the north-east part of the German federal state Mecklenburg–Vorpommern. At the end of 2012, 54,402 residents were registered as primary residents in the city of Vorpommern–Greifswald. The immigrants constitute 1,849 individuals. This is 186 residents fewer than reported in 2011. The number of secondary residents is still constant unchanged from 2011 with 5,956 residents who are mostly students. Therefore, the total number of inhabitants in Greifswald is 60,358 [Universitäts- und Hansestadt Greifswald 2012].

Child care in Greifswald is divided according to age within the following different facilities: day-care units for under one year of age, nurseries for children up to 3 years old, and kindergartens for children from 3 years old till entering the school. The child care service in the city is available either as full day (up to 10 hours/day), part time (6 hours/day) or half-day (4 hours/day). The total number of facilities in Greifswald is 19, varying between independent (private) and dependent (public) institutions. By law set on 1996, dental and medical examinations are to be performed in children (≥ 3 years) in child care centers and for pupils from grade 1 to 12 which are even compulsory in school. The dental examinations are performed once in a year for evaluating the dental status, examining the oral cavity and detecting any dental malformations [Verordnung Kinder- und Jugendärztlicher Dienst 1996].

4.3. Theoretical Framework of the Study

The successful decline of caries levels among the German population could not be achieved without the combination between the individual prophylaxes by patients and the dental professionals in their practice as well as population-based caries preventive programs. Thus it is difficult to distinguish between the effects of these two kinds of intervention for the prevention of ECC. Although randomised clinical trials (RCT) remain at the top of all known methods for evaluating the success of preventing strategies and oral health promotion programs, this high quality evidence cannot be accomplished often due to methodological or ethical reasons [Plutzer 2010]. Therefore, an assignment to an intervention and a control group was not feasible for this study and all children aged 6-36 months were subjected to the same community-based intervention program.

As in many other health issues knowledge gaps in parents lead to deterioration in the oral health status of children. A previous study on risk factors for ECC in Greifswald [Stumpf 2012] revealed that mother's education played a crucial role in ECC. With the help of the health belief model (HBM) which explains behaviour to be directed by perceptions and beliefs and which suggests the situations in which a person engages in preventive health actions, mother's conceptions of their children's oral health and also in regard to their own oral health may change via oral health education. The mother's desirable oral health behaviours regarding their children or themselves will lead to better oral health of the children [Rosenstock et al. 1988].

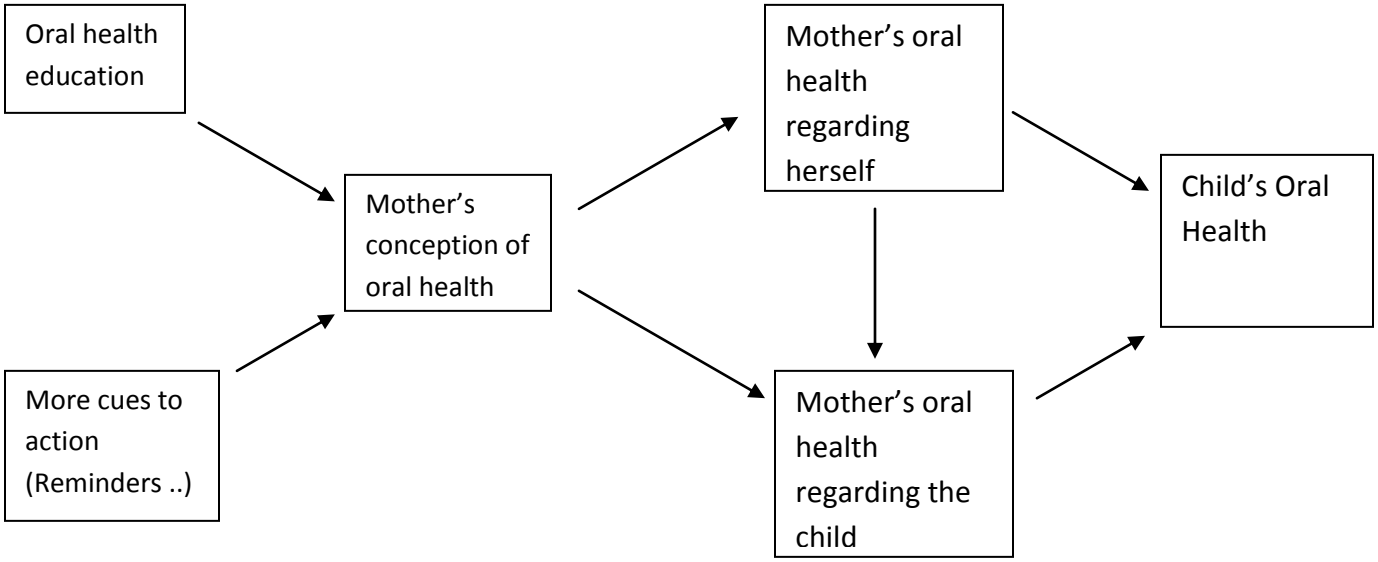

Fig. 2: Theoretical model of the study, modified from the Health Belief Model (HBM) by adding mother and child aspects (Rosenstock et al.1988)

In 2003, the federal oral health authorities known in German as Landesarbeitsgemeinschaft Jugendzahnpflege (LAJ) offered to finance prophylaxis assistance for each of the 17 countries, with a maximum of 25 working hours per week. These prophylactic assistants are stated to be under the scientific supervision of the dental authorities in each county of the state that has the freedom to set local goals according to circumstances such as social structure, activities of the NHS dentists, choices of fluoridation measures, and oral hygiene plans in different facilities.

After 8 years of this oral health program in MV, the evaluations were very positive regarding the caries levels in 6-, 9- and 12-year-olds which declined significantly [DAJ

2010]. Thus, in an effort to target children with ECC in kindergartens and nurseries, the responsibilities of the prophylactic assistant had been expanded and four working hours per week were added for each city. It was compulsory that the data on ECC had to be recorded systematically through continuous investigations in nurseries, and were evaluated scientifically.

Advanced training programs and exchange of experiences between dentists and prophylaxis assistants of the public health services are important to allow a standardization of preventive measures among counties. These annual meetings were supported by the LAJ MV for a quality management of the overall program.

4.4. Pilot Study

The success of such intervention programs requires long-term evaluation. The development of this program in MV could be considered as a step forward to the improvement of the German oral health system especially in the primary dentition and under the age of 3 years.

Therefore, this pilot study reports the current state in the change management of community-based caries-preventive approaches in MV.

4.5. Interventional Part of the Study

In order to reduce the incidence of ECC among young children and toddlers, interventional measures are to be implemented at early ages. Nurseries are the institutions to target for these sample groups. The interventional part of our study is based on two levels:

1) The whole federal state of MV with its counties including Greifswald
2) The city of Greifswald, where an additional use of fluoride varnish was tested in children with already exiting carious lesions.

4.5.1. Study Subjects and Data Collection

Mecklenburg Vorpommern

For the data provided to the ministry of work and social affairs [Landesgesundheitsstatistik Blatt 4 2012] almost half of the 12-13,000 3-year-olds were examined each year. With the start of the ECC prevention program, children under the age of 3 years had to be examined in all of MV from the year 2012-2013. Thus, a total of 4283 children were examined for especially for ECC with numbers of children ranging between 54 and 1077 per county. However, not all counties managed to enroll in the ECC program and were obliged to feed their data into this study. Therefore, 6 out of 8 public health centers with 3601 children ranging between 335 and 980 per site had participated.

The child's age was recorded with an accuracy of within one day. In order to ensure greater homogeneity, four age groups were formed: less than one year (n = 8), one year (n = 293), two years (n = 1618) and three years (n = 1888). The two older groups were somewhat overrepresented might be due to the low number of new born each year or due to mother's need not to put their children in nurseries during the first year of born.

