Comparison of the Prevalence of Molar Incisor Hypomineralization in Dubai/United Arab Emirate and Greifswald/Germany

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The Road Not Taken

I shall be telling this with a sigh

Somewhere ages and ages hence

Two roads diverged in a wood, and I

I took the one less traveled by,

And that has made all the difference.

Robert Frost, Mountain Interval. 1916
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<td>AI</td>
<td>Amelogenesis Imperfecta</td>
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<td>DDE</td>
<td>Developmental Defects of Enamel Index</td>
</tr>
<tr>
<td>DMFT</td>
<td>Decayed Missing Filled Teeth (permanent dentition)</td>
</tr>
<tr>
<td>dmft</td>
<td>decayed missing filled teeth (primary dentition)</td>
</tr>
<tr>
<td>EAPD</td>
<td>European Academy of Paediatric Dentistry</td>
</tr>
<tr>
<td>ECC</td>
<td>Early Childhood Caries</td>
</tr>
<tr>
<td>EDI</td>
<td>Enamel Defect Index</td>
</tr>
<tr>
<td>FDI</td>
<td>Fédération Dentaire Internationale</td>
</tr>
<tr>
<td>GIC</td>
<td>Glass Ionomer Cement</td>
</tr>
<tr>
<td>mDDE Index</td>
<td>moderate Developmental Defects of Enamel Index</td>
</tr>
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<td>MIH</td>
<td>Molar Incisor Hypomineralization</td>
</tr>
<tr>
<td>n</td>
<td>Number</td>
</tr>
<tr>
<td>P</td>
<td>P-Value</td>
</tr>
<tr>
<td>PEB</td>
<td>Post-eruptive Breakdown</td>
</tr>
<tr>
<td>RTA</td>
<td>Road and Traffic Authority</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Science</td>
</tr>
<tr>
<td>UBA</td>
<td>Umweltbundesamt</td>
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<tr>
<td>WHO</td>
<td>World Health Organization</td>
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<td>yrs</td>
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1. Introduction

Defects in tooth structure result in weakness and increase caries susceptibility. Developmental Defects of Enamel (DDE) affected a large number of the world population, which are generally associated with various complications including dental pain, deformity, and increase caries risk [Hall, 1994; Arrow, 2008]. DDE can have a local or general origin (Fig. 1). A particular tooth or a group of adjacent teeth can be affected by local factors, while general factors, which disturb mineralization process, can affect the teeth those were mineralized at the time of disturbance.

Figure 1: Common etiological factors of Developmental Defect of Enamel (DDE). (A) Local Factors. Mechanical factors, can present as a local trauma to a deciduous tooth, may effect on the permanent successor. Infection, following a local trauma or bone inflammation, may disturb mineralization by increasing the acidity of the environment. Radiation during local radiotherapy may disturb enamel development and mineralization. (B) General Factors. Nutritional disorders as malnutrition and disturbed calcium metabolism, can result changes in calcium or pH levels in blood and disturb enamel mineralization. Systemic diseases, as high fever and systemic infections are examples of a variety of perinatal and childhood diseases, which carry an increased risk for enamel defects. Toxic materials as fluoride and tetracycline can disturb enamel mineralization. Genetics, as in Amelogenesis Imperfecta [Jacobsen et al., 2013; Alves dos Santos et al., 2012; Chawla et al., 2008a; Alaluusua et al., 2001]. (Figure designed by author).
Enamel hypoplasia, enamel hypomineralization and fluorosis are the major developmental defects of enamel [FDI Commission on Oral Health R&E, 1992; Den Besten, 1994].

*Enamel hypoplasia:* A quantitative defect of enamel surface, associated with reduced enamel thickness, smooth borders and without fracture margins which is macroscopically detectable. The defect may present in different forms, such as pits or rows, shallow or deep, local or generally dispersed on entire enamel surface [Sabel et al., 2010].

*Hypomineralized enamel:* A qualitative defect of enamel surface, associated with normal enamel thickness at the time of eruption, however a post-eruptive breakdown (PEB) with fractured edges can be detected short after eruption. The color of the defect may vary from white, yellow or brown [Fagrell et al., 2011; Weerheijm et al., 2003].

*Fluorosis:* A qualitative defect of enamel surface, which can also manifest as quantitative defect in severe cases. It occurs as a result of exposure to high fluoride concentration during the developmental stage [Den Besten, 1994] with different clinical presentation (Table 3).

From developmental defect of enamel, Molar Incisor Hypomineralization (MIH) has become of great concern worldwide in the last few decades. MIH is predominantly a result of disrupted mineralization process, and more specifically of permanent first molars and incisors. Despite the fact numerous studies investigated this epidemic condition, still the etiological factors associated with MIH are unknown [Alaluususa, 2010]. Furthermore there is a significant difference in prevalence at the international level in young population (2.4%-40.2%) [Weerheijm, 2004; Crombie, 2009; Jälevik, 2010; Alaluusua, 2010]. Nevertheless, this variation in prevalence could be a result of the difference in socioeconomic status or health care systems, which can be revealed by conducting comparison studies [Steele et al., 2014; Struzycka, 2014]. Therefore, to understand the disease process of MIH, there are substantial needs for more
comparison studies, which could identify the causative factors associated with this condition [Abbas et al., 2010; Adriaenssens et al., 2011].

The number of MIH prevalence studies in the Middle East are few and it has been shown that this region experiencing high level of MIH prevalence [Ghanim et al., 2011; Zawaideh et al., 2011; Kuscu et al., 2009]. In addition, decayed, missing, filled tooth (DMFT/dmft) is reported as a parameter with high prevalence in Middle East [Al-Bluwi, 2014; Hashim et al., 2013; El-Nadeef, 2009]. The City of Dubai in United Arab Emirates (UAE), is one of the fast growing cities in the Middle East (68% population increase between 1995 and 2013) [Ministry of Economy in United Arab Emirates, 1995; Population Bulletin Emirate of Dubai, 2013] and high level of DMFT/dmft, in young age groups have been reported [El-Nadeef, 2009].

Based on the previous studies, which reported high level in dmft/DMFT indices in the Middle East, we hypothesize that the prevalence of MIH in Dubai/UAE, which represents a developed Middle Eastern city is also high and determining it helps in identifying the etiological factors associated with MIH, if compared with Greifswald/Germany, a developed European city with considerable difference in cultural, healthcare system, and socioeconomic status. Thus the aim of this study was to identify the prevalence of MIH in Dubai/UAE using the European Academy of Pediatric Dentistry (EAPD) criteria, and to compare it with the Greifswald/Germany MIH prevalence results, which were obtained by the same research group using similar study conditions. The study selected Dubai/UAE and Greifswald/Germany due to the considerable difference in cultural, health care system, and possibly different socioeconomic status, which could allow for a better understanding of MIH and its etiology. In addition, this study can help in increasing the awareness of MIH among the Dubai’s local clinicians and health authorities, which would enhance the preventive regulation of such a devastating dental condition.
2. Review of the literature

2.1 Molar Incisor Hypomineralization

In the late 1970s, demarcated opacities in molars that are occasionally associated with enamel breakdown, was identified for the first time and was named with different terms (i.e. idiopathic hypomineralization, Morbus S, Cheese molars) [Van Amerongen, 1995; Clarkson, 1989]. The causative factor is not identified [Weerheijm et al., 2003; Weerheijm et al., 2001]. The principal criteria for such hypomineralization defects were introduced officially in 2003 at the European Academy of Pediatric Dentistry and since then it has been named as “EAPD criteria” and it is used mainly to identify MIH. In addition, the defect was given the name “Molar Incisor Hypomineralisation” (MIH), which is caused by a systemic disturbance during crown formation and mineralization and it is seen mostly in permanent first molars and occasionally associated with incisors [Koch et al., 1987; Jälevik et al., 2000; Weerheijm et al., 2003]. Deciduous second molars, permanent second molars, tips of permanent canine, and premolars have been also described in some MIH cases [Weerheijm et al., 2003; Lygidakis et al., 2010; Heitmüller et al., 2012]. Involvement of such teeth could be due to the overlap of hypomineralization period of the mentioned teeth [Elfrink et al., 2012]. Among all the associating teeth with MIH, deciduous second molar hypomineralization is believed to be a significant clinical sign and predictor for MIH in permanent dentition which can be an aid in early prevention [Elfrink et al., 2012; Petrou et al., 2013].

2.2 Characteristics of Molar Incisor Hypomineralization

Demarcated opacities are clearly bordered with well-mineralized intact surface and a glossy appearance. The color of the opacities differs from white, beige to dark yellow colors. It was reported that demarcated opacities are the most common enamel defects among MIH teeth [Ghanim et al., 2011; Wogelius et al., 2008]. The severity of MIH may vary considerably in the same patient; one to all four of the PMF may be affected. However in some cases only slight demarcated opacities are shown with no
further complication. Disturbed enamel mineralization result into an abnormal and weak enamel integration, which is susceptible to caries and dental wear [Bhaskar et al., 2014; Lygidakis et al., 2010; William et al., 2006]. In some cases newly erupted MIH teeth can have severe structural breakdown under normal load of masticatory function. Such complications occur because histologically there are areas of porosity of varying degrees [Chawla et al., 2008a; Weerheijm et al., 2003].

In severe cases, MIH affected teeth are very sensitive to stimulations such as air, cold and hot, as well as mechanical stimuli, which make effective oral hygiene procedures difficult [Da Costa-Silva et al., 2010; Kilpatrick, 2009]. Insufficient oral hygiene, due to hypersensitivity is a considerable fact in MIH cases [Leppäniemi et al., 2001; Weerheijm, 2003 and 2004] (Fig. 2).

Figure 2: Oral hygiene status in MIH; Plaque detector displays higher accumulation of plaque on MIH teeth comparing to adjacent teeth without MIH. (A) Tooth 16 with MIH and post-eruptive breakdown. (B) Teeth 36, 46 affected with MIH and present as post-eruptive breakdown. (Photos by author).

Several studies showed that MIH has different variables of characteristics and most of them stated that there is no gender specification in MIH cases [Martínez Gómez et al., 2012; Jasulaityte et al., 2007; Behrendt et al., 2004; Jälevik et al., 2001] However, few studies did not support this finding [Chawla et al., 2008a; Cho et al., 2008; Dietrich et al., 2003; Lygidakis et al., 2008a]. It is common to see MIH in one or more than one teeth, but the number of affected teeth differs in between studies (mean 2.4 to 5.7) as well as the number of affected molars (mean 1.5 to 3.16) [Ghanim et al., 2011; Lygidakis et al., 2008a; Wogelius et al., 2008; Cho et al., 2008; Muratbegovic et al., 2007; Calderara et al., 2005; Jasulaityte et al., 2003]. In addition, incisors association
has been shown in 2.2% of the cases [Jälevik et al., 2001; Jasulaityte et al., 2003; Calderara et al., 2005; Muratbegovic et al., 2007; Preusser et al., 2007; Willmott et al., 2008; Cho et al., 2008; Lygidakis et al., 2008a; Wogelius et al., 2008; Chawla et al., 2008a-b; Ghanim et al., 2011]. While some studies showed that maxillary molar are more affected than mandibular molars [Gomez et al., 2012; Lygidakis et al., 2008a; Preusser et al., 2007], other reports showed no statistically significance difference [Jälevik et al., 2001; Chawla et al., 2008a].

2.3 EAPD Criteria of MIH

In the last decades, different diagnostic criteria have been described and established for MIH (Table 1). Some of these criteria have simplified the diagnosis of MIH for clinician to proceed with early prevention, treatment and more importantly to facilitate and standardize, prevalence studies [Jälevik, 2010].

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tr>
<td>Modified DDE “mDDE” [Jälevik, 2010; Alaluusua et al., 1996; Balmer et al., 2012]</td>
<td>Enamel defects in first permanent molars can get recorded excluding dental fluorosis, hereditary defects and defects produced by health problem.</td>
<td>Failure in differentiating post-eruptive breakdown, which is a characteristic sign of MIH from enamel hypoplasia. Time consuming.</td>
</tr>
<tr>
<td>Enamel Defect Index “EDI” [Weerheijm et al., 2003; Brook et al., 2001]</td>
<td>More specific definition than DDE.</td>
<td>Use one score for both demarcated and diffuse opacities together.</td>
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According to EAPD criteria, MIH can present itself as a demarcated opacity, post-eruptive enamel breakdown (PEB), and atypical restoration (Fig. 3). These clinical
presentations can help in the acceleration of clinical evaluation and treatment [Weerheijm et al., 2003; Lygidakis et al., 2010].

