DENTAL CARIES EXPERIENCE AND ORAL HEALTH IN DOWN SYNDROME CHILDREN IN DUBAI, UNITED ARAB EMIRATES: A CASE CONTROL STUDY

By

Dr. Batool Ghaith

M Paed Dent, Royal College of Surgeons Edinburgh, 2016

MFD, Royal College of Surgeons Ireland, 2011

BDS, Trinity College Dublin, 2009

BA, Trinity College Dublin, 2009

Presented to the Hamdan Bin Mohammed College of Dental Medicine of
Mohammed Bin Rashid University of Medicine and Health Sciences
in Partial Fulfilment of the Requirements for the Degree of
Master of Science in Paediatric Dentistry
2016

ABSTRACT

DENTAL CARIES EXPERIENCE AND ORAL HEALTH IN DOWN SYNDROME CHILDREN IN DUBAI, UNITED ARAB EMIRATES: A CASE CONTROL STUDY

Dr. Batool Ghaith, BDS, BA, MFD RCSI, M PAED DENT RCSEd

Supervisors: Associate Professor Mawlood Kowash and Associate Professor Manal Al Halabi

Aims:

The purpose of this study was to assess the oral health status in Down syndrome (DS) children in Dubai, United Arab Emirates (UAE).

Materials and Methods:

A total of 106 DS children (mean age = 9.3 ± 2.8) and 125 healthy children (mean age = 11.7 ± 4.4) were recruited from both special needs centres and private/public schools in Dubai. A dental examination including caries assessment using dmft/DMFT indices, oral hygiene assessment using the Simplified Oral Hygiene Index, an assessment of occlusal anomalies, dentofacial abnormalities, soft tissue abnormalities and erosion were conducted.

Results:

The mean number of DMFT in DS children was significantly higher than that in healthy children (3.32 ± 4.62 vs. 2.16 ± 2.86). The dmft scores were highest among the youngest age groups in DS with primary dentition compared to their controls. The Met Need Index (MNI) and Restorative Index (RI) were calculated from the mean dmft/DMFT of the studied DS sample. DS children in the primary dentition group had higher RI and MNI scores than the control group (RI= 27% and MNI= 40% vs RI= 2.52% and MNI= 2.54%). On the other hand, Calculus Index (CI) was found

to be significantly higher among children with DS (0.25±0.52) compared with healthy controls (0.07± 0.27) (p-value < 0.004). DS subjects had a significantly higher proportion of open bite compared to the control group (40% vs 11.2%), crossbite (42% vs. 28%), scissor bite (9.5% vs 2.4%), anterior spacing (45.3% vs 32%) and posterior spacing (20.8% vs. 8%). Class III molar Angle malocclusion was significantly higher in DS (66%) compared to controls (11.2%). DS individuals had remarkably increased frequencies of dentofacial anomalies such as shovel shaped incisors, high arched palate and microdontia compared to controls. In addition, erosion was significantly higher among DS children compared to healthy control (34% vs. 15.3%).

Conclusions:

Individuals with DS feature unique medical and orofacial characteristics that might interfere with their oral health. This current study had concluded that DS children in Dubai had higher caries rate compared to healthy children. Despite the high caries rate among DS subjects, they received more restorations and dental treatment compared to the control group. DS subjects in Dubai demonstrated most of the dentofacial anomalies usually seen in DS individuals.

DEDICATION

This thesis is dedicated to my parents

For their endless love, support and encouragement

DECLERATION

I declare that all the content of the thesis is my own work. There is no conflict of interest with any other entity or organization.

Name: Batool Ghaith

Signature:

ACKNOWLEDGMENTS

There have been many people who have walked alongside me during the last three years, without whom this thesis might not have been written and to whom I am greatly indebted.

First and foremost, I have to thank my parents, for their love and support throughout my life. Thank you for giving me strength to reach for the stars and chase my dreams. My sisters and brothers deserve my wholehearted thanks as well.

I would like to sincerely thank my supervisors, Dr Mawlood Kowash, Dr Manal Halabi and Dr Iyad Hussien, in a special way, I express my heartfelt gratefulness for their guide and support that I believed I learned from the best. Thank you for your confidence in me. To Dr Ammar Hassan, I was grateful for your help in statistical data handling and analysis in this thesis. I learned from his insights a lot.

A very big thanks to my colleagues, indeed friends, Dr Haifa Al-Hashimi, Dr Ghada Hussain, Dr Eman Al-Nuaimi, Dr Shaikha Al-Raeesi and Dr Dina Mansour. I would like to thank each and every one of them for their contributions and support. I am truly blessed by their friendship.

Particular thanks must also be recorded to the paediatric nursing staff in Hamdan Bin Mohamed College of Dental Medicine of The Mohammed Bin Rashid University of Health and Medical Sciences. They have been exceptionally helpful, charming and patient throughout the data collection visits in the schools.

I would like to thank Dubai Health Authority for the sponsorship they awarded that enabled my financial support for the Master degree.

I would like to extend my sincerest gratitude to the following ministries, organizations, schools and centres for their great contributions and participation in this study:

- Ministry of Health – Dubai
- Ministry of Social Affairs – Dubai
- Al Noor Training Centre for Children with Special Needs
- UAE Down Syndrome Association
- Rashid Centre for Disabled
- Dubai Rehabilitation Centre
- Jumeirah Model Girls School
- Zayed Bin Sultan School
- Al Maaref Private School

I am indebted to the teachers and nurses in all the special needs centres and schools. They helped in organizing my visits to the schools and made the data collection process easy. Finally and without hesitation, I would like to thank the parents and children who participated in this study.

TABLE OF CONTENTS

Contents

List of Tables

List of figures

1. Introduction

Down Syndrome (DS) is a syndrome named after John Langdon Down, a British doctor who first described it in 1866 [1]. DS or Trisomy 21 is a genetic disorder caused by a trisomy of chromosome 21 [2,3], which is an extra chromosome No.21. An abnormal segregation of chromosomes during cell division gives the affected individuals three instead of the normal two chromosomes [4,5,6]. These individuals have a total chromosome count of 47 [4,6]. There are at least three forms of DS, the typical trisomy 21 with 47 chromosomes accounts for 95% of the cases [1]. The other cases are associated with other chromosomal abnormalities, including translocation (3%), mosaicism (2%) and partial trisomy [1,3,4,7].

Patients with DS have multiple general defects in their bodies. In general, these patients have a high incidence of congenital heart disease, gastrointestinal tract anomalies, immunodeficiency, visual impairment, skeletal defects, audiological dysfunction, nutritional difficulties during infancy, dermatological disorders, seizure disorders, sleep apnoea, increased weight in adolescence, mental deficiency, high risk of acute leukaemia and thyroid disorders [1,3,4,8].