Greifswald

For the additional pilot evaluation of fluoride varnish applications on carious lesions, a longitudinal clinical trial was carried out in which each individual served as his/her own control. Children aged between 6 and 36 months enrolled in nurseries in the city of Greifswald participated in this part of the study.

Several studies investigated the effect of fluoride varnish on white spots used a sample size ranging between 22 and 36 lesion [Silva et al. 2012; Almeida et al. 2011; Ferreira et al. 2009]. In our pilot study, all children (n = 32) previously diagnosed with ECC 1 (initial lesion) or ECC 2 (carious defects) in the community examinations were invited to inactivate these lesions via fluoride varnish (ECC 1: n = 15, ECC 2: n = 17). All parents agreed to take part.

4.5.2. Study Questionnaires and Clinical Examination

National data on the prevalence of early childhood caries are not available in Germany. The appropriate and effective measures for caries prevention are also not systematically collected and evaluated. This is due to the late adoption of policies to target ECC in nurseries by the LAJs and DAJ which expanded the group prophylaxis programs to children below 3 years of age in nurseries only after 2010. Therefore, the current study has a primarily aim to systematically collect data and develop a community–based, uniformly structured preventive program in nurseries starting from MV.

The data collection involved questionnaires sent to the dental community authorities in each county focused on two main subjects:

a) Prevalence and distribution of ECC
b) Preventive measures in nurseries

The values of ECC were recorded in conjunction with the dmf-t index that is accredited by the WHO criteria for diagnosing and recording caries [WHO 1997]. The ECC index in table 4 is the one modified by Robke and Buitkamp [2002]: In the children up to 3 years only the maxillary anterior tooth were examined and categorized from healthy to carious defect, fillings or extractions.

Table 4: Represents the criteria of Early Childhood Caries according to Robke & Buitkamp [2002]

ECC	Criteria
ECC 0	No caries
ECC 1	Represents either extensive or minimal initial carious lesions that are usually reversible (white spots)
ECC 2	Represents a true macroscopic extensive carious defect, filled or missed maxillary anterior teeth

These criteria and an according coloured atlas with multiple examples for each score had been sent to all examiners in the counties. Regarding the dmf-t, all examiners had been calibrated within the several DAJ surveys.

The questionnaire that was filled out by the community dental services of the participating counties included the following topics:

a) Information on the prophylaxis assistant
b) Number of examined children and care centers
c) The nature of measures implemented
d) Access to care centers
e) Interactions with teachers
f) Use of material for informational aid
g) Information regarding tooth brushing practice in care centers
h) The influence of beverage consumption in care centers
i) Use of fluorides

Fluoride varnish application

The inclusion criteria for the fluoride varnish were active carious lesions either incipient non-cavitated (chaulky, rough and opaque) or cavitated on the primary anterior teeth. While the exclusion criteria were syndromes, dental developmental anomalies and medications that altered salivary flow/composition.

The clinical examination and application of fluoride was performed under natural light in an open environment at the nursery. A form was drafted for the identification of the child and for recording of the data. The data were collected by a single, duly calibrated examiner with the assistance of a previously trained individual. The clinical exam involved the assessment of activity including texture and luminosity.

In addition, the simplified oral hygiene index (OHI-S) proposed by Greene and Vermillion [1964], was used prior to the clinical examination. Using a probe, six surfaces were selected for the examination from four posterior and two anterior teeth. Usually the

first fully erupted permanent molar is selected, but in this sample of under three-year-olds the last primary molar tooth was selected. Thus, in the posterior portion of the dentition, the buccal surface of the upper second primary molars (55 and 65) and the lingual surface of the lower second primary molars (75 and 85) whereas in the anterior portion of the mouth, the labial surface of the upper right (51) and lower left (71) central incisors were inspected. In the absence of either of these anterior teeth, the central incisors (61 and 81 respectively) on the opposite side of the midline are substituted.

The OHI-S has two components, the debris index and the calculus index. Each of these indices is based on numerical determination representing the amount of debris and calculus on the preselected tooth surfaces. The criteria for classifying debris according to Greene and Vermillion were as follows in table 5.

Table 5: Criteria of debris index [Greene and Vermillion 1964]

Scores	Criteria
0	No debris or stain present
1	Soft debris covering not more than one third of tooth surface, or presence of extrinsic stains without other debris regardless of the surface area covered
2	Soft debris covering more than one third, but not more than two thirds, of the exposed tooth surface
3	Soft debris covering more than two thirds of the exposed tooth surface

The OHI–S is calculated according to the following formula:

	Formula
Debris index	$\frac{\text{number of buccal surfaces + number of lingual surfaces}}{\text{total number of examined surfaces}}$
Calculus index	$\frac{\text{number of buccal surfaces + number of lingual surfaces}}{\text{total number of examined surfaces}}$
OHI – S	Debris index + Calculus index

Children were examined in time before their breakfast in the nurseries. Smooth surface of anterior teeth were cleaned and dried with gauze and the lesions were then evaluated and classified as either active (rough and opaque) or inactive (smooth and shiny). The classification is based on a report to investigate the difference between active and inactive caries lesions [Nyvad et al. 1999].

After recording the characteristic criterion for each lesion, the Duraphat® (5% NaF = 2.26% F, Colgate-Palmolive, Germany) fluoride varnish was applied with the aid of cotton swab according to manufacture guidelines. Any excess was removed using a cotton ball, and instructions for the teacher responsible in class not to brush the child's teeth at the day of application as well use a diet of liquids or pasty foods for at least two hours following application of the product. The clinical procedures were performed at baseline with application of varnish, and then re-evaluated at three months interval for changes in texture and luminosity of lesions as well as OHS-I values.

4.6. Ethical Considerations

The use of fluoride varnish on children with ECC was performed in the setting of the community dental services for which the ethics committee in the University of Greifswald has approved an analysis of its preventive measures (No 10/88). The parents had given their authorization for the participation of their child by signing a statement of informed consent.

4.7. Statistical Analysis

A descriptive analysis was used to illustrate the development of the caries prevalence in Mecklenburg-Vorpommern. The evaluation of statistical significance was made by means of Wilcoxin t-test for mean values and the McNemar test for frequencies. The level of significance set to be 5% ($p < 0.05$). The data were analyzed by SPSS, version 21.

5. Results

5.1. Prevalence and Distribution of Caries and ECC

The epidemiological situation in Mecklenburg-Vorpommern was analysed in order to evaluate the effectiveness of existing preventive program. Therefore, the data on 3-year-olds up to the year 2011-2012 [SozMin Blatt 4 2012] were selected and compared to the current data of this study from the year 2012-2013.

Over the last 17years, caries prevalence has dropped in 3-year-olds in Mecklenburg-Vorpommern from 0.7 dmf-t in 1996 to 0.5 dmf-t in 2013 (fig. 3) [Sozialministerium 2013]. In comparison to the more impressive caries reductions in the permanent dentition, this decline of 28.5% is rather small, even in the light of the 36.6% caries reduction for the primary dentition of 6-year-olds.