![Figure 3: Clinical appearance of MIH. (A) Demarcated opacities on erupting tooth 46. (B) Demarcated opacities in association with post-eruptive breakdown on tooth 26. (C) Atypical (occlusal-distal) restorations and demarcated opacities (mesial) on tooth 16. (Photos by author).]

Therefore, to avoid the problems of previous indices, the EAPD has developed the standardized MIH criteria [Weerheijm et al., 2003] (Table 2).

<table>
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<th>EAPD Criteria</th>
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<tr>
<td>Demarcated opacities</td>
<td>Demarcated opacities of different sizes, located on the crown.</td>
</tr>
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<td></td>
<td>Different in color, from white, creamy, and yellow to brownish</td>
</tr>
<tr>
<td></td>
<td>discoloration.*</td>
</tr>
<tr>
<td>Post-eruptive breakdown (PEB)</td>
<td>Different degrees of enamel hypomineralization increase level of</td>
</tr>
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<td></td>
<td>porosity, which in the severe cases crown is susceptible to collapse</td>
</tr>
<tr>
<td></td>
<td>under masticatory forces and leads to unprotected dentin and high</td>
</tr>
<tr>
<td></td>
<td>sensitivity and increasing the speed of caries process.</td>
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<tr>
<td>Atypical restoration</td>
<td>Restoration with similar pattern of defect extension.</td>
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<td>Failure in eruption or extracted teeth</td>
<td>Absence of the tooth is possible to be a sign of severely destroyed</td>
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<td>crown that led to extraction. It could be as well a sign of failure in</td>
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<td></td>
<td>eruption based on presence of other molars with MIH, otherwise it is</td>
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<td>not a diagnostic source for MIH.</td>
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* According to the EAPD guidance 2010, defects less than 1mm are not recommended to be record.

Tooth sensitivity which is usually reported in MIH cases, is other characteristic of MIH. The sensitivity differs from mild grade, which is a consequence of external stimuli, to severe spontaneous hypersensitivity [Lygidakis et al. 2010]. Although some authors suggested two scores for severity scales in order to limit the diagnostic variations that
exist in the literatures, some other prefer a three score severity classification according to the clinical features [Lygidakis et al., 2008; da Costa-Silva et al., 2010; Mathu-Muju, 2006]. The two degrees for sensitivity based on clinical features are categorized as a “mild” or “severe”. In the mild cases, there are occasional sensitivity to external stimuli such as air and water but no brushing sensitivity and difficulty. It is stated that in severe cases persistent and spontaneous hypersensitivity affecting oral hygiene procedure, which lead to higher caries level [Lygidakis et al., 2010]. In case of an extracted or missing tooth, it should be recorded as MIH, only when the dental record of the patient shows a diagnosis of MIH prior to extraction or presence of other permanent first molars with MIH.

2.4 Clinical Consideration of MIH

MIH has some clinical considerations in order to understand, prevent, manage and treat the etiological factors [Jälevik et al., 2002]. It is useful to increase the frequency of dental check-ups in children with history of repeated illnesses in the first three years after birth and children with opacities on deciduous second molars, before and during the eruption period of the permanent first molars. The signs of hypomineralization, in the crown of unerupted permanent first molars affected with MIH, can be detected sometimes on a radiograph even prior to eruption [William et al., 2006a], However it is questionable if there is an indication to expose children to x-ray prior to eruption of permanent first molars or incisors in order to detect MIH These check-ups give an advantage to detect and manage MIH conditions in early stage since the clinical management of this condition is challenging due to the rapid development of caries, limited cooperation of a young child, difficulty in achieving anesthesia, repeated marginal breakdown of restorations, discomfort and sensitivity stimulated by tooth brushing on affected teeth [William et al., 2006; Fayel, 2003; Jälevik et al., 2002]. According to the characteristics of MIH, the management can be complicated. Therefore, it is strongly suggested that the patients diagnosed with MIH receive early intensive prevention therapy based on the severity level of MIH, such as fluoride varnish, a fissure sealing, glass ionomer cement (GIC) restoration, composite restoration, and stainless steel crowns [Lygidakis et al., 2010; William et al., 2006b;
Fayle, 2003; Koch, 2000] (Fig. 4). In addition, an early diagnosis is of high importance since an inappropriate orthodontist approach on MIH teeth, can result in negative consequences, such as extraction of the molars in the age of 8 to 10 years [Kellerhoff et al., 2004].

2.5 Etiology

2.5.1 Amelogenesis

Although the developmental process of amelogenesis is genetically controlled, environmental disturbances can affect the development especially at the early stage of maturation [Alaluusua, 2010]. Disturbance during enamel formation affects the quality and quantity of the enamel, depending on the phase of amelogenesis and the duration of the disturbance on the ameloblast [Suga, 1989; Alaluusua, 2010]. Teeth development and mineralization start before birth and continues till late teen ages when the mineralization of the permanent molars is completed. In the beginning of the second trimester of pregnancy, the deciduous lower incisors show the first sign of mineralization which continues till the age of three month. The permanent first molars are the first teeth from permanent dentition which start mineralization at birth and complete approximately three years of age [Reid et al., 2006]. Secretory cells produce enamel from specialized
enamel forming cells called Ameloblasts, which are highly specialized cells of ectodermal origin [Simmer, 2010; Mahoney, 2010].

Histologically, developmental disturbances of organic matrix during enamel formation and maturation stages result in a defect known as enamel hypoplasia. Transitional ameloblast cell is the most vulnerable cell which needs to undergo the complete maturation otherwise the outcome is hypomineralization of full thickness enamel. Disturbed resorptive potential of ameloblast or inhibition of proteolytic enzyme lead to protein retention and interference with crystal growth and enamel maturation, which can reduce thickness of enamel layer resulting in white spots, grooves, fissures, and depressions in the enamel surface. Furthermore the conditions that affect the matrix pH and impaired calcium metabolism during enamel maturation may result in MIH. Therefore, enamel defects may contribute as local, systemic or genetic etiological factors. Neonatal disturbance of enamel formation and maturation can be a result of premature birth or hypocalcaemia [Alam et al., 2006; Garg et al., 2012].

Fluorosis: As mentioned in MIH process, any impairment during developmental stage of enamel leads to subsequent changes and defect. During enamel development an interface among ameloblasts, matrix, and mineral can result changes in enamel formation. Excessive amount of fluoride in body system during the enamel formation has a negative effect on ameloblasts, causing a hypomineralization defect in the enamel layer, known as fluorosis. The excess fluoride ions in the matrix during mineralization decrease the concentration of free calcium ions and interfere with the proteinases process leading to protein degradation during the maturation phase of amelogenesis. Therefore, there is higher fluoride level and protein content in enamel with fluorosis than normal enamel, which result an increase in enamel porosity and physical changes such as white spots, grooves, fissures, and different grades of discolorations. Most clinical feature seen in a tooth affected with fluorosis is striation pattern, parallel lines on the enamel surface [Den Besten, 2002; Aoba et al., 2002].
**2.5.2 Etiological Factors**

MIH occurs as a result of a disturbance in the ameloblastic function during the enamel formation and maturational phases of amelogenesis, which starts in the fourth month of gestation for the permanent first molars and stops in the end of third embryonic trimester or immediately after birth [Hess et al., 1932; Logan et al., 1933]. Therefore, environmental, systemic, medical, and genetical factors, that disturb maturation procedure during pregnancy and the first three years of life, can lead to MIH [Alaluusua, 2010; Crombie et al., 2009; Fagrell et al., 2010; Fagrell et al., 2011]. Although the etiology of MIH sustains unclear, there are numerous possible etiological factors during pre-, peri- and postnatal periods that have been linked with this condition (Fig. 5).

![Multifactorial etiology of MIH](image)

**Figure 5: Multifactorial etiology of MIH, that are suspected to cause changes in organic and/or inorganic composition of tooth affected with MIH.** [Schlesner et al., 2013; William et al., 2006; Souza et al., 2012; Fagrell et al., 2011; Alves dos Santos, 2012]. (Figure designed by author).
**Prenatal period**: It was shown that the mothers of the children with MIH had medical illness during pregnancy more than the mothers of children without MIH. However there was no specific related illness [Whatling et al., 2008; Lygidakis et al., 2008].

**Perinatal period**: There is a controversy in results regarding the effect of disturbance in this period. A study in Greece showed that MIH was more frequent in children born by mother who had Caesarian section, prolonged delivery, premature birth and twining, compared to the control group children [Lygidakis et al., 2008]. However in an English [Whatling et al., 2008] and a German [Diedrich et al., 2003] study, perinatal problems could not be linked with MIH.

**Postnatal period**: Most of the researches showed that there is a direct relation between postnatal medical problem such as hemolytic anemia, which occurs in the first three years of life and MIH [Jälevik et al., 2001; Beentjes et al., 2002; Lygidakis et al., 2008; Kusku et al., 2008; Alaluusua, 2010].

**Childhood illness**: It can be of high concern, since it was found in many studies that there is an association between MIH and childhood illness such as high fever [Beentjes et al., 2002; Jälevik et al., 2001; Tapias-Ledesma et al., 2003].

**Medically compromised children**: These children have shown higher prevalence of dental defect due to their medical conditions (e.g. coeliac disease) and treatments [Crombie et al., 2009].

**Antibiotics**: Studies in concern of antibiotic relation to MIH show, that there is a direct link between these two issues [Jälevik et al., 2001; Beentjes et al., 2002; Whatling et al., 2008; Laisi et al., 2009]. Amoxicillin and erythromycin use, in the first year of life showed increase in the MIH [Laisi et al., 2009].

**Environmental toxicants**: Exposure to high level of polychlorinated biophenyls (PCBs) an industrial process waist, and dioxins a by-product of manufacturing process, is associated with enamel defects as hypoplasia and demarcated opacity hypoplasia [Alaluusua et al., 2001; Jan et al., 2007].

**Breast feeding**: In one report it was shown that prolonged breast feeding and the toxin in the breast milk has been associated with MIH [Alaluusua et al., 1996a; Fagrell et al., 2011].
Low birth weight: Children with the history of low birth weight were shown to be at higher risk of enamel hypoplasia compare to the control group [Masumo et al., 2013].

Malnutrition: Malnutrition during early childhood is also among possible etiological factor of MIH [Nelson-Piercy, 1998; Fagrell et al., 2011].

Genetics: It was reported that specific genes are involved in enamel and dentin structures formation [Bailleul-Forestier et al., 2008].

2.6 Differential diagnosis

Teeth with developmental defects of enamel may present similarities regardless of the etiology. This may cause confusion in the diagnosis of MIH (Fig. 6), especially in case of fluorosis, where a dull enamel surface is a common characteristic for hypomineralized enamel and dental fluorosis. Therefore, fluorosis was of great importance in the present study since it was reported that 30% of young population in Dubai /U.A.E are affected with fluorosis [El-Nadeef, 2009].
Figure 6: Differential diagnosis of MIH. (A) MIH, which presented as demarcated opacities on tooth 46 and distal cusp post-eruptive breakdown on tooth 36. (Figure by author) (B) Caries on tooth 46 opacities on occlusal enamel surface due to demineralization in response to metabolic and chemical activity of oral biofilm, which presents as spots or diffuse opacities. (Figure by author) (C) Enamel hypoplasia, a quantitative defect of enamel, showing localized decrease of enamel thickness with no fracture line and sharp edges, affecting all teeth in symmetry (reprint with copyright permissions by Jacobsen [2013]). (D) Amelogenesis imperfecta, defect of genetic origin, all teeth and surfaces are affected, which is usually diagnosed base on radiographic form of taurodont (E) Fluorosis, diffuse opacities affecting the homologous teeth in symmetry, which depends on the time and duration of exposure to excessive fluoride. (Figure by author) (F) Localized trauma, a localized defect, which could be a result of a traumatic injury or a prolonged periapical inflammation of a primary tooth, that affect the delicate developmental procedure of permanent successor by increasing the acidity of environment, leading to hypomineralization [Petrou et al., 2013].