DS patients have distinct features in the head and neck region. The most prominent features consist of brachycephy, thin cranium with late closure of fontanelle, fine and sparse hair, frontal bossing, blocked tear ducts, small and broad nasal bridge, hypotonia of muscles with tendency to keep the mouth open and protrude the tongue, mid face deficiency, short neck, small or absent ear lobes, hearing loss, fluid accumulation in the middle ear and a risk of atlanto-axial dislocation [1,4].

DS is the most common chromosomal condition diagnosed in the US [7]. Approximately one out of every 700 infants born in the United States is diagnosed with DS [9]. Regionally, DS prevalence is around 1 in 554 in Saudi Arabia and 1 in 853 in Hyderabad in India [10,11]. Surprisingly, Dubai has

scored the highest incidence in the region, One in every 319 live birth among UAE nationals and 1 in every 602 live births among non-nationals are diagnosed with DS [12].

As the life expectancy among this population is increasing [1], schools, work and community settings are becoming the norm for DS persons [1,7]. The demand for dental care for this group with special needs is also increasing with this incidence trend and thus every practitioner should have a clear understanding of DS's unique characteristics that would undoubtedly influence their dental care and treatment.

Intra orally, DS patients suffer from a higher prevalence of periodontal disease compared to the normal population, hypoplasia of teeth, supernumerary teeth, atypical patterns of eruption, bruxism, ectopic eruption, macroglossia, high arched palates, prognathism, open bite, fissured tongues, angular cheilitis, smaller permanent dentition and larger deciduous dentitions [1,4,13]. A very common finding is congenitally missing teeth [1]. Also, during tooth development a number of dental morphologic abnormalities occur such as shovel-shaped incisors, missing or reduced marginal ridges, nipple appearance of the canine tips and wrinkled occlusal surfaces of molars[1].

Individuals with DS have different degrees of intellectual impairment. Most of them have a mild to moderate range of IQ and are able to cooperate in the normal dental setting. However, there are some with severe delay in language development [7]. The reduced intellectual capacity of DS persons has made it more challenging for them to access health care services [14]. Several studies have concluded that persons with intellectual disabilities experience higher health disparities compared to the healthy individuals [14].

In general, children with disabilities tend to have poorer oral hygiene, and an increased prevalence and severity of periodontal disease compared to their normal counterparts [15]. The compromised immune system with a decrease in the number of T cells in DS individuals makes them more prone

to infections and periodontal disease [7]. Moreover, several papers have noted that disabled subjects have higher levels of caries, untreated lesions and lower levels of care [16,17]. These children usually receive less treatment than the normal population [15]. A study conducted to observe differences in dental care behaviours and experiences within the families with DS and non-DS siblings demonstrated that DS subjects were less likely to consult a dentist yearly and less likely to receive oral preventive and restorative care [18].

The US Surgeon General's report [19] stated that dental caries is the most common infectious disease of childhood. Moreover, it is the major cause of tooth loss in individuals with physical and mental disabilities [15]. The prevalence of dental caries in DS persons in different areas of the world is inconsistent [13]. For instance, in Jordan and Portugal, the prevalence of dental caries in children with DS is reported to be low compared to other normal children [8,13]. However, in Saudi Arabia, DS patients have higher caries prevalence compared to healthy children [20]. On the other hand, some studies have shown that there is no difference in caries prevalence between children with DS and children without DS [13]. The precise cause of this conflict in caries prevalence is not well understood and depends on a lot of factors across the world.

In the United Arab Emirates (UAE), there is only one study conducted on oral health condition of DS patients in the city of Sharjah. This study has shown that DS children have poorer oral health and increased prevalence of periodontal disease and dental caries compared to healthy children [16]. Given that Dubai has scored the highest DS incidence in the region [12], there is a pressing need to study the oral condition of the DS group in Dubai as well as the rest of the UAE. Investigating this group with special needs will help highlight their dental health issues and re-direct the national dental programs to provide the best oral health treatment to different groups according to their needs.

1.1 Literature Review

1.1.1 Definition

The normal human cell is a diploid cell that contains two sets of chromosomes. One set of chromosomes is donated from each parent. The total number of chromosomes in each cell is 46 chromosomes arranged in 23 pairs. Any abnormality in the number or constitute of these chromosomes will result in a chromosomal disorder [21,22].

Down syndrome (DS) is a chromosomal anomaly that occurs during the embryonic development and is caused by an extra chromosome (no.21) resulting in a total of 47 chromosomes instead of the normal 46 chromosomes in each cell. The presence of three chromosomes instead of two is termed a trisomy [23].

1.1.2 History

In the 19th century, John Langdon Down, an English physician, was the first to describe a person with DS [24,25]. Dr Down was named as the "father" of the syndrome after his publication in 1866. Later on, a French physician Jerome Lejeune proved that DS is a chromosomal condition. He identified that the cell of DS individuals contains 47 chromosomes instead of the normal 46 chromosomes [26].

During the first half of the 20th century, the majority of children with DS in the United States (US) were isolated from their parents and the society. They were locked in institutions and people were convinced that DS children were less than human and it would be difficult to raise them. Parents, who did not follow this standardized advice, were given no support or services for their DS children. Kate and Marty McGee were the first to stand up for the rights of DS children as their child was born with the condition. They were the founder of the first organization that recognized

the great values of DS individuals and provided great support to their families. This organization was first called Mongoloid Development Council and now is the National Association for Down syndrome [27].

1.1.3 Epidemiology

DS is the most common chromosomal condition diagnosed in the United States (US) [7]. Approximately one out of every 700 infants born in the US is diagnosed with DS [9]. In the United Kingdom (UK), the number of diagnosed DS has increased by 71% , whereas the number of live births decreased by 1%, owing to antenatal screening and pregnancy termination [28]. Looking at the Middle East region, DS incidence is around 1 in 554 in Saudi Arabia and 1 in 853 in Hyderabad in India [10,11].

As mentioned previously, Dubai has scored the highest incidence in the region, 1 in every 319 live birth among UAE nationals and 1 in 602 live births among non-nationals are born with Down Syndrome [12]. This relatively high incidence may be explained by advanced maternal age, with mothers bearing children as late as their 50s [12].

However, the data in Dubai was generated through a single study that was conducted in a specialized maternity hospital where there are higher chances of finding DS new-borns. This might not be solid data since it might not be a true reflection of the incidence in the UAE, but it is the only incidence reported.