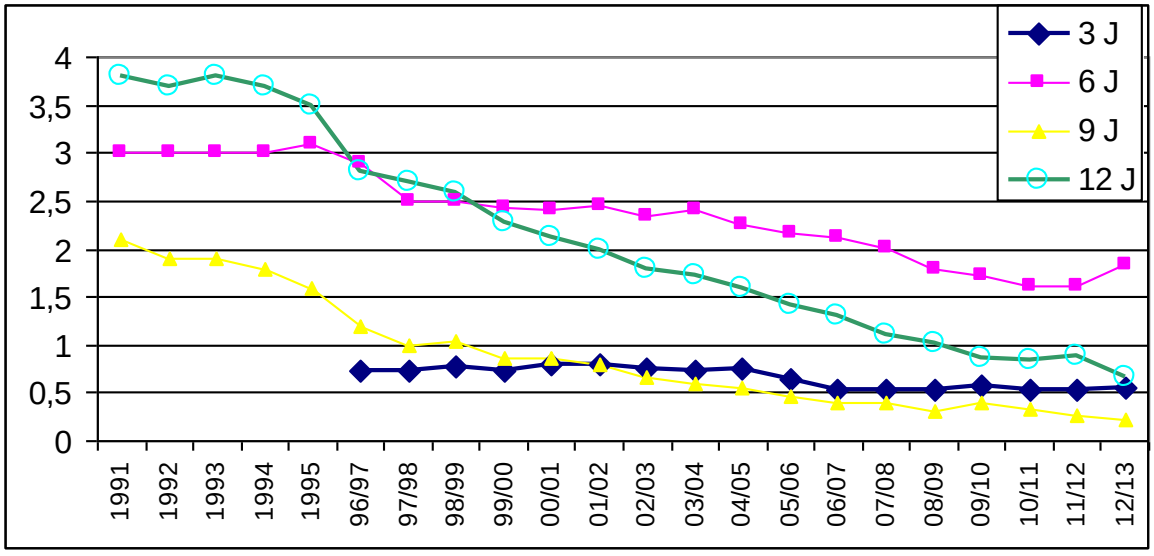

Fig 3: Caries data overview for children in Mecklenburg-Vorpommern from 1991 to 2013.

Regarding the special cohort of this study, approximately 13300 children (birth rate: 8.1) were born in year 2010 in Mecklenburg Vorpommern with a slight upward trend in comparison to previous year. With a very high number of children attending the almost 600 nursery centers and kindergartens, group prophylactic actions will serve most of children [Statistische Landesamt 2011].

In 2012/2013, 6830 3-year-old children were examined by the public health services. The average value for carious, missed and filled primary teeth was 0.55 dmf-t (fig. 4). The detailed information for all different counties is presented in table 6 and 7 [Sozialministerium 2013]. The majority are the untreated carious teeth with 78% (d-t = 0.43) while the restored and extracted teeth represent 7% and 15% with an index of 0.04 and 0.08 dmf-t, respectively [fig. 4 & table 7].

Whereas in 2011/2012, 7078 3-year-old children were examined by the public health services in Mecklenburg-Vorpommern, and the mean value of decayed and filled teeth (df-t index) scored 0.53. The majority were untreated carious teeth with 85% (d-t = 0.45) while the restored teeth represent 15% (f-t = 0.08) of the total sample (table 6).

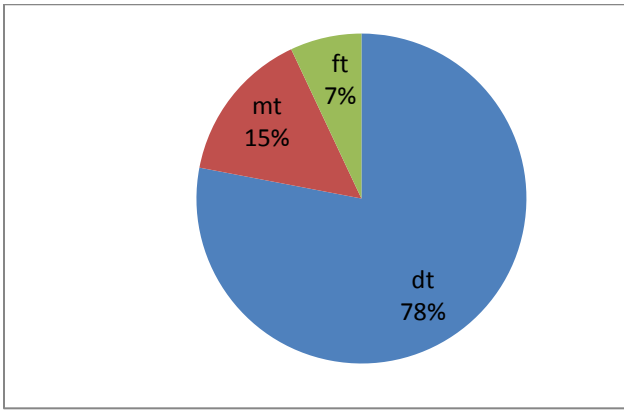

Fig. 4: Distribution of the single components of the dmf-t index for 3-year-old children in Mecklenburg-Vorpommern in 2012/2013

Table 6: The dmf-t index and its single components for 3-year-old children for Mecklenburg-Vorpommern in 2011/2012.

County	Examined children	decayed teeth	filled teeth	d-Index	f-Index	d/f-Index
Rostock	1067	302	100	0.28	0.09	0.38
Schwerin	474	251	45	0.53	0.09	0.62
LK Mecklenburgische Seenplatte	1314	691	162	0.53	0.12	0.65
LK Rostock	1210	563	112	0.47	0.09	0.56
LK Vorpommern Rügen	1024	431	67	0.42	0.07	0.49
LK Nordwestmecklenburg	212	84	4	0.40	0.02	0.42
LK Vorpommern Greifswald	1094	438	34	0.40	0.03	0.43
LK Ludwigslust Parchim	683	419		0.61	0.00	0.61
Mecklenburg-Vorpommern	**7078**	**3179**	**571**	**0.45**	**0.08**	**0.53**

Table 7: The dmf-t index and its single components for 3-year-old children for Mecklenburg-Vorpommern in 2012/2013.

County	Examined children	d-teeth	m-teeth	f-teeth	d-Index	m-Index	f-Index	dmf-Index
Rostock	963	269	49	81	0.28	0.05	0.08	0.41
Schwerin	455	102	24	23	0.22	0.05	0.05	0.33
LK Mecklenburgische Seenplatte	1417	552	75	136	0.39	0.05	0.1	0.54
LK Rostock	1066	412	28	96	0.39	0.03	0.09	0.5
LK Vorpommern Rügen	897	542	30	76	0.60	0.03	0.08	0.72
LK Nordwestmecklenburg	66	19	2	5	0.29	0.03	0.08	0.39
LK Vorpommern Greifswald	984	531	8	65	0.54	0.01	0.07	0.61
LK Ludwigslust Parchim	982	536	37	92	0.55	0.04	0.09	0.68
Mecklenburg-Vorpommern	**6830**	**2963**	**253**	**574**	**0.4338**	**0.037**	**0.08**	**0.55**

On the other hand, children that were under 3 years of age (n=4283) had a mean dmf-t of 0.1, where untreated cavitated teeth represent more than 80% of the total value (d-t index =0.08). The percentage of missed teeth is more than half (6%) the value for children at 3-years old with almost equal values of filled teeth. This may explain the increase in decayed teeth at lower ages. Table 8 shows the distribution of dmf-t values with its single components and the total caries prevalence in Mecklenburg-Vorpommern for children younger than 3 years is 15% in the year 2012/2013.

Table 8: The caries prevalence for children younger than 3-years-old for Mecklenburg-Vorpommern in 2012/2013 (**i**nitial lesion, **n**bs defect, **m**issing, **f**illed, **z**erstört, **e**xtracted)

County	Number of examined children	i-teeth	n-teeth	m-teeth	f-teeth	z-teeth	e-teeth
Rostock	736	45	24	1	16	0	4
Schwerin	335		39				
Mecklenburgische Seenplatte	1077	36	139	12	15	0	0
Landkreis Rostock	779	38	67	7	0	0	19
Vorpommern-Rügen	160		4				
Nordwestmecklenburg	54	2	3			4	
Vorpommern-Greifswald	434	16	67	0	0	0	0
Ludwigslust-Parchim	708						
Mecklenburg-Vorpommern	**4283**	**137**	**343**	**20**	**31**	**4**	**23**

For the same age group, 3265 children in Mecklenburg-Vorpommern were examined in 2011/2012, and the caries prevalence was 9% with almost 91% of children were caries-free, where the majority of children had caries to be treated 8% (table 9).