2.6.1 Enamel hypomineralization

Hypomineralized enamel has normal thickness at the time of eruption and it is associated with white, brown or yellow discoloration. Change in the refractive index (propagation of light, or any other radiation, through a medium) caused by the increased degree of porosity in the enamel results in a clinical discoloration. To some extend the color seen is dependent on the degree of hypomineralization and possibly also to the protein content in the enamel [Farah et al., 2010a; Da Costa-Silva et al., 2011]. A dull
enamel surface is characteristic for hypomineralized enamel, which is also seen in case of dental fluorosis. An association of opaque clinical appearance with distinct borders, a well mineralized intact and glossy surface, is the characteristic of the hypomineralized area. In severe cases of enamel hypomineralization, the surface may collapse and a loss of substance with fractured borders will be seen. Fractured edges are seen with post-eruptive breakdown (PEB) [Fagrell et al., 2011].

2.6.2 Fluorosis

Fluorosis is an enamel developmental defect as a result of exposure to high fluoride concentration during the developmental stage [Den Besten, 1994]. The affected teeth contain low mineral and high level of porosity [Abanto Alvarez, 2009]. The safe level of daily fluoride intake is 0.05-0.07mg F/Kg/day and a chromic consumption during teeth development to more than this amount can cause fluorosis [Burt, 1992]. Severity of fluorosis depends on the age, duration of exposure, weight, degree of physical activity, nutrition, and bone growth. The main fluoride source is fluoridated water, which range between 0.7 to 1.0 ppm depending on the season of the year and geographic area. Fluoridated water is responsible for 40% of dental fluorosis [Richards et al., 1967]. Fluoride supplements, mostly recommended in the fluoride deficient areas, have shown to be a contributory factor of dental fluorosis in fluoridated and non-fluoridated area. However it is more risky in fluoridated area [Jackson et al., 1999; Pendrys et al., 1998; Mascarenhas, 2000]. Fluoride containing toothpastes can also be a contribution factor, especially in children under age of 6, since they swallow around 30% of the toothpaste during brushing. Hence if this action is associated with fluoridated water the fluorosis risk is increased [Villena, 2000].

Diffuse opacities of fluorosis should not be included in the scoring for MIH tooth since the opacity in MIH is well demarcated [Weerheijm et al., 2003]. Fluorosis has classical appearances; it is bilateral, substantial symmetry on homologous teeth, and diffuse opacity in form of striation or banding, which follow the lines of enamel development. Fluorosis can occur on any tooth, however, MIH is affecting only Molars and incisors [Levy, 2003]. In severe cases of fluorosis, where the hypomineralization
extends to the dentin enamel junction and can cause extensive post-eruptive enamel breakdown and brown to black staining [Wright et al., 1996]. In addition mild fluorosis is a caries resistant defect [Waidyasekera et al., 2007], while MIH is caries susceptible in all phases [William et al., 2006]. Unlike MIH and caries, fluorosis does not result in pain or abscesses, and no anesthetic (e.g. local or general) is required for the treatment [Mullen, 2005].

### 2.6.3 Enamel hypoplasia

A quantitative defect is associated with a reduced localized thickness of enamel, rough or pitted surface, smooth and rounded borders, and no fractured boundaries. Such condition occurs due to disruption of the secretory phase of amelogenesis while MIH is a qualitative defect of enamel which occurs due to disturbed mineralization phase of amelogenesis [Suckling, 1989]. EHP can occur in a single tooth or multiple teeth [Seow, 1991]. The defect might have a different depth in the enamel, one surface or all the enamel surfaces [Sabel et al., 2010].

### 2.6.4 Amelogenesis imperfecta

Amelogenesis imperfecta (AI) is a genetically originated defect, which affects all the permanent dentition. In AI, the effect is more generalized and the molars may also appear taurodont on radiograph. This defect is often associated with family history [Witkop, 1988; Lygidakis et al., 2010]. MIH is affecting the teeth in asymmetrical pattern but only in very severe cases, the molars are equally affected and mimic the appearance of Amelogenesis imperfecta.

### 2.6.5 Trauma as localized factor

Traumatic injury as well as a prolonged periapical inflammation of a primary tooth could affect the delicate developmental procedure of permanent successor by increasing the acidity of environment, leading to hypominaralization [Alaluusua et al., 2001; Chawla et al., 2008a].
2.6.6 Dental caries

A chronic infectious bacterial disease, a demineralization response to metabolic and chemical activity of oral biofilm content, such as acid by-product of bacterial metabolism, which dissolves the mineral after disseminating into the enamel and dentin by initiating an environmental imbalance in the oral microbiome [Featherstone, 2008]. Dental plaque on the tooth surface, which presents itself as a classic biofilm is formed by oral microorganisms. Acid product of cariogenic microorganisms and large scale change in protein expression, influence the biofilm formation by decreasing the pH level of oral environment below 5.5, which induce demineralization of enamel hydroxyapatite crystals and proteolytic breakdown of the hard tissues structure of the tooth. This may change the surface texture of enamel and dentin [Takahashi, 2008] and appears as a spot but not well demarcated opacity, which can be differentiate from MIH [Kidd, 2004; Chawla et al., 2008a].

Caries is a multifactorial disease, but it mainly occurs due to coexistence of three principal factors, which are acidogenic and acidophilic microorganisms (e.g. Streptococcus mutans, non-mutans streptococci group, Actinomyces and Lactobacillus), carbohydrates containing food, and host factors [Struzycka, 2014], however additional etiological factors such as educational, behavioral, and socioeconomic status have strong influence in caries development [Steele et al., 2014; Struzycka, 2014].
2.7 Epidemiology

2.7.1 MIH

High prevalence of this MIH has been shown in great number of studies [Lygidakis, 2010]. Based on these studies the prevalence of MIH ranges from 2.8% to 40.2% and it differs between regions and studies [Jälevik et al., 2002; Jälevik, 2010]. In Europe, the prevalence of MIH ranges from 3.6% to 25% [Weerheijm et al., 2003] and studies have demonstrated that MIH prevalence has increased remarkably in Germany [Jasulaityte, 2003]. Although limited numbers of studies have taken place in the Middle East, high prevalence’s of MIH were reported in this region (8.6% to 20%) [Allazzam et al., 2014; Zawaideh et al., 2011; Ghanim et al., 2012; Ghanim et al., 2011; Ghanim et al., 2014]. In addition to Middle East, other parts of the world such as Asia and Africa are also having limited number of MIH studies. This deficiency in data leads to a weakness in comparable studies, which might cause limitation in the understanding of MIH and its causative factors, since potential etiological factors in different countries cannot be compared [Jälevik et al., 2001; Jasulaityte et al., 2007]. More prevalence studies are needed to investigate the etiological factors of MIH. The comparison of the MIH prevalence and possible etiological factors among different countries can be performed only by epidemiological studies, which used the identical criteria and the same calibration system.
2.7.2 Dental caries

Caries is the most common dental disease, which has been found in almost every population, studied over a million years ago. It has increased considerably after introduction of sugar to the Western world in the year 1000 A.D [Keene, 1980; Price, 1989]. Epidemiological studies of dental caries, especially in children, show increasing levels in many developing countries and decrease in many highly developed countries of the world, which indicate that socioeconomic factors have great impact in determining the ratio of caries risk in developing countries [Winter, 1990; Steele et al., 2014; Struzycka, 2014].

The caries prevalence is high in the Middle East and parts of Europe [Struzycka, 2014; Khan, 2014]. Based on the latest studies in UAE, Dubai has the highest dmft/DMFT prevalence in comparison to the other cities of UAE [El-Nadeef, 2009 and 2010]. Caries values were also high in Germany [DAJ, 2000]. In 1990, the dmft/DMFT values in Greifswald were higher than most of Mecklenburg-Vorpommern state of the Germany. However, during the last decades these values dramatically decreased, through applying a highly structured public dental health program, in which schools are visited regularly by dental hygienists, dental assistant or even dentists for theoretical and practical oral prevention [Pieper, 2010; Splieth, 2013]. Therefore, similar to the study carried out in Greifswald, an estimation of caries prevalence in Dubai and comparison to the previous studies, can help improve the clinicians` and public's awareness and to diminish this problem with improving preventive strategies.
2.7.3 Dental fluorosis

In 1925, fluoride found to be caries resistant and in 1931 it was proved that the fluoride in natural water could cause a specific developmental defect, which was called as fluorosis. In 1942 Dean has announced the safe fluoride level (1ppm or below) [Dean, 1942]. This finding was a scientific revolution that helped dentistry to step in the preventive medicine. Artificial water fluoridation with amount of 1 ppm started in 1945 in a low fluoride area to reproduce the beneficial dental health effect, which had a positive outcome and studies reported 50% and more reductions in dental caries experience. However, the result was obtained at a time when the only source of fluoride was fluoridated water [Mullen, 2005; Murray et al., 1982]. Nevertheless, it has always been known that a low level of enamel discoloration would be associating with the water fluoridation [Murray et al., 1982]. In addition, the prevalence of fluorosis has increased over the past fifty years [McKnight, 1998].

Germany is from the countries with low fluoride concentration in natural water and more than 90% of the drinking water contains less than 0.3 mg/L fluoride per liter [BfR, 2005] and currently there is no artificial water fluoridation in drinking water of Germany. Low level of fluorosis was reported in Germany (4.9%-11.3%) with mild severity [Pieper et al., 2008; Momeni et al., 2007]. The Middle East, including UAE, however, is a region where the drinking water has a naturally high level of fluoride [WHO, 1994]. However tap water was reported by a local study to be 0.00 ppm [Nimr, 1997]. Nevertheless almost 90% of the population in UAE are using bottled water [Nsanze, 1999] containing a controlled level of fluoride, which is below the conventional level and relatively lower than the national standards [Abouleish, 2012; Nimr, 1997]. Although the level of fluoride in water supplements in Dubai does not exceed 0.7 ppm (Tap water 0.00 ppm, bottle water 0.03-0.68 ppm) [Abouleish, 2012; Nimr, 1997], the prevalence of fluorosis is significantly high and affected 30% of Dubai’s young population [El-Nadeef, 2009]. Fluorosis is assumed to have a masking effect on MIH teeth and its prevalence [Chawla et al., 2008]. This fact gives a great importance in studies, to include the differential diagnosis of MIH (e.g., fluorosis) in researches to avoid any confusion between MIH and its differential diagnosis.
3. Aim of the Study

The purpose of this study was to find the prevalence of MIH in the city of Dubai/UAE and to compare it with the literature on the prevalence of MIH, especially with a detailed study conducted with the same methodology in the city of Greifswald/Germany. Furthermore, this study explored the prevalence of fluorosis and caries in Dubai in order to assess the chance and influence of the differential diagnoses and to analyze the possible relationship between MIH and caries level. This could help to optimize the recording of enamel defects and especially MIH, to find indications for etiological factors and also to assess the needs for treatment in Dubai/UAE. In addition, dental caries and fluorosis prevalence in this study was compared with other studies in Dubai, which could possibly be a trigger for further studies to develop adequate prevention and treatment procedures.
4. Materials and Methods

For standardization, this study was based on the same methodology as in the community based study on MIH and caries conducted in Greifswald, Germany [Petrou et al., 2013]. The epidemiological data of the Greifswald study was also used further in the comparison process of this research.

4.1 Ethics Committee

This study has received the approval from the Ethical Committee in Greifswald: [Reg.-Nr.: BB 102/12] (Attachment No. I). In addition, an ethical approval was taken from Ministry of Health in UAE/Dubai [Reg.-Nr.: 122012-1] (Attachment No. II).