The life expectancy of DS individuals has improved and the prevalence is increasing [1]. The death rate is highest between the ages of 28 days and 1 year. The death rate is stable until 40 years of age and it falls to one in 3250 by 45-49 years of age [24].

1.1.4 Aetiology

The chromosomal anomaly that results in DS occurs mostly before or around the time of conception. Therefore, it is unlikely that effects happening during pregnancy can increase the incidence of this anomaly. No clear behavioural or environmental factors that might cause DS have been identified, however a strong dependency on the maternal age has been advocated in the literature [23].

In order for the fertilization to occur, both paternal (sperm) and maternal (egg) gametes must fuse to form a zygote that contains a mixture of chromosomes from both parents. Before this process takes place the gametes undergo a specialized type of cell division which reduces the chromosome number by half. This latter process is called meiosis [23]. There are three types of DS that occur during the meiosis process as follow:

1. Typical trisomy 21 (non-disjunction), which accounts for 95% of the cases. The child has three copies of chromosome 21 instead of the usual two copies. This extra chromosome addition occurs during the development of the egg cell and the sperm cell specifically in the meiosis stage that has been explained earlier on [4,23].
2. Mosaic type, which accounts for 2% of the cases. In this rare type the child has normal (cells that contain 46 chromosomes) along with abnormal cells that contain an extra copy of chromosome 21(a total of 47 chromosomes). This mosaic pattern is caused by abnormal cell division after fertilization [4,23].
3. Translocation type, which accounts for 3% of the cases. The child will have two copies of normal chromosome 21, but also an additional material from chromosome 21 gets attached to another chromosome which is known as translocation. Individuals with this type exhibit fewer characteristics of DS than those with other types of DS [4,23]

DS is not commonly an inherited disorder; however the translocated type is the only type that can be passed on to the child. This happens when one of the parents has no extra genetic material but only a translocated genetic material. This means that the father or the mother is a balanced carrier. They usually exhibit no signs or symptoms of DS, but can pass on the translocation to the child, causing an extra genetic material from chromosome 21 [4,23]. The risk of recurrence is 20-25% if the mother is a balanced carrier and 2.5% if the father is the carrier. If neither of the parents is a carrier the risk is less than 1%. If one of the parents carries the rare 21:21 translocation, all of their children will have the syndrome [24,29].

DS occurs in all races and economic levels; however the maternal age is strongly associated with increasing the chance of having a child with DS. This chance is 1 in 350 in women of 35 years of age and it increases gradually to 1 in 100 by age 40. By age 45 the incidence becomes around 1 in 30 [23,30–33].

Other risk factors had been investigated in the literature such as smoking, maternal obesity and drugs during early pregnancy. Maternal smoking had no significant effect on conceiving a child with DS [23,34], however maternal obesity increased the risk [23,35]. Researches had shown that the use of drugs during early pregnancy increased the risk slightly [23]. An example would be the use of thyroid drugs which may suggest an association between thyroid disease and an increased risk of DS [23,36].

1.1.5 Diagnosis

Diagnosing children with multiple malformations is essential. Accurate diagnosis of a specific syndrome will help in determining the appropriate medical management plan and future needs and prognosis [4].

The UK National Screening Committee advised that all pregnant mothers should be screened for foetal chromosomal anomalies including DS in the first trimester, and the tests used should have a detection rate of more than 75% and a false positive rate of less than 3% [28].

The main screening test used for DS is the "combined test". This test includes a blood test and an ultrasound scan which is also known as a nuchal translucency scan [27,37–39]. The screening tests are only designed to tell whether a foetus might be at increased risk of having a chromosomal disorder [27,40]. The screening tests are different from the prenatal diagnostic tests because they do not give a diagnosis of DS nor rule it out [27,40].

DS can be diagnosed during pregnancy or after birth. There are several techniques to screen for DS prenatally such as the combined test, quadruple blood test, amniocentesis, chorionic villus sampling, chromosomal analysis and fluorescent in situ hybridization [27,41]. After birth the diagnosis is based on the child's appearance looking for the typical physical characteristic of DS. In addition, a chromosomal analysis can be performed after birth to look for the extra copy of chromosome 21 that will confirm the diagnosis [27,41]. Early diagnosis can help arrange genetic counselling for the parents where they will be given different options including pregnancy termination [27,42,43].

1.1.6 General Characteristics

DS is a multisystem disorder that has well-recognized features. Each DS individual can have different system involvement with varying severity. In general DS children have physical, medical problems, intellectual impairment along with delayed cognitive and motor development [44,45]. Also, they have respiratory hematologic, neurological, cardiac, dermatological, immunological, neuropsychiatric, infectious diseases, endocrinal, ophthalmologic, hearing loss and gastrointestinal problems [4,45].

Some DS Children have short stature, infertility, epicanthus, obesity, palpebral fissure, hypotonic tongue, hyper flexibility of the joints, short extremities and a single palmar crease [4,45].

The different abnormalities that characterize DS can be divided into medical and craniofacial features.

1.1.7 Medical Problems

Cardiac Anomalies

Congenital heart defects are very frequent in DS individuals, they occur in 40-60% of all children born with the condition [44]. Different types of defects are found and the most common ones are atrio-ventricular septal defect (AVSD) (45%), ventricular septal defect (35%), atrial septal defect (26%), coarctation of the aorta (1%), tetralogy of Fallot (5%) and other defects (9%) [46].

When a child with DS is born, an assessment is done to establish his/her cardiac status in the first few weeks of life. Even those who have no congenital cardiac defects at birth can still develop heart disease later on in life. The latter is usually due to upper airway obstruction. During adulthood

they are at risk of developing primary valvular dysfunction such as mitral valve prolapse and aortic regurgitation [44].

It is well known that some cardiac conditions put the patient at an increased risk of developing Infective Endocarditis (IE) especially following bacteraemia [47]. IE is a rare and fatal condition that is caused by bacteria in the blood stream that infects the heart's inner lining or valves. IE is a serious condition with a significant morbidity and mortality [48]. Therefore, when dealing with a DS individual the healthcare professional including the dentist should have an updated cardiac status and follow the up to date subacute bacterial endocarditis antimicrobial prophylaxis protocol prior to any interventional procedure [47].

Cervical Spine Stability

Persons with DS have a number of musculoskeletal abnormalities due to defective collagen structure. This abnormal collagen leads to an increased ligamentous laxity and decreased muscle tone [32,49,50]. The major area that is to the dentist's concern is the cervical spine.