Table 9: Dental status of children in Mecklenburg-Vorpommern under three years old in year 2011/2012

County	Total number	Examined Teeth number	in %	Dental status (%)		
				Healthy teeth	Treatment need	Treated
Rostock		**0**				
Schwerin	471	398	84.5	94.5	4.5	1.0
Mecklenburgische Seenplatte	1682	809	48.1	92.1	6.6	1.4
Landkreis Rostock	1043	688	66.0	93.2	6.0	0.9
Vorpommern-Rügen	198	153	77.3	88.2	9.8	2.0
Nordwestmecklenbrg	469	191	40.7	50.3	45.5	4.2
Vorpommern-Greifswald	661	661	100.0	94.9	5.0	0.2
Ludwigslust-Parchim	831	365	43.9	94.5	5.5	0.0
Mecklenburg-Vorpommern	**5355**	**3265**	**61.0**	**90.8**	**8.2**	**1.0**

The dental public health departments of all counties in MV performed the ECC examination that is supported by the LAJ. The majority of children under 3 years of age are free of caries in their anterior primary teeth (table 10), whereas children with ECC 1 or ECC 2 constitute 4% of the total children which is similar to the results from the previous year (table 11).

Table 10: The values of Early Childhood Caries for children in Mecklenburg-Vorpommern in 2012/2013.

	No. of examined children	ECC 0	ECC 1	ECC 2	No. of examined children	ECC 0	ECC 1	ECC 2
County		<3 years				3-<6 years		
Rostock	736	724	4	8	3022	2832	39	151
Schwerin	335	321	1	13	1364	1273	3	88
Mecklenburgische Seenplatte	1077	1023	10	44	4691	4312	77	302
Landkreis Rostock	779	732	13	34	3259	2999	15	245
Vorpommern-Rügen	160	158	0	2	2,887	2,732	7	148
Nordwestmecklenburg	54	51	1	2	243	211	6	26
Vorpommern-Greifswald	434	408	3	23	1731	1497	5	228
Ludwigslust-Parchim	708	690	3	15	2960	2787	34	139
Mecklenburg-Vorpommern	**4283 (100%)**	**4107 (96%)**	**35 (1%)**	**141 (3%)**	**20157 (100%)**	**18643 (92%)**	**186 (1%)**	**1327 (7%)**

Table 11: The values of Early Childhood Caries for children in Mecklenburg-Vorpommern in 2011/2012.

County	No. of examined children	No. of children with ECC	in %	No. of examined children	No. of children with ECC	in %
	<3 years			3-<6 years		
Schwerin	398	5	0.3	1775	17	1.0
Mecklenburgische Seenplatte	809	39	0.8	5034	203	4.0
Landkreis Rostock	688	22	0.5	4454	193	4.3
Vorpommern-Rügen	153	0	0.0	3914	190	4.9
Nordwestmecklenburg	191	4	0.4	1128	8	0.7

Vorpommern-Greifswald	661	28	0.9	2998	146	4.9
Mecklenburg-Vorpommern	**2900**	**98**	**3.3**	**19303**	**757**	**3.9**

Oral health prophylaxis in the nursery centers included a total of 3601 children up to 3 years of age that constitutes more than 80% of examined (3601 out of 4283) children in the state of MV (table 12).

Table 12: Number of children in Mecklenburg-Vorpommern with prophylactic impulse in 2012/2013.

County	0 Years	1 Year	2 Year	3 Year	**Total**
LK Rostock – Bad Doberan	0	0	302	454	**756**
Schwerin	0	0	352	0	**335**
LK Vor. Greifswald – Anklam	2	99	342	537	**980**
LK Meck. Seenplatte – Neustrelitz	0	8	298	472	**589**
Nordwestmecklenburg					
LK VP-GW – Greifswald	6	186	324	425	**941**
Mecklenburg-Vorpommern (Total)	**8**	**293**	**1618**	**1888**	**3601**

For the city of Greifswald had consecutive data for the ECC categories were available (fig. 5) which were both very similar and in the range of the overall prevalence in Mecklenburg-Vorpommern (table 10).

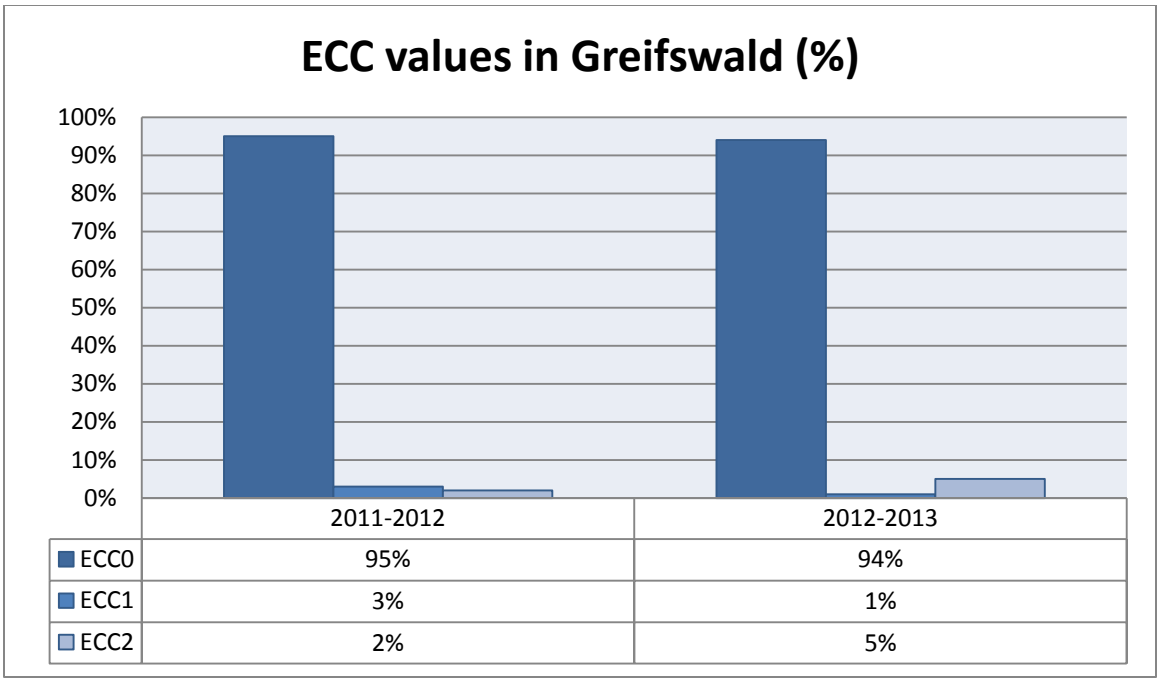

Figure 5: The Early Childhood Caries values in the city of Greifswald throughout the years 2011/2012 and 2012/2013

5.2. Preventive Measures in Nurseries

5.2.1. Job Position

The position of prophylaxis assistant for the prevention of ECC in nurseries was uniformly increased and occupied in most counties starting from September 2012. For Vorpommern-Greifswald/Pasewalk and the city of Schwerin, the position was not filled until April and July 2013, respectively which reduced the sample in the academic year 2012 – 2013.

5.2.2. Number of Facilities and Children

In the district of Mecklenburg Vorpommern, 261 nursery centers are registered ranging from 23 to 60 nurseries in the different counties. Over 16 thousand children up to the age of three were enrolled in these institutions (table 13).

Table 13: The number of children and nurseries distributed among different counties of Mecklenburg-Vorpommern in 2012/2013.