4.2 Materials

The following materials were used for the examination (Fig. 7):

- Toothbrush
- Tooth brushing instruction sheet
- Examination gloves
- Hygienic dental mirror
- Examination chart on excel program (Attachment No. X)
- Portable light

Figure 7: Materials used in the examination: portable light, tooth brushing instruction, toothbrush, dental mirror, examination gloves. (Photo by author).
4.3 Sample

Children aged 7-9 years old (mean 8.1±0.8) in randomly selected governmental schools of Dubai were examined for the presence of MIH, caries (DMFT/dmft) and fluorosis (n=782). The sample size in Dubai study was determined statistically using NQuery Advisor software (version 4.0, Statistical Solutions Ltd. Ireland). The cross-sectional sampling was carried out after receiving the acceptance from the Dubai’s health and education authorities (i.e., Ministry of Education and Ministry of Health) for school examination. A list of all governmental schools registered in Dubai was obtained from the educational district to be utilized for random sampling. The randomly selected schools were contacted and the consent form and parent information form were distributed among children with a determined date for examination. Students of age group 7 to 9 years old who attended 2nd to 4th grades and appeared on the day of the examination with the parent’s approval, were included in this study. In addition, children without any permanent first molars were excluded from the study since the main MIH manifestation presents on permanent first molars. Figure 8 illustrates sample selection in Dubai study, which is following the same standard method as the comparable study of Greifswald.

![Sample selection in Dubai & Greifswald](image)

**Figure 8:** Graphical representation of the selection process in Dubai and the comparable Greifswald studies: enrollment, inclusion, exclusion and final included sample. (Figure designed by author).
4.4 Dental examination

The examination was performed by one calibrated examiner (Somayeh Haidary, DDS), who was previously trained by the calibrated examiner (M. Petrou) who performed the equivalent German study and advisor (Prof. Dr. Ch. H. Splieth) in Greifswald. During the examination, a dentist accompanied the examiner to assist only in recording the data into computer.

4.4.1 Caries scores

The caries scores in the primary and permanent dentition were calculated according to the World Health Organization criteria for the dmft/DMFT-index [WHO, 1997], which is the sum of decayed, missing, and filled tooth in 28 permanent and 20 primary teeth per child. The overall mean of the dmft/DMFT is calculated by dividing the sum of all dmf/DMF-teeth by the number of participating children.

4.4.2 Fluorosis

The Dean’s Index (Table 3) was used to classify fluorosis. Since the index of choice is recorded on wet teeth, no additional drying of the teeth was needed. The same index was used in Dubai and in the equivalent study in Greifswald/Germany.

Table 3: Fluorosis diagnostic criteria, according to the Dean classification index (1942)

<table>
<thead>
<tr>
<th>Dean’s Criteria</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>The enamel surface is smooth, glossy, pale creamy-white translucent.</td>
</tr>
<tr>
<td>Questionable</td>
<td>The translucency of normal enamel is abbreviated, ranging from a few white</td>
</tr>
<tr>
<td></td>
<td>flecks to occasional white spots.*</td>
</tr>
<tr>
<td>Very mild</td>
<td>25% or less from the tooth surface is covered with small opaque, paper white</td>
</tr>
<tr>
<td></td>
<td>areas. Included teeth in this classification are showing almost 1-2 mm of</td>
</tr>
<tr>
<td></td>
<td>white opacity at the tip of the cusps bicuspids or second molars.</td>
</tr>
<tr>
<td>Mild</td>
<td>Less than 50% of the tooth surface is covered with white opaque areas.</td>
</tr>
<tr>
<td>Moderate</td>
<td>Enamel surface is completely affected; biting surfaces shows attrition and</td>
</tr>
<tr>
<td></td>
<td>brown discoloration might be present.</td>
</tr>
<tr>
<td>Severe</td>
<td>All enamel surfaces are affected. The general form of the tooth might be</td>
</tr>
<tr>
<td></td>
<td>changed. It is diagnosed by discrete or confluent pitting, presenting brown</td>
</tr>
<tr>
<td></td>
<td>stains and often a corrosion appearance.</td>
</tr>
</tbody>
</table>

* When a defect is not considered healthy, nor very mild fluorosis
4.4.3 MIH

The following criteria, which were based on the EAPD criteria [Weerheijm et al., 2001b; Lygidakis et al., 2010] were used to diagnose MIH cases:

1. Examination of permanent first molars and incisors (12 index teeth).
2. Examination should to be performed on wet teeth after cleaning.
3. Each tooth should be recorded for:
   - Demarcated opacities, but not less than 1 mm
   - Enamel breakdown following tooth eruption
   - Atypical restoration
   - Extraction due to MIH
   - Molar or incisor tooth failed in erupting

Since the examiner had no access to dental treatment data of the children, therefore, missing teeth that are extracted or failed to erupt in MIH cases were categorized as “missing”.

The examination chart includes (Attachment No. X):

- Date of the examination
- Name of the school
- Class number/grade
- Birthday
- Age
- Gender
- dmft/DMFT
- Fluorosis
- MIH index tooth/teeth number with
  - MIH defect, not less than 1 mm
  - Presence of demarcated opacities
  - Post-eruptive breakdown (PEB)
- Atypical restoration, type of restoration
- Hypersensitivity
- Missing tooth/teeth, is used and coded since there is no access to dental record
- Co-existence of caries/orthodontic treatment

Children with one of the above clinical MIH criteria with at least one affected permanent molar were considered as MIH case. To avoid the masking effect in cases where the DMFT score is more than 5, the MIH criteria were investigated carefully. Defects less than 1mm, which affected only incisors were not included as a MIH case. The affected index-teeth, their clinical view, atypical restorations, and the restoration material used on MIH affected tooth, were also recorded in an Excel spreadsheet. Teeth, which had only atypical restoration and did not have another MIH signs, were not included in MIH cases.

One of the diagnostic features of MIH severity is hypersensitivity. Therefore, children with suspected MIH were asked, if they had any pain or sensitivity during air/water stimuli and teeth brushing. The children were also asked if the pain comes occasionally and by stimuli and if it is persistent and spontaneous. The following standardized questions were asked from all the children where MIH condition is suspected to justify the kind of discomfort:

- Does it hurt when you brush your teeth? What about your back teeth?
- Does it hurt when you drink a hot tea or cacao? Do you enjoy having ice cream or does it make your teeth hurt?

The severity of MIH cases were then recorded based on the EAPD criteria [Lygidakis et al., 2010].

The examination procedure was structured in the following way:

- Brushing the teeth prior to examination under the instruction and observation of a calibrated examiner and a school teacher.
- Examination by the dentist under supervision of one school member/teacher.
4.5 Calibrations

The examination was carried out by a single calibrated examiner (dentist Somayeh Haidary) who received standardized caries calibrations trainings for the standardized German dental school examinations (Deutsche Arbeitsgemeinschaft für Jugendzahnpflege) and was trained in Greifswald university dental clinic (Feb-Jun 2012), by Prof. Dr. Ch. H. Splieth and Dr. M. A. Petrou. Dr. Petrou was previously calibrated and attained the “gold standard” of the German epidemiological study in identifying and differentiating MIH defects [Pieper, 2010].

4.5.1 Calibration for dmft/DMFT

The school examination procedures were standardized according to DMFT/dmft values. The same criteria which was used in the German study were used for the calibration of Dr. Haidary by Prof. Dr. Ch. H. Splieth (kappa value>0.9) [Pieper, 2010].

4.5.2 Calibration for MIH and Fluorosis

Prior to the calibration, a clinical and theoretical training of the examiner (Dr. Haidary) on the differential diagnosis of MIH including dental fluorosis was performed. For the theoretical training, the international literature [Chawla et al., 2008 and Lygidakis et al., 2010] as well as the previous presentations of German data were used. The calibration was performed with the use of a slide presentation of 20 clinical pictures of MIH and other enamel defects. The same pictures were used to calibrate the examiner of the Greifswald study. The examiner achieved an intra- and inter-kappa values > 0.9 for MIH and fluorosis. Children diagnosed with MIH, were given the diagnostic form to inform their parents about the findings including DMFT/dmft, fluorosis, and MIH.
4.6 Statistical Analysis

4.6.1 Method of Analysis

Following the examination, the data were collected, coded, and statistically analyzed with the Statistical Package for Social Science (SPSS) system 18.0 [SPSS for Windows, version 18.0, SPSS Inc., Chicago, IL, USA]. In this system the mean values and the standard deviation of dmft, DMFT, age, gender distribution, prevalence of MIH, and distribution of MIH criteria were achieved using descriptive statistics. The difference and probable association of children’s age, gender, caries experience, and presence of MIH were statistically analyzed using t-test, Levene-test, Chi-square-test ($\chi^2$-test), and Pearson correlation.

4.6.2 Method of Comparison

Prevalence of MIH in the city of Dubai/UAE was compared with the literatures on the prevalence of MIH, especially a detailed comparative study from Greifswald/Germany, since the same methodology was used in the both studies.

The comparison of MIH and caries prevalence in Dubai/U.A.E with Greifswald/Germany was performed using the data obtained from the MIH study in Greifswald/Germany [Petrou et al., 2013].
5. Results

The results of this study are presented in each section accordingly with immediate comparison to the data of the study with identical methodology from Greifswald [Petrou et al., 2013].

5.1 Sample

779 school children were examined (Table 4) with an age range of 7 to 9±1 years in Dubai (mean age 8.1±0.8 yrs). The sample in Greifswald, which was directly compared to the Dubai’s data, consisted of 443 children (mean age 8.45±1.0 yrs) [Petrou et al., 2013]. In contrast to the Greifswald sample, in Dubai study the sample was not evenly distributed based on gender (Greifswald: 228 Female, 212 Male; Dubai: 515 Female, 264 Male) (Fig. 9). However, there was no significant gender difference in MIH prevalence in the Dubai (7.57% Female, 7.59% Male) and Greifswald studies (4.37% Female, 4.21% Male) (p>0.05).

Table 4: Sample age population and distribution of MIH (n, %) in different age groups in Dubai.

<table>
<thead>
<tr>
<th>Age group</th>
<th>6 year</th>
<th>7 year</th>
<th>8 year</th>
<th>9 year</th>
<th>10 year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>8</td>
<td>166</td>
<td>306</td>
<td>255</td>
<td>44</td>
<td>779</td>
</tr>
<tr>
<td>MIH (n)</td>
<td>0</td>
<td>7</td>
<td>27</td>
<td>21</td>
<td>4</td>
<td>59</td>
</tr>
<tr>
<td>MIH (%)</td>
<td>0</td>
<td>4.2</td>
<td>8.8</td>
<td>8.2</td>
<td>9.0</td>
<td>7.58</td>
</tr>
</tbody>
</table>
5.2 DMFT/dmft

The DMFT/dmft indices in Dubai were significantly higher (DMFT: 2.41±1.7; dmft: 5.46±3.1) than Greifswald (DMFT: 0.1±0.4; dmft: 0.9±1.7). The difference of DMFT index between children with and without MIH was statistically significant in both cities (p< 0.001) (Table 5). 33.7% of the children in Dubai with MIH had less than 2 carious teeth, 48.9% of them had 3 to 5 carious teeth, and 16.8% had more than 6 DMFT (Fig. 10).

Table 5: DMFT value in children with and without MIH.

<table>
<thead>
<tr>
<th></th>
<th>Greifswald</th>
<th>Dubai</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIH DMFT (±SD)</td>
<td>0.4± 0.7</td>
<td>3.5±1.7</td>
</tr>
<tr>
<td>NO MIH DMFT (±SD)</td>
<td>0.1±0.4</td>
<td>2.3±1.7</td>
</tr>
<tr>
<td>MIH dmft (±SD)</td>
<td>1.1± 1.7</td>
<td>6.5±3.2</td>
</tr>
<tr>
<td>No MIH dmft (±SD)</td>
<td>0.9± 1.7</td>
<td>5.4±3.1</td>
</tr>
</tbody>
</table>
3.3 Comparison of DMFT values among children with and without MIH in Dubai (p< 0.001). 33.7% of the MIH cases had DMFT<2, almost 50% had DMFT 3_5 and 16.8% DMFT>6, which is significantly higher than the DMFT values in children without MIH (DMFT<2= 59.8%; DMFT 3_5= 34.5%; DMFT>6= 5.5 (p< 0.001).

5.3 Prevalence of MIH

The result demonstrated that there was a significant difference (p< 0.001) in MIH prevalence between the city of Dubai (7.4%) and Greifswald (4.3%) [Petrou et al., 2013] (Fig. 11).
5.3.1 Distribution of MIH criteria

The mean number of molars involved with MIH in Dubai was 2.42±0.9, which is not significantly different than Greifswald (2.0±1.1). 89.80% of children with MIH have at least 2 or more affected molars (Fig. 12). However only in 25.4% of the MIH cases of Dubai, incisors were involved (0.37±0.7) which is significantly less than Greifswald (40%).