The atlanto-axial joint is the joint responsible for movement between the first [51] and the second vertebrae [45,52,53]. Laxity of the transverse ligament between the atlas and the odontoid processes of the cervical vertebrae and between the atlas and occipital condyles at the base of the skull or dysplasia of C1/C2 can predispose DS individuals to dislocations or subluxation of the atlanto-axial joint [44]. The atlanto-axial joint instability (AAI) is found in 20% of the DS individuals [44].

Most of these cases are asymptomatic and difficult to detect by clinical examination alone [32,54]. Those who have asymptomatic AAI are advised to avoid contact sports, trampoline and diving [24,55]. Sudden movements of flexion and extension of the neck in individuals with AAI can cause spinal cord compression [45,56]. Unfortunately, the first presentation of AAI can be catastrophic with quadriplegia and death after severe hyper flexion and hyperextension injuries [32,57]. Consequently,

DS children who are scheduled to undergo treatment under general anaesthesia which is very common in dentistry are at increased risk for spinal cord injury [32,58]. A pre anaesthesia assessment is really important, where a thorough assessment by the anaesthetist should be carried out looking for signs and symptoms of cervical spine compression [32]. The dentist must also be very careful while manipulating the head and neck of an unconscious DS child [45,56]. Head and neck manipulation during dental procedures might result in increased morbidity in patients with AAI. The cervical spine must be carefully stabilized during intubation and restoration placement especially stainless steel crowns. The anaesthesiologist might consider fibre optic laryngoscopy for intubation in patients with limited neck movement [59].

The operator should be aware of warning signs such as abnormal head posture, restricted neck movement, neck pain, altered gait, deteriorating manipulative skills, incoordination, weakness, spasticity and bladder control problems [32,60–63]. If the child presents with any of the previous signs, an urgent referral should be done to a paediatric orthopaedic surgeon or paediatric neurosurgeon for management [44].

Compromised Immune System

Many differences have been found between the immune system of DS and non-DS individuals. DS individuals have partial reduction in the number and function of T lymphocytes besides antibodies deficiency. The combination of immunodeficiency and immune dysregulation makes them more prone to haematological malignancies (leukaemia), autoimmune diseases (acquired hypothyroidism, coeliac disease and diabetes mellitus), infections and hepatitis B surface antigen carriers [64].

In addition, DS children frequently present with recurrent ear-nose-throat (ENT) and airway infections in their early years, followed by increasing frequency of autoimmune diseases and

lympho-proliferation at older ages. The altered anatomy, hypotonia and macroglossia play an important role in their ENT infections [64–66].

DS individuals have up to 20 times higher risk of developing leukaemia [33,45], thus the dentist must address any persistent lesions and spontaneous gingival bleeding seriously as it might be the only sign of leukaemia at that point [45,67].

Thyroid Dysfunction

Both hypothyroidism and hyperthyroidism are seen frequently in DS individuals, however hypothyroidism is more common. The prevalence increases with age and all DS children should be screened for thyroid dysfunction [44,68]. Hypothyroidism is found to be associated with underdevelopment of the bones and teeth as well as delayed tooth eruption [45,69].

Epilepsy

Although epilepsy was not included in the original description of DS, it has been shown that the prevalence of seizures in DS is higher than in the general population [24,25,70]. Epilepsy rates in DS range from 1 to 13% [71]. Seizure develops in 40% of DS children before the age of 1 and the other 60% have an onset in their thirties or later [72].

Caution must be taken when treating DS individuals in the dental clinic. The dentist must avoid the known triggers for seizures such as flickering lights, anxiety, etc. In addition, the dental team must be trained and ready to handle seizure attacks. Some antiepileptic drugs such as Phenytoin can cause gingival fibrous overgrowth (hypertrophy and hyperplasia) [24,73].

ENT Problems

Patients with DS have multiple ENT problems including chronic nasal obstruction, short Eustachian tube and recurrent sinusitis as a result of craniofacial malformations and hypotonia. All the previous problems together with their immunodeficiency, predispose them to chronic otitis media and conductive hearing loss [45,74,75].

Over 50% of children with DS have hearing loss. This could be either congenitally due to sensorineural deafness or due to glue ear. The former becomes more prevalent with age [44]. The hearing disability can greatly affect their speech and language acquisition [45,75,76].

Obstructive Sleep Apnoea (OSA)

OSA was mentioned in the literature under seven different names; the latest is upper airway resistance syndrome (UARS). It is defined by the British Snoring and Sleep Apnoea Association as a disorder that is characterised specifically by "the occurrence of repetitive episodes of partial or complete collapse of the upper airway which prevents breathing" [77]. This is usually accompanied by a series of signs and symptoms such as loud snoring, reduction of blood oxygen saturation, excessive daytime sleepiness, night sweats, gasping or choking during sleep [31,77].

The prevalence of OSA in DS children ranges between 31% - 100% [31,78]. DS individuals have physical characteristics that predispose them to OSA such as short neck, relative macroglossia, maxillary hypoplasia and hypotonia. Studies showed that DS children have similar tongue sizes compared to normal children, but significantly smaller tonsils and adenoids. The smaller skeletal structures leaves less room to accommodate the soft tissue in the upper airway which results in crowding [31,79]. They also have physical characteristics that predispose them to OSA such as short neck, , maxillary hypoplasia and facial muscle hypotonia [77].

OSA can have a lot of negative consequences on DS children and can affect their quality of life. OSA can adversely affect their behaviour, growth and neurodevelopment [45,56]. It is associated with cognitive deficits, attention deficit, hyperactivity disorder and poor school performance [31].

Recently, dentists have become part of the team players in the field of sleep medicine.DS children should be examined for the risk of OSA. Every DS patient should be asked and examined for snoring, sleepiness, and morning headaches in the presence of obesity, change in behaviour, large tonsils, xerostomia and other oral malformation. An appropriate referral should be done if OSA is suspected [80]. Different treatment modalities are available to treat OSA such as adeno-tonsillectomy, continuous positive airway pressure (CPAP) and oral appliances [31,80]. There are two types of oral appliances used for the treatment of OSA, those that bring the tongue forward and those that reposition the mandible forward during sleep. The treatment should be in a multidisciplinary approach involving both the dental and medical team [80].

Mental Health and Behavioural Problems

Individuals with DS have variable severity of cognitive impairment, learning disability and behavioural problems which include hyperactivity, attention deficit disorder ,obsessive-compulsive disorder and depression [45].