County	No. of children	No. of children <1	No. of children 1-3	No. of nursery centers
LK Rostock - Bad Doberan	5314	1770	3544	60
Schwerin	1435	118	1317	30
LK Vor. Greifswald - Anklam	2350	800	1550	60
LK Meck. Seenplatte - Neustrelitz	1701	552	1149	49
Nordwestmecklenburg	3973	1290	2683	23
LK Vor. Greifswald - Greifswald	1582	532	1050	39
Mecklenburg-Vorpommern (Total)	**16355**	**5062**	**11293**	**261**

5.2.3. Types of Preventive Activities Undertaken

Each county were obliged to report about the specific preventive measures that were applied in nurseries. These measures were as follows:

a) Discussions with administrators and teachers of nurseries through educating, directing and motivating them.
b) Discussions with parents via parents meetings in nurseries.
c) Parents counseling about early childhood caries and how to adopt proper nutrition and brushing techniques.
d) Training parents and children on proper teeth cleaning.
e) Emphasis on children's health and smile.
f) Introduction of tooth brushing practice for children from 2 years in the nurseries.
g) Helping in performing tooth brushing on site.
h) Handing out well organized information material.

i) Playful communication about brushing teeth with small children.
j) Nutritional counseling, practical cleaning training, meetings with parents.
k) Implementation of events on dental health.

The prophylaxes assistants in all counties used informational material and tooth brushing practice was performed for all children using fluoridated tooth pastes that were suitable for children with a fluoride content of 500 part per million (ppm). The information materials used varied between the counties (table 14).

Table 14: Informational materials used by prophylaxis assistance in nursery centers of Mecklenburg-Vorpommern

- Brochure “Health of the baby teeth” by GABA
- Brochure by the association of dental hygienist (Title: parents brush children’s teeth)
- Brochure in the title of “how to protect children against caries”.
- Children’s dental pass (Zahnärztlicher Kinderpass)
- Scientific information working materials
- Info sheets adopted by the DAJ and used since years for 2 year old children (Title: baby’s teeth should be shiny – proper drinks help)
- Self – made brochures about oral health and ECC

Regarding the drinks consumed in nurseries and their impact on oral health, discussions with teachers and parents about healthy drinks and nutrition were taken in almost all districts except in that of Bad Doberan. Also all except Nordwestmecklenburg used neither fluoride varnish nor gel in children up to three years old with signs of initial lesions.

5.2.4. Access and Cooperation in Nurseries

Despite of the potentially positive attitude and good cooperation in nurseries, still there are some problems in applying proper oral hygiene issues in regards to parent’s meetings and motivation of teachers. In general, the feedbacks of access and cooperation range from bad to good.

The positive and negative points concerning the access and cooperation are described in table 15.

Table 15: Positive and negative points concerning access and cooperation with nurseries

Positive	Negative
• Open discussions with teachers • The teachers generally were open minded and interested • Good contact with the administrator of the nurseries	• Difficulty in setting appointments with parents for meetings • Cooperation was difficult in some places due to weak personnel and motivation of the teachers • Hygiene rooms in nurseries complicated the implementation of prophylaxes for educators • Late cancellation for several appointments

The target groups of our preventive program were as follows: children, parents and teachers in nursery centers. The prophylaxis assistants performed preventive measures on an average of 796 children in Mecklenburg Vorpommern. The number of children ranges between 0 and 1436 in each county. Performing tooth brushing on site and playful communication about tooth brushing as well is the most delivered action to children whereas information or administration of fluoride tablets is the least. Regarding the parents sessions with the prophylaxis assistants, an average of 375 parents managed to attend the counseling sessions. Parents had the opportunity to be more informed about preventive measures especially messages concerning early childhood caries and how to adopt proper nutrition and brushing techniques as well. Most of the parents experienced and are trained for proper teeth cleaning. The third target group that received prophylactic information were the teachers in nursery centers. A mean number of 299 teachers get acknowledged about importance of tooth brushing, the use of fluoridated tooth pastes and practiced proper brushing techniques [tables 16- 18].

Table 16: The number of children in counties of Mecklenburg-Vorpommern that received the prophylactic messages in 2012/2013.

County / prophylaxis information	Bad Doberan (LK Rostock)	Schwerin	Anklam (LK. Vorp. Greifswald)	Neustrelitz (Seenplatte)	NWM	Greifswald (LK. Vorp. Greifswald)	Parchim	**Total MV**
Explaining caries	0	335	320	0	391			**1046**
Explaining ECC	0	335	320	0	391			**1046**
Diet counseling	0	0	320	0	391			**711**
Recommendation of bottle stoppage	0	0	320	0	0	128		**448**
Brushing technique counseling	131	0	320	267	391	128		**1237**
Practicing brushing training	51	173	320	232	391	128		**1295**
Fluoride tablets	0	0	0	0	0			**0**
Fluoride toothpaste	0	335	320	255	391	128		**1429**
Recommendation of toothbrush	0	335	320	262	391	128		**1436**
Using cotton swab	0	0	0	0	0			**0**
Using finger brush	0	0	0	108	0			**108**

Table 17: The number of parents in counties of Mecklenburg-Vorpommern that received the prophylactic messages in 2012/2013.

County / prophylaxis information	Bad Doberan (LK Rostock)	Schwerin	Anklam (LK. Vorp. Greifswald)	Neustrelitz (Seenplatte)	NWM	Greifswald (LK. Vorp. Greifswald)	Parchim	**Total MV**
Explaining caries	50	108	135	115	20	62		**490**
Explaining ECC	50	108	135	107	20	62		**482**
Diet counseling	50	108	135	107	20	62		**482**
Importance of bottle stoppage	50	108	135	107	0	62		**462**
Brushing technique counselling	50	108	136	107	20	62		**482**
Practicing brushing training	0	108	107	101	0	82		**398**
Fluoride tablets	0	0	0	0	0			**0**
Fluoride toothpaste	50	108	135	107	20	82		**502**
Importance of toothbrush	50	108	135	107	20	62		**482**
Cotton swab	0	0	0	0	0			**0**
Finger brush	50	0	0	105	0			**105**

Table 18: The number of teachers in counties of Mecklenburg-Vorpommern that received the prophylactic messages in 2012/2013

County / prophylaxis information	Bad Doberan (LK Rostock)	Schwerin	Anklam (LK. Vorp. Greifswald)	Neustrelitz (Seenplatte)	NWM	Greifswald (LK. Vorp. Greifswald)	Parchim	**Total MV**
Explaining caries	32	73	96	38	60	28		**327**
Explaining ECC	32	73	96	36	60	28		**325**
Diet counseling	32	0	96	38	60	28		**254**
Importance of bottle stoppage	32	0	96	45	60	28		**261**
Brushing technique counseling	32	73	96	55	60	28		**344**
Practicing brushing training	0	73	96	55	60	28		**312**
Fluoride tablets	0	0	0	0	0			**0**
Fluoride toothpaste	32	73	96	54	60	28		**343**
Importance of toothbrush	32	73	96	53	60	28		**342**
Cotton swab	0	0	0	0	0			**0**
Finger brush	0	0	0	16	0			**16**

5.2.5. Fluoride Varnish Intervention

A total of 735 children less than 3 years old are distributed among the different 19 nursery centers and kindergartens in the city of Greifswald. Only 32 children in 9 centers acquire a grade of either ECC 1 or ECC 2.