![Percentage of affected molars in Dubai (%)](image)

**Figure 12: Distribution (%) of affected permanent molars in MIH cases, in Dubai.**

Nevertheless, demarcated opacities were the most common alterations among other MIH changes (96.6%). 57.6% of children with MIH in Dubai had at least one index tooth with post-eruptive enamel breakdown. 30.5% of children with MIH had at least one tooth with filling (69.5% Amalgam, 30.5% Composite). Compared to the distribution of Greifswald MIH criteria (Demarcated opacities 85.6%, post-eruptive enamel breakdown 14.4%, MIH tooth with filling 15.5%), Dubai has higher levels for all categories (Fig. 13).
Figure 13: Distribution (%) of MIH alterations in Dubai and Greifswald. Comparison to the data with identical methodology from Greifswald [Petrou et al., 2013], which show significantly higher levels of alteration categories except for demarcated opacities, in Dubai as compared to Greifswald.

Furthermore, 39% of children affected by MIH have shown only demarcated opacities and mild sensitivity with cold stimuli but no other alteration of MIH. The rest of MIH cases had combination of different MIH criteria. Post-eruptive breakdown and atypical restoration were mainly observed in molars and only two incisors demonstrated with atypical restoration. Although the molars 26 and 36 were almost equally affected in Greifswald and Dubai, 16 and 46 and the incisors were more affected in Greifswald than in Dubai (Fig. 14). Both maxilla and mandible were affected equally in Dubai (maxilla: 49.8%, n=86; molars=62, incisors=24; mandible: 50.2%, n=87; molars=82, incisors=5, mean maxilla= 1.28 ± 0.8; mandible= 1.32 ± 0.9) (Fig. 15) where in Greifswald differences among the mean number of affected teeth in the maxilla (1.56 ± 1.21) and mandible (1.25 ± 0.99) was statistically significant (p< 0.001).
Figure 14: Comparison of teeth distribution (%) with MIH in Dubai and Greifswald. Comparison to the data with identical methodology from Greifswald [Petrou et al., 2013].

Figure 15: Distribution (%) of MIH in maxilla and mandible. Comparison to the data with identical methodology from Greifswald [Petrou et al., 2013]. Dubai (Maxilla: 49.8%; Mandible: 50.2%). Greifswald (Maxilla: 61%) (Mandible: 39%). Although there is no significant difference in the mean number of affected teeth per jaw in Dubai (maxilla= 2.28 ± 0.81; mandible= 2.32 ± 0.93) it is statistically significant (p< 0.001) in Greifswald (maxilla= 1.56 ± 1.21; mandible= 1.25 ± 0.99).
Amalgam and composite were the atypical restorative materials on MIH affected teeth in Dubai (Amalgam: 69.5%; n=41; composite: 30.5%; n=18). However, no glass ionomer cement (GIC) was observed in Dubai. In Greifswald, 15.5% of MIH teeth were having atypical restoration (GIC: 93.3%; n=14; amalgam: 6.6%; n=1) (Fig. 16).

Figure 16: Distribution (%) of filling materials used for MIH affected tooth in Dubai and Greifswald. Comparison to data with identical methodology from Greifswald [Petrou et al., 2013].

5.3.2 Severity of MIH

98.3% (n=58) of the children with MIH experienced discomfort during cold or hot stimuli (Fig. 17). According to the EAPD grading guidelines [Lygidakis et al., 2010], 18.6% (n=11) of these teeth had extreme sensitivity to hot or cold stimuli and during tooth brushing, 79.6% (n=47) were occasionally sensitive (Fig. 18).
Figure 17: Distribution (%) of hypersensitivity experienced by children in Dubai and Greifswald. Comparison to data with identical methodology from Greifswald [Petrou et al., 2013].

Figure 18: Severity distribution (%) of “mild” and “severe” in MIH cases in Dubai and Greifswald. Comparison to the data with identical methodology from Greifswald [Petrou et al., 2013]. In mild cases there are occasional sensitivity to external stimuli such as air and water (Dubai: 81.4%; Greifswald: 47.4%). In severe cases (Dubai: 18.6%; Greifswald: 52.6%), persistent and spontaneous hypersensitivity results to external stimuli as well as sensitivity during tooth brushing.
5.4 Fluorosis

The prevalence of fluorosis in Dubai was 10.9%. There was no significant age (Table 6) and gender difference in fluorosis (female 11.06%; male 10.98%) (p> 0.001) (Fig. 19a) and most fluorosis cases were very mild or mild (Fig. 19b).

Table 6: Sample age population and distribution of fluorosis (n, %) in different age groups.

<table>
<thead>
<tr>
<th>Age group</th>
<th>6 year</th>
<th>7 year</th>
<th>8 year</th>
<th>9 year</th>
<th>10 year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>8</td>
<td>166</td>
<td>306</td>
<td>255</td>
<td>44</td>
<td>779</td>
</tr>
<tr>
<td>Fluorosis (n)</td>
<td>1</td>
<td>18</td>
<td>34</td>
<td>28</td>
<td>4</td>
<td>85</td>
</tr>
<tr>
<td>Fluorosis (%)</td>
<td>12.5</td>
<td>10.8</td>
<td>11.1</td>
<td>10.9</td>
<td>9.1</td>
<td>10.9</td>
</tr>
</tbody>
</table>

A) Gender distribution of fluorosis

B) Severity distribution of fluorosis

Figure 19: Age and severity distribution (%) of fluorosis in Dubai. A) Gender distribution of fluorosis in Dubai. B) Severity distribution of fluorosis in Dubai.
6. Discussion

6.1 Discussion of the aim

This is the first study to determine the prevalence of MIH in UAE and to compare it directly to an equivalent study in Greifswald/Germany with different socioeconomic status, geographic origin, and healthcare system. Both studies used the same examination criteria and study design and the examiners were calibrated in identical locations and with identical concepts. These standards allow a direct comparison between different geographical and cultural areas. The results obtained from this comparison study may contribute in understanding MIH and the etiological factors associated with this condition. Furthermore, to compare the dental caries and fluorosis with the literatures to evaluate the caries status and the prevention progress in Dubai, as well as the fluorosis status in this region.

6.2 Discussion of the method

6.2.1 Sample

To have a standard and representative sample size for the Dubai study, the sample size was calculated statistically using a NQuery Advisor software (version 4.0, Statistical Solutions Ltd. Ireland). Based on this calculation, representative sample size was determined to be about 835 children for a prevalence of 10% and a 95% confidence interval within a range of 8-12%. An identical calculation method was performed for the sample in the Greifswald study. To avoid the risk of selection bias and to have the chance of examining all healthy children, the sample in Dubai study was collected from governmental schools where the obligatory oral examination are emphasized by the ministry of health. This was considered because children attending dental clinics or university hospitals were those who are requiring treatment, having emergency condition (e.g. pain, high caries level, trauma, MIH), or/and a general health problem [Jālevik, 2010]. The same pattern was performed in sample selection of the Greifswald study, making both studies representative and comparable. In addition, the schools in the Greifswald sample were selected randomly by the community services to avoid any possible selection bias and the schools in Dubai were also selected randomly.
from a list of governmental school, which was received from the Ministry Of Education (MOE), therefore, increasing the internal validity of the study. In both studies, the specific age group (i.e., 7-9±1 year) was chosen according to the eruption time of first molars and incisors to avoid the masking effect from advanced carious lesions and extraction, which can minimize the chance of proper diagnosis [Balmer et al., 2012].

6.2.2 Calibration

The examiner in this study was calibrated with the gold standard as in the German study and reached high Kappa values (Kappa value>0.9). This makes the study strongly comparable and the data obtained through this procedure reliable. In addition, to ensure a high inter-examiner reliability, the calibration was conducted at different sites (i.e., site A: university library and site B: university dental clinic). During the calibration sessions, 20 photographs demonstrating various enamel defects with different level of severity as well as different MIH scores were used. This calibration method has been proved to be the standard method for MIH diagnosis for many other studies [Elfrink et al., 2009; Wong et al., 2005].

6.2.3 Data Collection Forms

The evaluation process of MIH in both studies was preformed according to the EAPD criteria (Table 2). Demographic parameters (i.e., age, gender), DMFT/dmft values as well as fluorosis and its different degrees were recorded (Attachment No. X). The data collection sheet was identical for all children. All the healthy, MIH and fluorosis cases were recorded on one sheet. Different criteria and degrees of MIH and fluorosis were coded according to the standard criteria to accelerate the recording and to ease the analysis (Attachment No. XI, XII).

6.2.4 Examination and diagnosis of MIH, caries, and fluorosis

The EAPD criteria were used for the evaluation of MIH in Dubai to avoid diagnostic errors, which were reported in previous studies using the MIH criteria established before 2003 (Table 1) [Dietrich et al., 2003; Balmer et al., 2012]. This standard evaluation process allows clinicians to recognize and differentiate MIH
accurately from any other enamel defects [Weerheijm et al., 2003]. The EAPD criteria allow a standard comparison with the Greifswald and other international studies which had used the same criteria [Weerheijm et al., 2003; Lygidakis et al., 2010]. A defect size of less than 1 mm was not recorded as a MIH case, since it can result in misdiagnosis [Jälevik, 2010]. The recorded affected tooth with MIH, usually presented a single criterion or combination of criteria on different surfaces of the same tooth, which confirms the strength of diagnosis in this study. Defects on incisors only, without a molar involvement, were excluded as has been suggested, since incisor defects alone can be as a result of local trauma, local inflammation, fluorosis, and hypoplasia [Chawla et al., 2008a]. To determine the MIH severity in Dubai, the hypersensitive teeth were recorded based on child responses to standard questions, which were also asked in the Greifswald study (Section 3.4.3). According to the EAPD guidelines [Lygidakis et al., 2010], having pain during brushing MIH teeth is a symptom of severe form of MIH, this standard gave us an assurance not to encounter complication in diagnosis of MIH cases that are associated with high caries levels, since about 66% of the MIH cases had high DMFT values (DMFT>3) (Fig. 10; Table 5). This standard gives no value in mild MIH cases, as the hypersensitivity in mild cases cannot be differentiated when both MIH and dmft/DMFT are associated, however standard diagnostic criteria of EAPD and strong calibration, reassure a correct diagnosis of MIH and differentiate it from caries. Standard criteria were used to investigate caries and fluorosis in order to have standard results to compare with the available studies in Dubai and to differentiate the findings from MIH (Sections 3.4.1; 3.4.2).

6.2.5 Method of comparison

The data of the German study [Petrou et al., 2013] was used for comparison. This study with an identical and a well-designed methodology allows a perceptible comparison with the data from Dubai. The German study took place in few cities of Germany including Greifswald, Heidelberg, Hamburg, and Düsseldorf. The city of Greifswald was chosen due to access to the detailed data as well as the remarkable socioeconomic and health system differences from Dubai. However, there is no research in Dubai, which studied caries level in age group of 6 to 10 years old.
Therefore, a recent caries literature review [Al-Bluwi, 2014] and a study by El-Nadeef [2009] were used to compare caries and fluorosis level. The age groups in both studies are between 4 to 6 (mean dmft 5.1 to 8.4) and 12 (mean DMFT 1.6 to 3.24) years old.

6.3 Discussion of the results

6.3.1 MIH prevalence

Based on the results obtained in this study there is a significant difference in the prevalence of MIH between Dubai/UAE and Greifswald/Germany [Dubai: 7.4%; Greifswald: 4.3%]. However, MIH prevalence in Dubai is quite low in comparison with other cities in Germany (Düsseldorf=14.6%, Hamburg=14.0%) and Middle East countries, where MIH prevalence ranges from 8.6% to 20% [Allazzam et al., 2014; Zawaideh et al., 2011; Ghanim et al., 2013; Ghanim et al., 2011; Ghanim et al., 2014]. Considering the high calibration value (Kappa> 0.9) and the “gold standard” investigator, who did the examination, this significant difference in MIH prevalence, could not be caused by an examiner bias. It should be bearing in mind that the prevalence of MIH in Dubai does not represent the MIH prevalence of the entire UAE and further studies are advised to provide a representative prevalence for all United Arab Emirates.