Providing dental treatment for DS children can be challenging and depends on the level of learning disability, visual or hearing disability and any speech impairment. Recent studies on behavioural phenotype in DS revealed that DS individuals have strengths in nonverbal social functioning, visual processing and receptive language. On the other hand, they have weakness in expressive language skills and motor skills [81]. Therefore, it is advised to use simple language and nonverbal communication such as smiling and reassuring touch [24,82]. Also, a better result can be achieved by using visual teaching. For example, pictures and models can be used when giving oral hygiene

instructions instead of verbal advice. Other successful behavioural techniques that had been advocated in the literature are short and focused appointments, give one advice at a time, speak clearly and slowly, positive verbal reinforcement, use tell show and do technique and give rewards [24,83].

DS individuals' cooperation can range from being compliant and cooperative to mild to moderate phobia or complete lack of cooperation. For many patients, simple restorative and preventive treatment is possible to carry out. However, for less cooperative or anxious patients sedation can be used to provide dental treatment, but there might be complications of airway management due to the relatively large tongue, short neck and obstructed nasal passages that are often associated with DS [24]. On the other end of the spectrum, general anaesthesia might be the only option for some DS patients to allow a proper examination and treatment [24,84].

Grip Strength and Manual Dexterity

Part of the characteristics of DS is delay in the neuro-motor development, which includes delays in motor skills acquirement such as grip strength and manual dexterity. The reasons for this delay has been attributed to the syndrome characteristics itself such as hypotonia, obesity and hyper-mobility of the joints [85]. For instance, if we examine a DS patient's hand we will find it small and thick having short and sometimes arched fingers.

The hand characteristics of DS individuals make it very difficult to perform actions quickly or skilfully. Priosti and his colleagues studied the manual dexterity in different ages in DS and found that they have lower performance in both grip strength and manual dexterity compared to normal individuals [85]. Another study also found that neither DS manual dexterity nor their grip strength improved by age. Both DS age groups studied, the first group which was 7 to 9 years old and the second group between 14 to 15 years old, had similar weakness in their grip strength [85].

A person who lacks grip strength or have weak manual dexterity cannot perform proper oral hygiene, thus DS individuals have higher plaque, debris accumulation and sometimes poor oral hygiene depending on their skills levels [45,56,86]. The dentist should assess the child's manual dexterity and should advise parental supervision during brushing as needed [87].

1.1.8 Craniofacial Features

DS individuals exhibit distinguished head and neck features including brachycephalic cranium (short head) and flatter cranial base with late closure of fontanels, reduced or absent frontal sinuses, small nose, small or absent ear, accumulation of fluid in middle ear and short neck [4,45,51,88,89].

In regards to the eyes of DS children, both the high external angles and the slanting fissure with the presence of an epicanthic fold give an almond shaped appearance to the eyes [90]. The risk of developing refractive eyesight errors is around 50% in DS children especially between the age of 3 to 5 years old [32]. In addition to that, they have Brushfield spots, which is speckling in the iris with peripheral hypoplasia [4]. In adulthood, around 30-60% of DS individuals develop cataracts and blocked tear ducts. If eyesight impairment remains uncorrected, it results in poor performance and weakness in different activities [32].

Oral and Occlusal Anomalies

The orofacial characteristics are greatly influenced by facial muscle hypotonia. The tongue in particular looks abnormally large as a result of muscle weakness which makes it sit anteriorly and in a low position in the mouth (relative macroglossia) [91]. This unfavourable muscular weakness of the tongue will unfavourably influence the shape of the maxilla leading to malocclusion [45]. The maxilla will be underdeveloped and the maxillary teeth will erupt in an edge to edge relationship or with a reverse overjet. Both the lingual tongue posture and facial muscle hypotonia result in

imbalance in the muscular forces between the lip and the tongue, which develops an anterior open bite and an incomplete lip closure. Lack of lip seal is also caused by the hypotonic lip muscles [91]. As a result of this open bite, the tongue is forced to form an oral seal which will affect the swallowing action. The swallowing action can be compromised further if the tongue is used to stabilise the mandible against the maxilla [91]. Muscle hypotonicity can also cause joint hyper-flexibility and saliva drooling at the labial commissure. The latter will lead to angular cheilitis, aphthous ulcers, cracking, and candidiasis [45].

A. Fissured Tongue

Another tongue abnormality that has been reported in DS children is fissured tongue [4,16,45]. Fissured tongue is a non-pathological variation of the normal tongue, where the dorsal surface of the tongue is altered by the presence of a central groove and several clefts assembling veins of a leaf [92,93]. Microscopically, the main feature is the presence of various sizes of papillae and more inflammatory cells than in normal tongue [92]. This condition is usually asymptomatic and can sometimes be associated with geographic tongue. The exact aetiology is unknown and a polygenic mode of inheritance is suspected. Fissured tongue is noted on routine dental examination. These deep fissures can act as bacterial reservoir and cause glossitis [94]

B. Mouth Breathing

Another significant finding in this population is mouth breathing. This is usually as a result of several factors such as narrow nasal airways, recurrent upper respiratory tract infections due to immune deficiency, inflamed adenoids and tonsils which results in congestion of the upper airway [91]. When a person breathes through his mouth, the tongue takes an anterior position covering the mandibular anterior teeth, the lips will be apart and the mandible will assume a lowered position

to allow air passage [91,95]. Persistent Mouth breathing will lead to persistence of a primary swallow function, where the tongue moves back and forth against the palate. This latter action will encourage tongue thrust and a high narrow palate will develop as a result [91,96]. Tongue thrust and posture will also contribute to the anterior open bite that is commonly found in DS children [76]. DS children have greater tendency to acquire finger sucking habit, which contributes to the anterior open bite problem [92].

One fairly common finding is hypoplasia of the mid-facial region which consequently makes DS individuals present with flat nasal bridge and hypertelorism [51]. As mentioned earlier, the maxilla is narrow and underdeveloped, while the mandible follows normal development. Although the mandible measurements are not different from normal subjects, the tongue pressure lingually may produce a transverse expansion. The discrepancy between the upper and the lower arches as well shortened palate in the anteroposterior dimension will give various occlusal abnormalities such as anterior open bite, posterior crossbite, crowding of teeth in the upper arch, widely spaced teeth and Class III occlusal relationship [4,45].

In general, the combination of the oral motor dysfunction, orofacial hypotonicity and the restricted craniofacial growth can cause significant disturbances in occlusion, lead to weak lip closure, temporomandibular joint laxity, drooling, respiratory and orthodontic, speech, sucking, chewing, and swallowing problems [45,91].