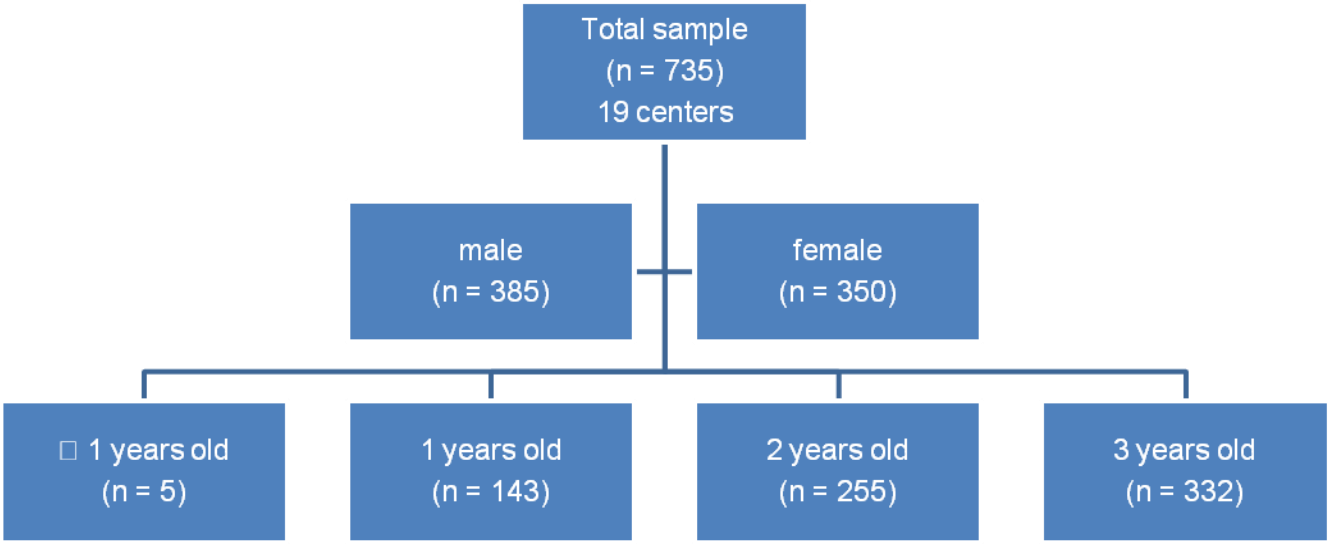

Figure 9: Flow chart of the children distribution in Greifswald according to gender and age.

The mean age of participating children was 2.24 years with standard deviation of 0.78. The sample was composed of 44 incipient carious lesions on the vestibular surface of the primary anterior teeth. At the beginning of the study, 36 white spots were active (chaulky, rough and opaque), while 8 spots were inactive (smooth and shiny) (fig.9 & 10).

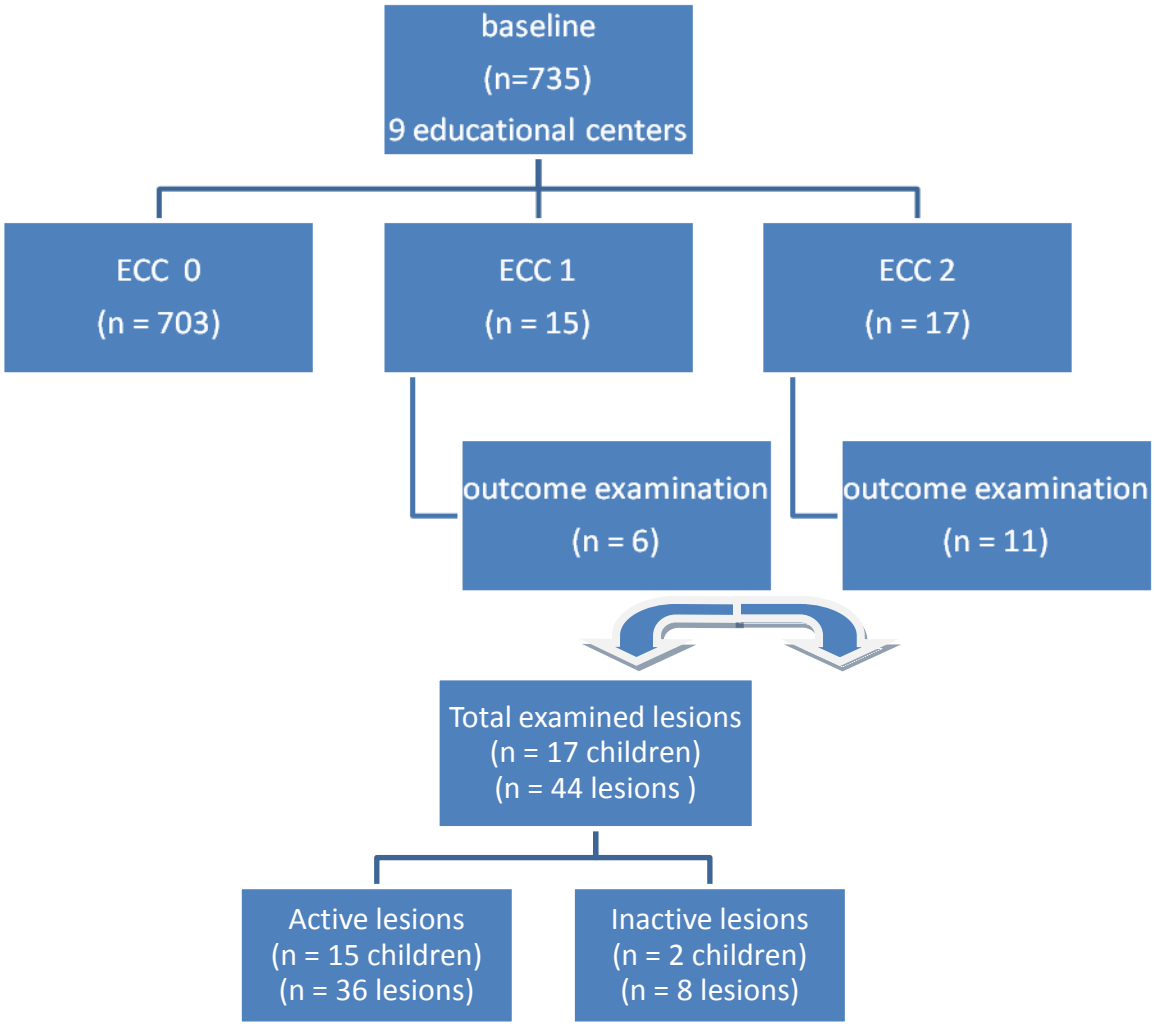

Figure 10: Flow chart of the interventional study on 6 months to 3-year-old children prior to fluoride application.

The statistical analysis showed no statistical difference between the initially very low mean OHI–S (1.10 ± 0.64) and the final evaluation (1.27± 0.31) after three months ($p > 0.05$, 2-Wilcoxon paired t-test) demonstrating basically no changes in oral hygiene.

Out of 17 children whose parents accepted to enroll in the fluoride varnish study, 44 lesions were diagnosed. At baseline, 36 lesions were active, while 8 lesions were inactive (table 19). In contrast to the unchanged low OHI-S values, there was a clear change in the caries status before and after the application of fluoride varnish: Eighty one percent of lesions were inactivated completely within 3 months. The lesions that

were inactive initially remained also inactive, while 19% of active lesions failed to be turned on to the inactive state (table 19). Using the McNemar test for paired sample statistical analysis, the difference between the caries status before and after the use of fluoride varnish is statistically significant (p-value < 0.05).

Table 19: Number and status of caries lesions prior and post fluoride varnish application

	Baseline (%)	3-month follow-up (%)
Active	36 (82%)	5 (11%)
Inactive	8 (12%)	39 (89%)

6. Discussion

6.1. Discussion of the Aim

The present study assessed the prevalence of early childhood caries in 6- to 36 month-old children living in the county of Mecklenburg-Vorpommern and analysed the initial stage of a program via parents and nursery teachers on caries prevention in early childhood. The data collection consisted of structured questions for the community dentists and clinical dental examination of children in nursery centers.

In addition to the educational intervention, the children with ECC living in the city of Greifswald were treated with fluoride varnish and the effectiveness of this measure was assessed from baseline to a three-month follow-up.

This study reported the current state in the change management of community-based caries-preventive approaches in Mecklenburg-Vorpommern and considered a step forward to the improvement of the German oral health system especially in the primary dentition and under the age of three years.