6.3.2 Distribution of MIH

The distribution of MIH obtained from Dubai/UAE was compared with Greifswald/Germany and other international studies. As a result, no significant difference (p> 0.001) in the distribution of MIH could be found for the variable gender in Dubai, which is comparable with the Greifswald study (Dubai: Female 7.57% and Male 7.58%; Greifswald: 4.21% Male and 4.37% Female). This was in agreement with other international studies [Leppäniemi et al., 2001; Jälevik et al., 2001; Calderara et al., 2005; Muratbegovic et al., 2007; Chawla et al., 2008a; Jasulaityte et al., 2008; Martínez Gómez et al., 2012]. Unlike Greifswald, no significant difference (p> 0.001) in MIH distribution in the upper and lower jaw was found in Dubai (Maxilla 49.8% and Mandible 50.2%) which is comparable to the international studies (Fig. 15) [Weerheijm et al.,
2001b; Chawla et al., 2008a; Cho et al., 2008; Ghanim et al., 2011]. Mean value of affected teeth per child with MIH in Dubai (2.7±1.1) is comparable to Greifswald (2.8±1.7) and other international studies (2.4 to 5.7) [Calderara et al., 2005; Cho et al., 2008; Jälevik et al., 2001]. Incisors affected with MIH in Dubai (25.4%) (mean 0.37±0.7), were significantly less than Greifswald (40%). However, it is comparable to the international reports (5.26% to 57.89%) [Jasulaityte et al., 2008; Lygidakis et al., 2008]. Mean value of affected molars per child with MIH (2.42±0.9) (Fig. 12), was found in Dubai to be comparable to Greifswald (2.0±1.1) and to other international studies (1.5 to 3.16) [Jälevik et al., 2001; Dietrich et al., 2003; Petrou et al., 2013]. Demarcated opacity was the most common criterion of MIH in Dubai and Greifswald, (Dubai: 96.6%; Greifswald: 85.6%) (Fig. 13) and other international studies [Jasulaityte et al., 2007; Muratbegovic et al., 2008; Soviero et al., 2009; Ghanim et al., 2011; Petrou et al., 2013; Heimüller et al., 2012]. Despite the fact of being uncertain about the previous status of the MIH tooth with restoration, atypical restorations are considered to be a severe form of MIH due to the invasion [Wogelius et al., 2008]. Nevertheless, 30.5% of children with MIH had at least one tooth with a filling, this was significantly higher than in Greifswald (15.5%). Although composite and glass ionomer cement (GIC) are the restorations of choice in MIH cases [Lygidakis, 2008; Fayle, 2003], no glass ionomer cement (GIC) was detected in Dubai and mostly amalgam was observed in MIH cases (Amalgam: 69.5%; n=41; composite: 30.5%; n=18) (Fig. 16). Severity and sensitivity due to structural breakdown were associated with a high number of MIH affected teeth [Petrou et al., 2013; Jälevik et al., 2001; Leppäniemi et al., 2001; Jasulaityte et al., 2007; Chawla et al., 2008a-b; Ghanim et al., 2011] as well as caries. 98.3% of the children in Dubai experienced tooth sensitivity, which could be also due to high caries level (Fig. 17). However, only 18.6% of the MIH cases had severe hypersensitivity, especially during tooth brushing (Fig. 18), which is a specific sign of MIH. Older children with MIH were more likely to have severe lesions compared to Greifswald, which can be due to the difference in implementing the prevention and treatment methods between the two cities (Fig. 16) [Leppäniemi et al., 2001; Lygidakis et al., 2008a; Jasulaityte et al., 2008; Petrou et al., 2013].
6.3.3 Distribution of possible etiological factors of MIH

Since the examiners in Dubai had no access to the information related to etiological factors (e.g. environmental factors, antibiotics use, breastfeeding, C-section, etc.) of the selected sample population, no specific and valid results regarding etiological factors of MIH can be concluded. Although the main purpose of this study was not to determine the etiological factors related to MIH, some probable assumptions can be drawn from our results, and available local and international data. However, the potential differences between Dubai and Greifswald and other Middle East studies can be as a result of the variance between the cities in multiple acquired factors, including environmental, healthcare, and socioeconomic factors [Steele, 2014; Struzycka, 2014; Winter, 1990].

Environmental Factors: Environment factors are among the most important etiological factors that might cause MIH. These results were obtained from studies that have compared two environmentally different areas such as urban and rural areas [Souza et al., 2012]. However, some other studies have shown no significant difference between the prevalence of MIH in polluted and non-polluted areas [Kusku, 2008, Kusku et al., 2009; Petrou et al., 2013]. To avoid this possible confusion factor bias in our study, the schools and their locations were selected randomly and if there are more than one school in the same area, one was excluded. Nevertheless Dubai air pollution is at a high level, mainly due to the rapid growth of industry and increased use of automobiles. It was found by Roads and Transport Authority (RTA), that there is an increase of 12% per year in using automobiles, which is five times more than other areas of the world [RTA, 2008]. This can cause an increase of different harmful pollutants, including nitrogen oxides, hydrocarbons, carbon monoxide, and carbon dioxide, which can indicate the pollution as one of the risk factors in Dubai [Al-Zubaidi et al., 2002; Corder, 2008; RTA, 2009]. However such pollution is not a concern in Greifswald [UBA, 2003] since the number of vehicles are low in this area. Comparing the result of our study with the Germany and other international, and Middle East studies, population tend to be an environmental risk factor, since cities with higher population showed higher prevalence (e.g. Dubai population 2.2 million=7.6% MIH; Hamburg population 1.8 million=14% MIH;
Düsseldorf population 1.5 million=14.6% MIH [Petrou et al., 2013]; Mosul, Iraq population 1.8 million=21.5% MIH [Ghanim et al., 2011]; Shiraz, Iran population 1.7 million=20.2% MIH [Ghanim et al., 2014]).

**Antibiotics:** Studies have shown that antibiotics are being misused in Middle Eastern countries including UAE [Habibzadeh, 2012; Bin Abdulhak, 2011]. An important contributing factor for this phenomenon is the cultural habit [Habibzadeh, 2012] where antibiotics are used without prescription either as a self-treatment action [Abasaeed, 2009] or pharmacists are willing to provide patients with antibiotics without prescription [Zaghloul, 2013; Habibzadeh, 2012; Bin Abdulhak, 2011]. The excess use of antibiotics have been linked with MIH due it’s possible negative effect on the amelogenesis phase of maturation [Alaluusua, 2010; Chawla et al., 2008a-b; Lygidakis et al., 2008b; Lygidakis et al., 2010]. Nevertheless MIH prevalence is low despite high antibiotic prescription in Dubai, which was also demonstrated in the German study where higher prevalence of MIH in cities with low antibiotic prescriptions compared to cities with high antibiotic prescriptions was observed [Petrou et al., 2013; BARMER, 2010; de With et al., 2004]. However, neither the study in Dubai nor in Greifswald had direct information regarding antibiotic use by the selected sample population and conclusions are based on the reports from health system regulation regarding antibiotics prescription and available studies regarding antibiotics use in UAE [BARMER, 2010; de With et al., 2004; Zaghloul, 2013; Habibzadeh, 2012; Bin Abdulhak, 2011; Abasaeed, 2009].

### 6.3.4 DMFT/dmft

The DMFT/dmft indices in Dubai were recorded to be high (DMFT: 2.41±1.7; dmft: 5.46±3.1) and comparable to other studies in UAE (DMFT mean: 1.6 to 3.24; dmft mean: 5.1 to 8.4) [Al-Bluwi, 2014; El-Nadeef, 2009], which supports the strength of the outcomes in this study. The caries prevalence obtained in this study and the most recent study [Al-Bluwi, 2014], are relatively similar compared to a previous study [El-Nadeef, 2009], which indicates no progress in the caries prevention. Therefore, an appropriate caries prevention program is needed to control the caries progress in Dubai. In addition, the mean DMFT/dmft indices in Dubai were higher than Greifswald (DMFT:
0.1±0.4; dmft: 0.9±1.7). The fact of high caries prevalence has been reported and discussed in different studies performed in the UAE different regions [Al-Bluwi, 2014; Hashim et al., 2013; Hashim et al., 2011; El-Nadeef, 2009; Hashim et al., 2009; Ur Rehman et al., 2008; Hashim et al., 2008; Hashim et al., 2006]. Based on the reported fact, MIH cases were recorded carefully by a strongly calibrated examiner, using the EAPD criteria, which allow differentiating MIH from other enamel defects, the possibility of a masking effect of high caries prevalence in this study has been minimized. Higher DMFT/dmft values associated with MIH defect was observed in this study (Table 5), which have been reported in many international studies [Leppäniemi et al., 2001; Weerheijm et al., 2003] as well as in the German study [Petrou et al., 2013]. This association indicates that MIH can increase caries susceptibility, specifically due to the weak structure of the affected tooth and the limitation of the oral hygiene maintenance as a result of discomfort and pain [Lygidakis et al., 2010]. Therefore, early diagnosis and treating hypersensitive MIH teeth are the optimal prevention measures to reduce caries levels in MIH patients.

6.3.5 Fluorosis

The prevalence of fluorosis in the age group of 7-9±1 year old in Dubai is 10.9% (Fig. 18). No significant age (Table 6) and gender (female 11.06%; male 10.98%) differences were observed (Fig. 19a) (p> 0.001). The majority of these cases were presented in a form of a very mild to mild (63.9%) form according to the Dean’s criteria (Fig. 19b). Currently, there is no study reporting the prevalence of fluorosis in Greifswald. However, the prevalence of fluorosis in Germany ranged from 4.9% to 11.3% and the majority of the cases were presented in a mild form of fluorosis [Pieper et al., 2008; Momeni et al., 2007]. Although, there is no water fluoridation in Germany and UAE, and the concentration of the fluoride in water supplements in UAE is lower than the recommended amount (1mg/L), the reason why fluorosis prevalence is still high, is unclear [Nimr, 1997; Momeni et al., 2007]. Although the prevalence of fluorosis in Dubai is relatively high, it does not provoke serious health concerns, since it is mostly “very mild, mild, and moderate” (based on Dean’s criteria), and only affecting the appearance of the teeth (i.e., esthetic issue) with no detrimental effect on teeth
structures [Muñoz, 2013; Abanto Alvarez, 2009]. In fact, teeth affected with moderate fluorosis have shown to be more resistant to caries lesions [Waidyasekera, 2007]. Therefore, the treatment option of fluorosis cases in Dubai is mostly esthetic to cover the discoloration. However, this condition can be prevented by controlling the fluoride intake during the teeth development.

6.4 Discussion of the challenges

In this study, we reported the prevalence of MIH in Dubai/UAE and compared it with Greifswald/Germany using identical diagnostic criteria and the same calibration system, which gave us a reliable prevalence. The strong methodology in this study of one examiner who was previously calibrated according to the standard calibration method, the examination in identical locations (i.e. schools), using similar clinical conditions (i.e. Class rooms), and standard instruments, increased the value of these results. A possible challenge was MIH masked due to the high prevalence of fluorosis and caries in Dubai. However, the standard EAPD criteria and strong calibration has reduced this challenge. The use of similar comparison approach between Middle Eastern and European studies has not been well explored or applied yet due to absence of access to patients medical histories, which could potentially provide a powerful mean to determine the etiological factors of MIH. Nevertheless, the lack of access to the medical record of the sample group in Dubai was also a challenge, which limited further comparison of etiological factors. Another limitation is that the sample collected from one city (e.g. Dubai) cannot provide a representative prevalence for the whole country (UAE). Therefore, further studies of the prevalence of MIH as well as its local contributing factors in UAE, Middle East, and Europe should be initiated for the aim of having a more comprehensive picture of the MIH prevalence in the region, as well as to provide evidence that increase the understanding of the main etiological factors of this condition. The German study and specifically the Greifswald data were successfully used as reference for comparison in this study due to the strong and similar methodology used in Greifswald study and also due to the opportunity and access to the detailed data, facilities for training and calibration through the same process.
7. Conclusions

Here, we presented the prevalence of MIH in Dubai/UAE for the first time, which represents a developed Middle Eastern city and compared it to results obtained from Greifswald/Germany, which represents a developed European city. The results have shown that the prevalence of MIH in Dubai/UAE is higher than Greifswald/Germany. However, in comparison to the literature, the prevalence of MIH in Dubai is lower than other Middle Eastern cities.