The malocclusion in DS children must be prevented and treated if possible. Early orthodontic assessment is advisable including airway examination and consideration of palate expansion, tonsillectomy and tongue crib appliances depending on the child's cooperation [45,97,98]. Their orofacial muscular dysfunction must be noted and orofacial physiotherapy is important to strengthen it [97].

Prevalence of Malocclusions and Craniofacial Features

The prevalence of different malocclusion types has been investigated in different studies. Soares et al found that Class III malocclusion is more common in DS children [45,99]. This Class III malocclusion is due to underdevelopment of the midface and not to prognathism of the mandible. The presence of Class III malocclusion has been confirmed as well by Jaber, where his DS study group showed higher prevalence of Class III malocclusion than the normal group [16].

In regards to posterior and anterior crossbite, Soares et al found a 39% prevalence of posterior crossbite and 26% anterior crossbite [45]. Another study reported a prevalence of 31% posterior crossbite and 33% anterior crossbite [45,76]. Almost similar results were found in a sample of DS in Sharjah city in the United Arab Emirates, where the prevalence of crossbite was 26% and 10% of open bite. In addition, high arched palate, fissured tongue and macroglossia have been reported to be more frequent in DS children than normal children [16,45,51,88,100].

Dental Anomalies

Anomalies of number, shape, structure and position are frequently observed in DS patients. Both primary and permanent dentition are affected and the incidence is approximately five times greater in DS children than in general population [45,101]. The most observed anomalies are hypodontia, delayed eruption, hypoplasia, supernumerary teeth, ectopic eruption, atypical patterns of eruption and abnormal dental morphology.

The prevalence of hypodontia is diverse in different ethnic groups [89]. Third molar agenesis was found to be around 4 times greater in DS than normal individuals. The latter is followed in decreasing order by agenesis of mandibular central incisors, maxillary lateral incisors, maxillary second premolars and mandibular second premolars [89,102]. The pattern of agenesis in DS is thought

to be associated with peripheral nervous system abnormalities and abnormal cartilaginous tissue [89,102]. Hypodontia prevalence is reported to be around 60% in DS children [89,103,104]. Other anomalies described in the literature are macrodontia, microdontia, talon cusp, dens evaginatus, double teeth, amelogenesis imperfecta, dentinogenesis imperfecta, taurodontia, peg shaped teeth and impacted teeth [45,89]. The roots tend to be conical in DS individuals and this finding is significant when considering orthodontic tooth movement and periodontal disease [4].Tooth anatomy can affect the degree of root resorption as teeth with pipette shaped and blunt roots are significantly at greater risk of root resorption [105].

Non Carious Tooth Wear

A. Bruxism

Bruxism is defined as parafunctional behaviour of the mandible, characterized by clenching or/and grinding of the teeth" [106,107]. It has been reported in the literature that bruxism prevalence is higher in children with cognitive impairment compared to normal children [106]. DS children have bruxism at a young age and usually it persists throughout life [45]. The factors that are thought to contribute to this phenomenon are that DS children have underdeveloped nervous system, malocclusion, chronic anxiety, temporomandibular joint dysfunction, hypotonicity and laxity of the supporting ligaments [8,45].

The discomfort of the malocclusion in DS children might unconsciously make them protrude their mandible to get a more comfortable position. This latter position traps the maxilla behind and retards its growth furthermore. This mandibular protrusion is also facilitated by the TMJ laxity [91,96]. The child might also clench or grind his teeth in an attempt to eliminate interferences in his/her occlusion and find a comfortable position [91,96]. Bruxism on the long term creates tooth wear facets, teeth fractures and overloading of the supporting tissues [106]. On the other hand, other studies

found similar or less bruxism habits in DS compared to normal children and that could be a result of the variability in the diagnostic criteria of bruxism between studies [106].

B. Erosion

Tooth wear due to acidic and chemical assault to the teeth are commonly noticed in DS children [53]. This issue is related to the fact that 13.8% to 59% of DS children suffer from gastric dysfunctions like vomiting and gastroesophageal reflux [53,108,109]. A study by Bell [107] showed that dental erosion was significantly higher in DS individuals than the normal population which accounts to 67% compared to 34% in normal people.

The dentist should take a careful note of tooth wear in DS children and try to identify the aetiology in order to avoid the problems of dentinal hypersensitivity and dental destruction [53].

Oral Diseases

A. Caries

History

Caries is a word derived from the Latin word for rotten. Historically many theories have been brought up to explain this condition. The ancient Chinese in 2005 BC came up with the first theory "tooth worm theory". They proposed that a tooth warm is the main cause of rotten teeth. Later on, Aristotle noticed that teeth developed cavities caused by eating sweets and figs [110]. Dental caries treatment in the 12th century was either extraction or plugging the cavities with home remedies such as tobacco ash and other materials [110]. Many theories followed until Miles and Underwood suggested that dental caries is caused by microorganisms that enter the dentinal tubules destroying the mineral content and leaving the organic components to be washed away by the saliva [110,111].

Aetiology

In 1988, Dr Willoughby and Dr. Miller proposed the chemoparasitic theory which is still accepted today. Their theory suggests that dental caries is caused by microorganisms that metabolize fermentable carbohydrates and then produce acids. The acid will cause demineralization of enamel and breakdown of the tooth [110]. However this theory failed to recognize the plaque biofilm as the main source of bacteria that produces acid. Researchers later on concluded that the presence of cariogenic bacteria is the main cause of dental caries, not the fermentable carbohydrates alone [110]. The current proven theory is that dental caries is a multifactorial disease that needs three primary factors namely a susceptible host, cariogenic microflora and fermentable carbohydrates [112,113].

The bacteria found to play a major role in the carious process are Mutans Streptococci and Lactobacilli. Under certain conditions, streptococcus mutans, which is part of the normal oral flora becomes cariogenic. The latter is essential in the formation of the carious lesion and have the ability to survive in low PH conditions generated from sugar metabolism and production of intracellular and extracellular polysaccharide [110,114–116]. Lactobacilli are acidogenic (acid-producing) and aciduric (acid-tolerating) type of bacteria found in the deep parts of the carious lesion and plays a major role in the progression of an established lesion [110]

Sucrose has been highlighted as the "Arch Criminal" of dental caries [117]. Sucrose is a disaccharide and is considered to be the most important sugar in the production of extracellular polysaccharides. Sucrose is consumed directly by the bacteria and broken down into glucose and fructose to form the extracellular polysaccharides. This extracellular polysaccharides act as a reservoir of substrate for plaque microorganism and a structural matrix of dental plaque. The matrix enables the bacterial adherence to the enamel surface [117]. Studies have shown no association between the quantity of sugar and dental caries, a strong association has been demonstrated between the frequency of sugar use and dental caries [117].