6.2. Methodological Aspects

6.2.1. Subjects and Sampling

The common problem in an oral health study of the very young children is that they are not easily reached and a representative sample is difficult to achieve. In some developed countries such as the Nordic countries, prevention is given a high priority for children and adults as well i.e. from birth until completion of mandatory school education. They are entitled to regular oral health care that is most often free of charge, and as a result they are easily available in dental settings [Kristiansen and Pedersen 2000]. In other countries, dental facilities are only available by private practitioners that will create difficulties for the low income groups.

In Germany, the oral health system managed to cover children over six years in community and professional–based preventive measures. However, the access to children younger than six and older than three is minimally available, where the health insurance pays the chair-side intervention only once a year [BEMA 2004]. On the other hand, the children under three years are not covered for professional dental prevention as other age groups, so this study is an attempt to reach the maximum number of these children in their public institutions. Therefore, it represents a marked improvement in the oral health system regardless of the difficulties in targeting all children of this age group.

The oral health screenings of the community services are performed widely and annually among all counties of Mecklenburg-Vorpommern. The extension of the existing prevention program provides high coverage for children under the age of three years. The similarity in distribution of children between present study and the general overview of oral health programs in Germany [DAJ 2010] speaks for the representativeness of the present sample. To ensure greater homogeneity of the sample, the child's age was recorded with an accuracy of one day and then creating four age groups.

6.2.2. Data Collection Form

The data collection questionnaires sent to the dental community authorities in each county. The evaluation process of ECC was performed according to Robke and Buitkamp (table 3). A well designed sheets including demographic parameters such as age and gender, dmf-t values with a record for every single component (i.e. d-t/ m-t/ f-t) were used. In addition to data on prevalence of caries and ECC, data on preventive measures undertaken in nurseries were collected to monitor the quality of actions and increase effectiveness of program via standardization of measures among all counties. Also the oral hygiene index (OHI-S) records for children diagnosed with ECC and status of lesions (i.e. active or inactive) were formulated in a different sheet for both baseline and their 3-month follow up.

6.2.3. Examination and Diagnosis of Caries

The WHO criterion for caries diagnosis is recommended in epidemiological studies [WHO 1997]. However, the use of enamel non cavitated caries assist the public health professionals in detecting changes in caries level in areas of moderate or low prevalence of caries [Kingman and Selwitz 1997]. This is commonly the case in very young children. In addition to enamel caries recordings for tracking the variation in caries trend is by giving a distinct value of the initial lesions – that are usually not considered in the decayed category [Buitkamp and Robke 2002]. In this study, upper anterior teeth were examined for initial as well as cavitated dentinal caries (at least two teeth). This offers the best control in field environment regarding light and moisture control, hence resulting in considerable reliability of the examiner. The overall image of the health status of the children in Greifswald is evaluated by recording the debris and calculus index using the simplified oral hygiene index (OHI-S) according to Greene and Vermillion [1964], preparing them to evaluate the type of initial lesions whether active (rough and opaque) or inactive (smooth and shiny) [Nyvad et al. 1999].

6.2.4. Method of Comparison

The data of the LAJ of three year old children from the year 2011-2012 [SozMin Blatt 4 2012] were used for comparison. The identical methodology and study-design of the group prophylaxis measures in 2012, allows a traceable comparison with this study. In the present study, all counties of Mecklenburg-Vorpommern managed to report data on primary teeth health status (dmf-t) and early childhood caries (ECC), unlike the compared year where two counties (Rostock & Ludwigslust-Parchim) did not report such data.

6.3. Discussion of the Results

6.3.1. Distribution of ECC/dmf-t in Comparison to International Studies

The prevalence of caries in primary dentition varies depending on age group examined. Most studies on ECC are on children aged three till five years. In this study, our target group are children below the age of three. In this child population, the overall caries prevalence on a child level (dmf-t>0) and prevalence of ECC were 15% and 4%, respectively. International records on overall caries prevalence range from 22% to 55%, for ECC from 14% to 83%. Hence, the present prevalence of caries and ECC were clearly lower than in the Far East Asian, Middle East and Latin America [Tiano et al. 2009; Vachirarojpisan et al. 2004; Rajab and Hamdan 2002]. However, the prevalence of caries at three years (55%) is rather high in comparison to other Western European countries – including Nordic countries as Sweden and Denmark with a range from 8% to 32% [Barfod et al. 2011; Hugoson et al. 2000; Davis et al. 2001]. The very low prevalence of caries in Denmark (8%) for children at three years old may be due to the developed oral health system that engages with children as early as six months of age. Taking into account the high prevalence of caries for the 3-year-old children in Mecklenburg-Vorpommern, a public health approach is essential to reach this young population.

6.3.2. Distribution of ECC/dmf-t in Comparison to German Studies

The values of early childhood caries in Germany vary between 5% and 20% according to age group [Splieth et al. 2009]. Different studies throughout different regions of Germany estimated the prevalence of ECC. In Mecklenburg-Vorpommern, children under the age of three years show a lower frequency of ECC compared to results in the federal state of Brandenburg [Diechsel et al. 2012]. Similar results are also found in older age groups (3 to 5) where Mecklenburg-Vorpommern results are considerably lower than those in North Western and middle of Hessen [Robke 2008; Nies et al.

2008]. This raises the question if these results are valid or the application of diagnostic criteria. In addition, it calls for a national and, therefore, comparable survey on 3-year-olds and ECC which would include initial caries lesions.

6.3.3. Effectiveness of the Preventive Measures

The city of Greifswald delivered longitudinal data on the severity of ECC for the years 2011-2012 and 2012-2013. For Greifswald, a group of children with ECC was subject to fluoride varnish applications also, which resulted in a clear conversion active to inactive lesions. This demonstrated that the severity and activity of ECC lesions can be recorded and reduced with easy public health measures.

The findings support the idea that different levels of ECC can be monitored and subsequent interventions are feasible which agrees with the results of some previous ECC programmes [Gussy et al. 2006; Rong et al. 2003; Kowash et al. 2000]. The low numbers of initial lesions and a possible decrease (ECC1) in the present study raises the question if this reflects the success of preventive intervention measures, if initial lesions are hard to detect in community examinations in small children or if they quickly convert into carious defects.

The emphasis on the importance and appropriate use of fluorides for young children concur with the evidence based knowledge of the effectiveness of fluoridated tooth pastes in caries reduction [Gussy et al. 2006; Marinho et al. 2004]. Hence, maintaining on routine oral hygiene practices via use of tooth brush with fluoridated paste is to be considered a public health measure to prevent caries [Petersen et al. 2004; Rong et al. 2003; Kowash et al. 2000].

Another mean of delivering fluoride for young children is the varnish that has been increasingly used by dental professionals. In this study, fluoride varnish is applied on children diagnosed with ECC (in the city of Greifswald only) to be recalled in three months. 81% of lesions that are active lesions turned into inactive state and caries progression is arrested. The present findings agreed with the previous studies that

concluded the inhibiting effect of fluoride varnish on primary dentition with the ability to reverse early tooth decay and reduce the incidence of caries in high risk children younger than five years old [Chou et al. 2014; Marinho et al. 2002]

The use of verbal explanation on oral health instructions via private meetings with parents and teachers at the nurseries may be a factor in improving the behavioral attitudes towards oral health than using brochures alone. This agreed with the findings of other studies that considered motivation of parents to follow oral health instructions and reinforcement on their information as a positive determinant in increasing the effectiveness of oral health promotion interventions [Plutzer and Spencer 2007; Weinstein et al. 2004].