Furthermore, we have shown that there is a higher caries level associated with MIH in Dubai. This is also true in Greifswald, Germany and other international studies [Jeremias et al., 2013; Grošelj et al., 2013; Lygidakis, 2010]. In addition, we have reported the prevalence of caries and fluorosis in Dubai and compared them to Greifswald and the previous studies in Dubai. Nevertheless, caries values presented in this study and previous studies indicate that strong attention is required from health authority to this topic.

This research provides a strong and comparable source of information on the prevalence of MIH in Dubai for other studies, since it followed strictly all methodological and clinical standards suggested for the assessment and diagnosis of MIH, which are the EAPD criteria [Weerheijm et al., 2001b; Lygidakis et al., 2010].

The findings presented in this study require particular attention from the local health authorities and general practitioners for such developmental defect to facilitate early and adequate diagnosis and treatment. This could be achieved by implementing continuing education courses on MIH detection, diagnosis, and treatment for general practitioners. Furthermore, this study has the potential to trigger new studies that would help in understanding the MIH etiology.
8. Summary

**Background:** Defects in enamel mineralization occur during tooth development resulting in structural breakdown. Among such defects, Molar Incisor Hypomineralization (MIH) is one of the most common enamel defects that occur in children, but the literature is still lacking data on the occurrence and etiology of MIH. Identifying this defect in population is of particular importance due to the association with increase of caries susceptibility and interference with treatment planning.

**Aim:** The purpose of this study was to find the prevalence of MIH in Dubai/United Arab Emirates (UAE) and to compare it with MIH prevalence in Greifswald/Germany. Furthermore, to explore prevalence of fluorosis and caries in Dubai in order to assess the chance and influence of differential diagnoses and to analyze the possible relationship between MIH and caries level. In addition, dental caries and fluorosis prevalence in this study will be compared with valid literatures in Dubai, which could possibly be a trigger for further studies to develop adequate prevention and treatment procedures.

**Design:** In this cross-sectional study, 779 children (female: 513; male: 261) age of 7 to 9 (±1) year-old in the city of Dubai/UAE were randomly selected and examined. The examination was carried out for children in Dubai governmental schools by one examiner who had previously been trained and calibrated with the MIH diagnostic criteria of the European Academy of Pediatric Dentistry (EAPD), fluorosis diagnostic criteria of Dean, and dmft/DMFT values for caries diagnosis. The data from Greifswald had been collected in year 2011 by the community dental services from 443 children, with same age group.

**Results:** The percentage of children with MIH in Dubai/UAE was 7.6% and higher than in Greifswald with 4.3%. There was no significant gender difference in Dubai (7.57% female, 7.58% male) or Greifswald (4.34% female, 4.21% male). The DMFT/dmft indices were generally high in Dubai with a mean DMFT of 2.41±1.7 and dmft 5.46±3.1, while Greifswald had much lower caries values (DMFT 0.1±0.5 and dmft 0.9±1.7). The difference of DMFT index between children with and without MIH was statistically
significant for Dubai (p< 0.001). However caries prevalence is comparable with the results from the previous caries studies in Dubai.

**Conclusion:** The prevalence of MIH and, especially, the caries values are higher among the children population of Dubai/UAE compared to Greifswald/Germany and no difference in fluorosis and caries prevalence's were observed in comparison to previous studies in Dubai. These findings require particular attention from the health authorities and the local dentists to such defects that might facilitate adequate prevention and treatment options.
9. Reference


32. DAJ. (Deutsche Arbeitsgemeinschaft für Jugendzahnpflege) Grundsätze für Maßnahmen zur Förderung der Mundgesundheit im Rahmen der Gruppenprophylaxe nach § 21 SGB V. Geändert am 20.06.2000


73. Kidd EA. How 'clean' must a cavity be before restoration? Caries Res. 2004; 38:305-313


85. Mahoney P. Two dimensional patterns of human enamel thickness on deciduous (dm1, dm2) and permanent first (M1) mandibular molars. Arch Oral Biol. 2010; 55:115-126


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10. Attachments

I. Ethical approval from Greifswald University
Submitted documents for evaluation:

- Study Protocol
- Information form
- Consent form

Der Ethikkommission gehören an:

reguläre Mitglieder
- Prof. Dr. M. Lerch
  Klinik für Innere Medizin A
- Prof. Dr. R. Biffl
  Zentrum für Zahn-, Mund- und Kieferheilkunde
- Prof. Dr. U. Runge
  Klinik und Poliklinik für Neurologie
- OA Dr. M. Gründling
  Klinik für Anästhesiologie und Intensivmedizin
- Prof. Dr. W. Siegmund
  Institut für Pharmakologie
- Prof. Dr. Th. Kohlmann
  Institut für Community Medicine
- PD Dr. B. Backholdt
  Institut für Rechtsmedizin
- Prof. Dr. H.-W. Eckert
  Fakultät für Rechts- und Staatswissenschaft
- Prof. Dr. H. Asuell
  Theologische Fakultät
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  Zentrum für Zahn-, Mund- und Kieferheilkunde
- Prof. Dr. B. Rauch
  Institut für Pharmakologie
- OA Dr. S. Friesen
  Klinik für Innere Medizin B
- Dr. Dr. G. Engel
  Universitätsapotheke
- Prof. Dr. W. Hoffmann
  Institut für Community Medicine
- Prof. Dr. W. Jocke
  Fakultät für Rechts- und Staatswissenschaft
- Prof. Dr. J. Legler und Prof. Dr. C. D. Classen
  Fakultät für Rechts- und Staatswissenschaft
- Prof. Dr. K. Ott
  FB Biologie
- PD Dr. R. Bruns
  Klinik und Poliklinik für Kindermedizin
- Prof. Dr. M. Zygmun
  Klinik und Poliklinik für Frauenheilkunde und Geburtshilfe
- PD Dr. R. Möllmann
  niedergelassener Internist, Greifswald
- Rahel Österreich-Lutz, Medizinstudentin
II. Ethical approval from UAE Ministry of Health

United Arab Emirates
Ministry of Health

Al Qassimi Clinical Research Centre
Research Ethics Committee
Al-Qassimi Hospital
Wasit Road
PO Box 3500
Sharjah – United Arab Emirates

Date: 03/APR/2013
Somayeh Haidary
Stoltebrucker Street, 8 Greifswald 17475
Greifswald, Germany
Tel: 49-176-70792162
Email: sh12003@uni-greifswald.de

Dear Somayeh Haidary,

Full title of study: Comparison of Molar Incisor Hypomineralization (MIH) prevalence and probable etiological factors in Dubai/U.A.E and Greifswald/Germany

REC Reference Number: 122012-12 Please quote this number on all correspondence

The Research Ethics Committee has reviewed the above application at its meeting held on 03/APR/2013.

Ethical Opinion
A favourable ethical opinion was given for the above research on the basis described in the application form, protocol and supporting documentation subject to the conditions below:

1. The understanding that the research team complies with ICH-GCP guideline and all applicable regulations governing the conduct of clinical studies
2. Management permission or approval must be obtained from each site prior to the start of the study at the site concerned.
3. Annual progress reports from the date of approving the study must be submitted to the REC.
4. Study Termination:
   a. In case of premature termination of the study, the REC should be notified within 15 days of termination.
   b. In case of a planned termination/endpoint of study, the REC should be notified within 90 days of its conclusion.
5. Study should commence within 6 months of the approval date.
6. End of Study Report/Summary of study outcome should be submitted within 6 months of end of study.
7. The REC should be notified of serious breaches of the protocol or of the conditions or principles of Good Clinical Practice (GCP) within 15 days.
8. Other conditions:

Telephone: +971 6 5188 702
Fax: +971 6 5384 365
E-Mail: moh.rec@moh.gov.ae

www.gov.ae
Changes/Clarification in the Informed Consent Form.

The approval of your study expires on 03/APR/2014. Should you wish to continue the study after this date, please submit an application for renewal together with the Annual Study Progress Report no later than 15 days prior to the expiry date.

Approved documents
The final list of documents reviewed and approved by the Committee is as follows

<table>
<thead>
<tr>
<th>Document</th>
<th>Version</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover Letter to REC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research Application</td>
<td></td>
<td>11/12/2012</td>
</tr>
<tr>
<td>Research Summary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CVs</td>
<td></td>
<td>31/12/2012</td>
</tr>
<tr>
<td>REC Opinions (Germany)</td>
<td></td>
<td>12/09/2012</td>
</tr>
<tr>
<td>Approval Letter from University</td>
<td></td>
<td>12/09/2012</td>
</tr>
<tr>
<td>Letter of approval from supervisor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Dr. Ct Spleth</td>
<td></td>
<td>10/7/2012</td>
</tr>
<tr>
<td>• Dr. Raghad Hashim</td>
<td></td>
<td>10/7/2012</td>
</tr>
<tr>
<td>Cover Letter to REC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study Protocol</td>
<td>Version 2</td>
<td>March 2013</td>
</tr>
<tr>
<td>Informed Consent Form (English-Arabic)</td>
<td>Version 2</td>
<td>March 2013</td>
</tr>
<tr>
<td>Diagnosis Form (English-Arabic)</td>
<td>Version 2</td>
<td>March 2013</td>
</tr>
<tr>
<td>Data Collection Form</td>
<td></td>
<td></td>
</tr>
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</table>

Committee Members
The following Subcommittee members were present at the meeting and voted

<table>
<thead>
<tr>
<th>Member Name</th>
<th>Designation</th>
<th>Attended</th>
<th>Voted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Ghada Al Tajir</td>
<td>Chair</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Dr. Yasir Al Rawi</td>
<td>Member</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Statement of Compliance
The Committee is registered with the Office for Human Research Protection and authorized to conduct the ethical review of clinical studies. The committee is fully compliant with the regulations as they relate to Ethics Committees and the conditions and principles of good clinical practice. The committee is constituted in accordance with the WHO and ICH-GCP guidelines and works according to written Standard Operating Procedures.

With the Committee's wishes for the success of this study
Yours Sincerely

Dr. Ghada Al-Tajir
Chair

Telephone: +971 6 5388 702  Fax: +971 6 5384 365  E-Mail: moh.reo@moh.gov.ae
III. Approval from Dubai Ministry Of Education

المحترم

السيد / ضابط أمين الوزارة

تحية طيبة وبعد ...

أبحث لكم بخصوص القيادة ويسننر أن نعلمنك بطلب الطالبة / سمية حيدر أحمد (0506575706) بالLongrightarrow مع المدارس الحكومية / الحلقة الأولى لاستكمال بحثها

لتفضل بالعلم والتكرم بإداء الرأي بشأن الموضوع المشار إليه أعلاه.

وتفضلوا بقبول فائق التقدير والاحترام ...

مكتب وكيل وزارة التربية والتعليم

www.moe.gov.ae

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IV. Information form

**Information form**

1. What is Molar Incisor Hypomineralization (MIH)?
   Tooth consist of layers in which that the most peripheral part called Enamel. It is the strongest and most protective layer. Enamel protects the internal content of a tooth. Defect in Enamel makes the tooth susceptible to caries and further faster extension of caries to inner layer of tooth including nerve and causing inflammation, and further complicated situation. Complication in tooth leads to complicated dental treatment with higher cost. MIH is one of such defects in Enamel. Therefore it needs to be diagnosed and treated to prevent further complication and cost which is our goal in this research. This research will be carried by Dr. Somayeh Haldary, a PhD candidate in university of Greifswald/Germany who has been trained by qualified professor and instructors who have done the same researches a year ago in most of the cities in Germany including Greifswald.

2. Study procedure: In this research your child will go through normal dental examination (checkup), using only a normal mouth mirror, however before the examination a routine tooth brushing will be carried out and your child will receive information by the professional examiner about ideal brushing technique.
   Aim: to check and find out the number of children having the defect.
   We will inform school and provide your child with an diagnose paper in case he/she has the defect so you visit your dentist and ask for required treatment based on the defect level.