Protective Role of the Saliva

Saliva plays an important role in maintaining oral health and provides protection against demineralization. Saliva prevents dental caries by several means such as mechanical cleansing of debris and plaque, the presence of calcium, phosphate and fluoride which reduces enamel solubility, capability of neutralizing the acids produced by the cariogenic bacteria and the antibacterial activity [118]. The major components that form buffering system are bicarbonate, phosphate and proteins [119].

Caries in DS Children

As far as caries is concerned, the majority of the literature and researches describe a low prevalence of dental caries in DS children both in the primary and permanent dentition [8,45,90,120–123]. However, some studies reported similar caries rate between DS and normal control children [120,124,125], while others reported that DS children have more caries than healthy children [16,17]. The results are conflicting and this could be attributed to the inappropriate study designs, the sample number used, and not controlling covariates [126].

The literature attributes the reduced caries risk in DS individuals to several factors such as higher salivary pH [24], higher salivary bicarbonate levels which improves its buffering capacity [119], eruptive pattern (delayed eruption of teeth so they have less time to be exposed to cariogenic factors), bruxism (teeth are flatter and have reduced fissure depths so debris do not accumulate easily and the surfaces are self-cleansing), hypodontia (makes the dentition spaced) and microdontia (spaces are present between teeth and visual detection of caries is easier and earlier). Also, due to the nature of their complex medical condition, their parents tend to be more concerned about their dental health and seek dental advice earlier [8,45,56,86,120].

Regardless of the favourable factors mentioned above, the dentist should not underestimate the occurrence of dental caries in this group of children. DS children might have some dietary and oral hygiene habits that put them at a higher risk of developing gross caries [24]. When compared to normal children , DS children are more likely to bottle feed during sleep (50% compared to 12%), are on medications that contains sugar, have less help with their brushing and are weaned off bottle at an older age [127].

B. Periodontal Disease

Gingivitis is an "inflammation of the gingiva in the absence of clinical attachment loss". Clinically, it is noted as redness and oedema of the gingiva with bleeding upon probing. Gingivitis has no radiographic evidence of bone loss [128]. On the other hand, periodontitis is inflammation that involves the gingiva and the adjacent apparatus. Periodontitis is characterized by clinical attachment loss and loss of the adjacent supporting bone [128].

Periodontal disease in DS individuals has been first described by Nash, where she reported that 90% of DS patients exhibit some evidence of periodontal disease [129]. The sample she examined included children below 7 years and she suggested that the gonads hypofunction is the main reason, which is not accepted nowadays [129]. The occurrence of periodontal disease in DS patients is mostly due to defective immune system rather than poor dental hygiene on its own [90,130]. All of the longitudinal studies along with the cross sectional studies reported that the prevalence of periodontal disease in DS individuals is very high and can rapidly progress especially in the young age groups [1,45,129]. The prevalence has been reported between 90% and 96% in adults with DS [7,90]. The periodontal disease is also noted in the deciduous dentition [129].

The limited manual dexterity in DS children, lowered self-home care and limited access to care all lead to poor oral hygiene and increased level of gingivitis [1]. Gingivitis can differ in DS children

than healthy children. In an experimental gingivitis study, it was found that DS children developed rapid and more extensive gingivitis around deciduous teeth than normal control children. The amount of plaque between the two groups was similar [131].Other studies tried to explain this and reported that there are no differences between the plaque composition in DS children and healthy children; however abnormalities in host defence particularly in leucocyte response may be the reason [132].This pattern of gingivitis in DS has been also explained by the presence of defective connective tissue and altered vascularisation [132].

The greater concern about the periodontal disease in DS individuals is the progressive pattern of the disease. Children with the syndrome can present with marginal gingivitis, gingival recession, advanced periodontitis and pocket formation. Brown and Cunningham found that 36% of DS children had pocket formation below the age of 6 years [129]. They can also experience acute necrotizing ulcerative periodontal disease more frequently before the age of 12 [129]. Clinical and radiographic presentation of periodontitis in DS individuals resembles the pattern of bone loss in aggressive periodontitis and it might be seen as early as 11 years of age. The most affected teeth are mandibular incisors followed by maxillary and mandibular first molars and canines [1]. DS children might have congenital structural abnormalities of capillaries; they tend to be thin and narrowed, which leads to anoxia of the tissues especially in the anterior mandibular region [129]. The latter might be the reason for severe periodontal breakdown in the mandibular incisors.

There are many researches that highlighted the abnormalities in the DS immune system including the non-specific defence mechanism, the cellular and the humoral immune systems [129]. Several defects have been reported in advanced periodontal destructions in DS such as diminished chemotaxis of neutrophils, decreased phagocytic ability and shortened half-life of the neutrophils [1]. The polymorphonuclear leucocytes (PMN) activity towards aggregatibacter actinomycetemcomitans (AA) is reduced in DS individuals compared to age matched controls [1].

The PMN defect in DS is a qualitative type, where there bactericidal function fails and the neutrophil adhesiveness to bacteria is reduced [129]. An integral feature of DS immune system is defective T-cell maturation, low level of immunoglobulins IgM and altered function of B-cell lymphocyte [129].

The amount of periodontal pathogens in DS individuals has been found to be higher than patients with other mental challenges. Higher amounts of P. Gingivalis, motile organism, Tannerella forsythia and spirochetes have been reported in different studies. Viruses have also been reported to co-exist with the periodontal pathogens in some DS cases such as Epstien-Barr virus, human cytomegalovirus and herpes virus [1].

Treatment of periodontal disease in DS children can be very challenging and the family plays an important role in the treatment. DS children have compromised capacity in performing oral hygiene and parents should get involved and supervise them [1]. Despite treatment, some cases can show severe destructive pattern. A longitudinal study was done by Barr-Agholme to measure the progression of periodontal disease [1]. He found that most of the patients showed increased bone loss from 35% to 74% particularly in the mandibular incisors.

1.1.9 Access to Oral Care

Today, no statement of reasons is needed to say that optimal oral health is an essential prerequisite for good general health. Oral health optimises self-esteem, nutrition communication and quality of life [133]. Although, the oral health has been improved over the decades, some groups might still experience suboptimal oral care.

Children with special needs have specific intellectual, physical and psychological problems and should get special oral care in the dental office [134]. Special need children may have jeopardized oral health because of their medical issues, use of medications, craniofacial defects, teeth anomalies, enamel abnormalities and difficulty in practicing the routine oral hygiene measures [133].