Despite the improved strategies in oral health in Germany, caries prevention for young children is still far from optimal. Children younger than 2½ years are not covered for chair-side prevention and those between 2½ and six years old only once a year (FU) [BEMA 2004]. Countries with free of charge dental services, managed successfully to reach children under three years of age, but the cost was high as a result of using a dentist dependent oral health promotion. The key factor of successful oral health promoting programs is to be accessible for all population while taking into consideration the health care financial resources. Conventional oral health education that tends to concentrate on individual's behaviour is not effective. Therefore, a "common risk factor" approach designated by Health Promoting Schools regarding the impact of diet and hygiene on general health as well as on dental health is proved to be an effective way for promoting oral health [Sheiham and Watt 2000]. In the present study, the nursery centers with non dental prophylactic assistants providing parents and teachers with oral health instructions seemed to be appropriate for oral health of children. This approach agreed with studies that health promoting behaviours are established in infancy and early childhood [Pine et al. 2004].

6.4. Assessment of the Economic Impact

The costs for dental treatment are high, thus effective prevention can yield an excellent cost-benefit ratio. This is especially true for the use of fluorides where plenty of data is available (table 20).

Table 20: Cost effectiveness for different forms of fluoride application [Schmelzer 2002].

	caries reduction	cost per person and year	cost per healthy preserved surface	saved treatment costs	cost-benefit ratio
Fluoride salt	50 %	0.01 €	0.01 €	13 €	1 : 1000
Water fluoridation	50 %	0.50 €	0.50 €	13 €	1 : 25
Fluoridated tooth paste	20 %	2.00 €	5.00 €	5 €	1 : 2.5
Fluoridated Gel 1xweekly	40 %	4.40 €	6.00 €	10 €	1 : 2.27
Fluoride tablets	50 %	7.00 €	7.00 €	13 €	1 : 1.92
Professional fluoridation (IP4) in dental practice	40 %	12.00 €	14.50 €	10 €	1.15 : 1

For example, the use of fluoridated salt program saves 1000 € for every Euro paid for the sake of the program. The fluoridated preventive programs implemented on community basis allow more savings than professional programs in dental practices. A detailed health economic analysis includes the follow-up costs of dental treatments such as root canals and dentures, thus a moderate savings in fillings will permit a reduction in the high follow up costs as well. Thus, long-term analyses point out a clear benefit for caries prevention with fluorides [Splieth and Flessa 2008].

In dental practice, there is a balance-like phenomenon between unfavorable costs like treatments under general anaesthesia or of abscesses that call for extractions with subsequent orthodontic interventions and savings from professional and individual prophylaxis as well like sealants and teeth brushing with fluoridated tooth pastes.

The overall caries prevalence in Mecklenburg-Vorpommern per child declined during 12 years (2000 to 2012) from 1.97 to 0.89 DMFT. So with an annual number of almost 13 thousand children a total savings of fillings of about 14 thousand (1.08 DMFT x 13 thousand children). Therefore, the filling's savings are approximately 475 thousand Euro per year. An additional 300 thousand Euro is saved from subsequent primary teeth fillings. The state of MV planned a budget of about 230 thousand euro for the LAJ to accomplish the annual group prophylaxis program and added again a supplementary fund of 230 thousand Euro for the intensive prevention program. Thus, the submitted program should be one of the few measures that will evidently prove their effectiveness.

6.5. Discussion of the challenges

In this study we reported the prevalence of ECC in counties of Mecklenburg-Vorpommern using identical diagnostic criteria and the same calibration system of nationally representative DAJ [2010] surveys. A possible challenge was the access to young children especially those who are at high risk, but in East Germany the percentage of children attending nurseries is generally high as well as the willingness to take part in the dental examination in these nurseries. In contrast to the representative and reliable data, the approach to tackle ECC differs considerably in the various counties and the informational materials also differ. A standardized program would be probably more helpful.

7. Conclusion

The prevalence of caries in young children in Mecklenburg-Vorpommern is high compared to some Western European countries with a dominance of untreated caries. The specific values for ECC values .in Mecklenburg-Vorpommern are comparatively low, but possibly this is influenced by the difficulties in diagnosing initial caries lesions in very small children and the limitation for ECC in upper incisors. Thus, there is still room for further reduction through an improved and standardized preventive programme

The use of fluoride varnish in children with ECC can result in a clear conversion from active lesion into an inactive, arrested status.

The inclusion of nurseries closes another gap in the caries prevention system and this pilot study shows a promising setting for reducing caries prevalence in very young children. Yet standardization of the various undertaken preventive measures is needed for a uniform and optimized programme. Education regarding infant’s and toddler’s oral health and tooth brushing in nurseries by non dental staff seems to be a feasible way in preventing or slowing down caries development in early childhood.

8. Summary

Background: Despite of the remarkable caries reduction in permanent dentition, caries levels of primary teeth has stagnated in Germany. Early Childhood Caries (ECC) or also known as baby bottle tooth decay is the most vulnerable form of caries in young children, but minimal data and information from different German states are available to determine the appropriate preventive programs.

Aim: The purpose of the current study is to find the prevalence of ECC among young children in the state of Mecklenburg-Vorpommern (North-East Germany) and to optimize an intervention on ECC prevention in a community setting. In addition to education, fluoride varnish is evaluated on young children with active ECC.

Design: In this cross-sectional study, a total of 4283 children living in the state of Mecklenburg-Vorpommern were examined. Four age groups - with an accuracy of one day - were formed as follows: less than one year (n=8), one year (n=293), two years (n=1618) and three years (n=1888). The examination was carried out by community dental service's examiners whom are calibrated to ECC diagnostic criteria of Robke and Buitkamp (2002), and dmf-t values for caries diagnosis. These data are compared by those of children (n=5355) of same age group for the year 2011-2012.

In addition, a structured questionnaire on the starting preventive programme on ECC was filled out by the community dentists and for the city of Greifswald, fluoride varnish (Duraphat®, 5% NaF = 2.26%F, Colgate-Palmolive, Germany) was applied for 32 children previously diagnosed with active ECC (ECC1: n=15, ECC2: n=17). Lesions are identified as active or non active according to texture and luminosity, and oral hygiene index (OHI-S) is measured and re-evaluated at three months follow up.

Results: The percentage of children under three years old in 2012-2013 with ECC was comparatively low (4%) which possibly reflects the very young age of the children and a restriction for ECC on the upper incisors. The overall caries prevalence in Mecklenburg-Vorpommern varied from 9% to 15%. Most cavitated lesions are untreated. These

results are comparable with the results from other German counties. The interventions of the ECC programme vary considerably among the different counties.

There was no significant difference in the oral hygiene index (OHI-S) prior and post fluoride varnish application (p-value = 0.25). The use of fluoride varnish resulted in an 81%, statistically significant decrease of active ECC lesions in Greifswald ($p < 0.001$).

Conclusion: The prevalence of caries among young children was considerable in Mecklenburg-Vorpommern. A preventive intervention in nurseries and fluoride varnish applications for active ECC lesions seems to be a feasible approach in controlling caries in early childhood. However, further quality management and standardization of the program should be reinforced.

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10. List of Figures

11. List of Tables

12. Eidesstattliche Erklärung

Hiermit erkläre ich, dass ich die vorliegende Dissertation selbständig verfasst und keine anderen als die angegebenen Hilfsmittel benutzt habe.

Die Dissertation ist bisher keiner anderen Fakultät, keiner anderen wissenschaftlichen Einrichtung vorgelegt worden.

Ich erkläre, dass ich bisher kein Promotionsverfahren erfolglos beendet habe und dass eine Aberkennung eines bereits erworbenen Doktorgrades nicht vorliegt.

Ort, Datum Unterschrift

Greifswald, 12.07.2016

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I promise you all that this thesis is only a beginning of my journey.

Finally, I would like to leave the remaining space in memory of my late Grandfather who passed away before seeing this happened.

14. Lebenslauf

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