3. Possible risks: Since this examination is as much same as the normal dental checkup there will be no risk associating this procedure.

Participation in the study is voluntary, no penalties for refusal or withdrawal
Schools' approvals were obtained and all obtained information will be kept confidential
Examiner name ______________ signature ______________
Ministry of Health: 009716 51 88 702
1- ما هو المقصود بنقص الأملاح في الأضراس والقواطع الأمامية؟

يتكون السن من عدة طبقات، وتعتبر الطبقة الخارجية المسمى بمناء الأسنان، الطبقة الأقوى، وتكمن وظيفتها في حماية المكونات الداخلية للسن. حدوث أي خلل في هذه الطبقة يجعل السن عرضة للتسوس و يزيد من سرعة وصوله وانتشاره إلى الطبقات الداخلية للسن بما في ذلك العصب، والالتهابات الناجمة عن ذلك قد تزيد الوضع تعقيدا. حدوث أي من هذه المضاعفات يؤدي إلى تعقيد عملية العلاج وبالتالي ارتفاع التكلفة. تعتبر حالة نقص الأملاح في الأضراس والقواطع الأمامية إحدى الأسباب المؤدية للخلل في تكوين مناء الأسنان، وذلك لابد من تشخيصها وإزالتها من السوائل عالية من التعقيدات أثناء عملية العلاج وبالتالي تقليل التكلفة.

2- الدراسة في هذا البحث تتبقي طفلك الفحص الاعتيادي لأسنان ،بالإضافة إلى تلقيه بعض النصائح والإرشادات من قبل المختصين عن كيفية استعمال فرشاة ومعجون الأسنان.

3- كيف من الدراسة فحص وأخذ عينات عدد الأطفال المصابين بخلل في تكوين مناء الأسنان في دولة الإمارات العربية المتحدة.

4- الأخطار المحتملة بما أن هذا الفحص يعتبر كأي فحص اعتيادي لأسنان ، فإنه لا يوجد هناك أي خطير يذكر في هذه الدراسة.

رقم وزارة الصحة - خمس أخلاقيات طب: 6518870-2021
VI. Consent form

Consent form

Dear parents,

Your child is invited to participate in a research study about Molar-Incisor hypomineralization prevalence (MIH) which is a defect on specific teeth. The research is safe and requires only a normal dental checkup free of charge. Hereby we request your kind corporation in a research which will be under the observation of school authority. This research is for health purpose and your corporation will help humanity. The researcher conducting this study is Dr. Somayeh Haidary. You may ask her any questions you have through the following telephone number 06-7056394

We would highly appreciate if you provide us with following information since this research is about the children who were living in UAE for long time. Therefore if your child is a new residence in UAE will not be included in this research, but will receive ideal brushing technique instruction.

How long has your child been living in UAE? __________________________

Child name __________________________
Signature of Participant parent __________________________ Date ____________
عزيزي ولي الأمر

يسرنَا أن نوجه دعوة لطلالكم للمشاركة في دراسة بحثية حول انتشار حالة نقص الأملاح في الأضراس والقوانين الأمامية، وهو خلل يحدث في

هيئة عامة أن هذه الدراسة دراسة أمريكية إذا لم تتعلق سوى فحص اعتيادي للأسنان. لذلك نرجو من حضراتكم المشاركة معنا في هذا البحث والذي

سيتم تحت رعاية إدارة المدرسة. وتشير النتائج أن الهدف من هذا البحث هو إجراء العربي الصحي في الدولة، ولن تكون مساهمتك معنا إنجاز هذا

البحث تكراراً للاستغلال من جهودكم الإنسانية.

سنقوم الدكتورحة سنية حياني بإجراء هذه الدراسة إن كان لدينا أي استفسار الربط الاتصال على هذا الرقم: 05639427

في حالة الموافقة على فحص الطفل، أرجو التزودينا بالمعلومات التالية:

اسم الطفل: ........................................... توقيع ولي الأمر: ...........................................

ما عدد السنوات التي كان طفلك مقيماً في دولة الأمارات؟ ................................................... سنوات.
Dear parent

Hereby we inform you that your child has a dental defect called molar incisor hypomineralization.
Please visit your dentist to receive required care and treatment.

Dentist name _ _ _ _ _ _ _ _ _

Signature/Date _ _ _ _ _ _ _ _ _ _
إفادة تشخيص

عزيزي ولي الأمر

نود إعلامكم أنه تم تشخيص طفلكم الكريم بحالة حالة نقص الأملاح في الأضراس والقواطع الأمامية.

الرجاء مراجعة طبيب الأسنان ليتم توفير الرعاية اللازمة لطفلك.

اسم الدكتور: ............................................................

توقيع والتاريخ: ......................................................
### X. Examination Chart

<table>
<thead>
<tr>
<th>Date:</th>
<th>School Name:</th>
<th>Class:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Numbers</th>
<th>Grade</th>
<th>Age</th>
<th>Gender</th>
<th>dent</th>
<th>DMFT</th>
<th>Fluorosis</th>
<th>Level of fluorosis</th>
<th>MMR</th>
<th>Index Tooth/T</th>
<th>Molar</th>
<th>Incisor</th>
<th>Demarcated Opacity</th>
<th>PEB</th>
<th>Atypical restoration</th>
<th>Type of restoration</th>
<th>Hyper Sensitivity</th>
<th>Sev.</th>
<th>Not erupted/missing</th>
<th>Coexistence of caries</th>
<th>Coexist. of ortho</th>
</tr>
</thead>
</table>

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XI. Index table coding

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dean’s Criteria</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Normal = (0)</strong></td>
<td>The Enamel surface is smooth, glossy, pale creamy-white translucent.</td>
</tr>
<tr>
<td><strong>Questionable = (1)</strong></td>
<td>The translucency of normal enamel is abbreviated, ranging from a few white flecks to occasional white spots.</td>
</tr>
<tr>
<td><strong>Very mild = (2)</strong></td>
<td>25% or less from the tooth surface is covered with small opaque, paper white areas. Included teeth in this classification are showing almost 1-2 mm of white opacity at the tip of the cusps bicuspid or second molars.</td>
</tr>
<tr>
<td><strong>Mild = (3)</strong></td>
<td>Less than 50% of the tooth surface is covered with white opaque areas.</td>
</tr>
<tr>
<td><strong>Moderate = (4)</strong></td>
<td>Enamel surface is completely affected; biting surfaces shows attrition and brown discoloration might be present.</td>
</tr>
<tr>
<td><strong>Sever = (5)</strong></td>
<td>All enamel surfaces are affected. The general form of the tooth might be changed. It is diagnosed by discrete or confluent pitting, presenting brown stains and often a corrosion appearance.</td>
</tr>
</tbody>
</table>
XII. Coding table

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>M/F</td>
</tr>
<tr>
<td>Fluorosis</td>
<td></td>
</tr>
<tr>
<td>MIH</td>
<td></td>
</tr>
<tr>
<td>Demarcated opacity</td>
<td>Yes=1 No=0</td>
</tr>
<tr>
<td>PBD</td>
<td></td>
</tr>
<tr>
<td>Atypical restoration</td>
<td></td>
</tr>
<tr>
<td>Hypersensitivity</td>
<td></td>
</tr>
<tr>
<td>Severity</td>
<td></td>
</tr>
<tr>
<td>Not erupted/missing</td>
<td></td>
</tr>
<tr>
<td>Coexistence of caries</td>
<td></td>
</tr>
<tr>
<td>Coexistence of orthodontics</td>
<td></td>
</tr>
<tr>
<td>Type of restoration</td>
<td>Amalgam=0 Composite=1</td>
</tr>
</tbody>
</table>
XIII. Presented Conference Abstract

Conference Abstract: European Academy of Paediatric Dentistry 2014, Sopot, Poland

Comparison of Molar-Incisor Hypomineralization Prevalence in Dubai/United Arab Emirates and Greifswald/Germany

Somayeh Haidary1*, Marina-Agathi Petrou1, Raghad Hashim2, Azza Alhumrani2, Christian Splieth1

1 Preventive and Pediatric Dentistry Department, University of Greifswald, Greifswald, Germany
2 Growth and Development Department, College of Dentistry, Ajman University of Science and Technology, Ajman, UAE
*Correspondence to: Somayeh Haidary, 17475 Greifswald, Germany.
E-mail: Somayeh.Haidary@outlook.com

Background: Defects in enamel mineralization occur during tooth development resulting in structural breakdown. Among such defects, Molar-Incisor Hypomineralization (MIH) is one of the most common enamel defects that occur in children. Identifying this defect in population is of particular importance due to the association with increase caries susceptibility and interference with treatment planning. A recent study in Greifswald/Germany reported a prevalence of MIH 4.29%.

Aim: The purpose of this study was to find the prevalence of MIH in Dubai/United Arab Emirates (UAE) and to compare it with MIH prevalence in Greifswald/Germany.

Design: In this cross-sectional study, 779 children (female: 513; male: 261) age of 7-9 (±1) year-old in the city of Dubai/UAE were randomly selected and examined. The examination was carried out for children in Dubai governmental schools by one examiner who had previously been trained and calibrated with the MIH diagnostic criteria of the European Academy of Pediatric Dentistry (EAPD).

Results: The percentage of children with MIH in Dubai/UAE was 7.6%. There was no significant gender difference in Dubai (7.57% female, 7.58% male) or Greifswald (4.34% female, 4.21% male). The DMFT/dmft indices were generally high in Dubai (DMFT= 2.41±1.7; dmft= 5.46±3.1). However, the difference of DMFT index between children with and without MIH was statistically significant (p < 0.001).

Conclusion: The prevalence of MIH is higher among the children population of Dubai/UAE compared to Greifswald/Germany. This finding requires a particular attention from the local dentists to such developmental defect to facilitate adequate treatment.
11. Declaration

I hereby declare that I have written this thesis independently and have used no other than the means and sources mentioned. The thesis has so far not been submitted to any other faculty. I declare that I have not completed any doctoral process unsuccessfully and no withdrawal exists of an already acquired doctoral degree.

Greifswald, 15/11/2014

Somayeh Haidary

Eidesstattliche Erklärung


Greifswald, 15/11/2014

Somayeh Haidary
12. Dedication

I am thankful to GOD for being here and reach this point I am, I am thankful to him for giving me countless blessings in my life.

I dedicate my work to my family who supported me through the difficulties I faced. I am grateful for having each of them in my life.

I thank my parents for giving me a chance to improve myself and allowing me to go further in my studies. Not every Afghan girl has such a chance in life. I thank my lovely beautiful mom for teaching me being kind and good to people. I thank her for her patience with me. I thank her for her love and guidance towards GOD and his love. I love you mom, without you and dad I would not be here.

I dedicate this work especially to my loving fiancé with special feeling of gratitude, whose words of encouragement and support cheered me up, and kept my spirit high, who have never left my side, who had believe in me even when I didn’t. My dear, here I thank you from all my heart for your unconditional support. I am blessed and honored to have you.

I also dedicate this dissertation to my family and friends in Greifswald who have supported me throughout these three years. Who have always been beside me when I needed help. I will always appreciate all they have done for me and keep their love in my heart.

I have learned, there is nothing undoable in life as long as you believe in god by your heart.
13. Acknowledgment

I wish to thank Prof. Dr. Ch. H. Slieth for giving me the opportunity for being here, my colleagues, better to say my family in the dental clinic for the support and encouragement, and for the generosity with their expertise and love.

I would like to acknowledge and thank Dr. Marina Petrou and Dr. Ruth Santamaria for their limitless help. Special thanks to, Dr. Mohammad Alkilzy, and Dr. Julian Schmoeckel for their kind instruction.

I would like to thank Dr. Raghad Hashim, Head of Growth & Development Department, College of Dentistry, Ajman University (AUST), without her guidance this research could not start. Special thanks to Dr. Azza Alhumrani for her kind help and support.

I would like to acknowledge the Ministry Of Health (MOH) especially Dr. Kalthoom Hassan, director of specialized health care department MOH, for her kind guidance through my research application. Sincere thanks to ministry of education in UAE for supporting this research. Many thanks to all the schools for providing the requested assistance, their excitement and willingness to cooperate made the completion of this research a pleasant experience despite all the difficulties.