The insufficiency in these children's oral care is not only because of their physical and intellectual, but could also be due to barriers to proper oral healthcare [133]. These barriers are either environmental or non-environmental. The environmental barriers are focused on the oral care delivery system such as insurance, financial aspects, finding a dentist that will accept to treat the disabled child. On the other hand, the non-environmental barriers are those that originate in the special need individual himself such as anxiety, dental phobia, medical conditions that complicated his/her dental treatment [133].

A study was conducted to compare oral health care utilization between special needs children and healthy ones during a 7 year period in Belgium. This study found that 50% of the special needs children had only one dental visit in four or more of the seven observation years. Most of the visits were emergency visits. On the other hand, the healthy group had dental visits for radiographs, restorations, orthodontic assessments and treatments. The same study stated that there were very low rate of attendance among the special needs children group and preventive oral health care was not frequently received [133]. Another study which was conducted in Canada found that children with DS received less restorative work and more extractions compared to their healthy siblings [126].

Looking at another study in India, where they compared dental care between DS children and their siblings through a questionnaire filled by their parents, the study found that DS children received different oral care than their siblings. DS children were less likely to visit a dentist yearly,

less likely to receive restorative treatment and caries prevention and less likely to have dental extractions [18]. The author concluded that it is a cumulative neglect and mostly parental neglect of their children's basic health measures. It also reflects lack in the overall scheme of health management to this disadvantaged group of children [18].

Children with DS vary and often they lack cooperation or have neuromuscular problems, craniofacial deformities and joint laxity which make the routine oral hygiene measures difficult [134]. Several studies have found that DS children exhibit poor oral hygiene compared to normal children [134,135]. In the UAE, a study of DS children showed that they have poor oral hygiene, higher occurrence of periodontal disease and dental caries compared to normal matched children [16]. Parents and caregivers should be encouraged to assist their children to accomplish acceptable oral hygiene measures. Therefore, the dentist should educate the parents as part of the prevention plan for DS children [134].

1.2 Aims

The aim of this study was to assess to assess the oral health status among children with DS and in a control subjects in Dubai, UAE. There is little information on the status of oral health and the

dental treatment needs among DS children in Dubai, UAE. This data is very important in order to develop interventions to improve the oral health of this group of special needs children.

2. Materials and Methods

2.1 Study Design, Location and Population

A quantitative case control study design was used to compare oral health characteristics of DS children and healthy control in Dubai. The study group consisted of DS individuals from the special needs centres located in Dubai. The controls were healthy children from both government

and private schools that were located in the same demographic region as with the special needs centres in Dubai. The controls were matched to the DS group in age and sex. The calculation of the sample size is explained in the below section.

2.1.1 Sample Size

The sample size calculation based on Cochran Equation of sample size using the formula:

$$B = 1.96 \frac{s}{\sqrt{n}}$$

$$N = \frac{(1.96)^2 s^2}{B^2}$$

B = width of 95% confidence interval and S is standard error of the mean estimation

Our calculation depended on the prevalence of caries among DS in a comparable community in the region. Using the data reported in previous study in the UAE [16]. The following data was available:

The estimation was 13.2 ± 0.84, where the s was 0.84

B = 1.96 * 0.84/Square Root(60) = 0.2

N = (1.96*1.96)*(0.84*(0.84)/(0.2*0.2) = 68

A 20% of the nonresponse was added to the sample size calculated to yield the working sample size, which was 82. The total sample size projected was 82 Down syndrome and 82 healthy children.

2.1.2 Sampling Technique

1. DS group:

For this group, census sampling technique was used. All DS children that were registered in the special needs centres in Dubai were invited to participate in the study (2013-2015).

2. Control group:

For this group, stratified random sampling technique was used. This was done by random selection of every 3rd student from schools that were living nearby to the special needs centres. In regards to the age, for each DS age group a matching grade in the school were chosen that had similar age ranges. Also, females and males number were matched between DS group and the control within the age groups.

2.1.3 Participating Schools

1. Special needs centres in Dubai :

An approval letter was obtained from the Ministry of Social Affairs in Dubai to access DS children in the special need centres that are located in Dubai (Appendix I). All the special needs centres agreed to participate in the study except Dubai Centre for Special Needs, where the principal decline to take part. The following centres agreed to participate in the study:

- Al Noor Training Centre for Children with Special Needs
- UAE Down Syndrome Association
- Rashid Centre for Disabled
- Dubai Rehabilitation Centre

2. Public/private schools in Dubai:

An approval letter was obtained from the Ministry of Health in Dubai to access the control group in the public and private schools in Dubai (Appendix II). The following schools agreed to participate in the study:

- Jumeirah Model Girls School
- Zayed Bin Sultan School
- Al Maaref Private School

2.2 Inclusion and Exclusion Criteria

2.2.1 Inclusion Criteria

1. DS Group :

    - DS patients age 4 to18 were invited to participate
    - Both UAE and non-UAE nationals were eligible to participate
    - All children previously diagnosed with DS according to the centre's medical records.
    - Consent was obtained from parents or legal guardians for both DS and control groups (Appendices III, IV, V and VI).
    - Approval to access the centres and schools was obtained from the headmasters.

2. Control Group :

    - Healthy with no known disease
    - Children were matched to the DS group in age and sex

2.2.2 Exclusion Criteria

Uncooperative DS children and the healthy non DS who were difficult to examine were excluded

2.3 Data Collection

Data was collected using standard form (Appendix VII) through dental examination. The examination was conducted by two principal investigators and an assistant recorded the findings in the data sheet. Initially the data sheet was identifiable by the child's name. Once the data sheet was checked for completeness the sheets were coded.

2.3.1 Examiners Calibration

A pilot study was conducted before starting the data collection. The two examiners were trained and calibrated to use the basic WHO Oral Health survey methods by Dr Mawlood Kowash Associate Professor in Hamdan Bin Mohamed College of Dental Medicine , who was also calibrated for all the indices used in this research [136]. Intra and inter examiner reliability was calculated using Kappa statistics prior to starting the data collection. The results were as follow:

- Intra Kappa: There was matching between before and after reading (X (1, P=0.317)).
- Inter Kappa (Mc Nemar's test): There was matching between the two examiners' reading (Kappa= 0.029, P=0.606).

2.3.2 Dental Examination

The dental exam was performed on a portable dental chair (Figure 1) at the centre/school nursing room. One student at a time was examined using sterile gloves, artificial light, disposable mouth mirror and a WHO ball ended dental probe [137]. The probe was only used to remove debris and not to probe the fissures [136].

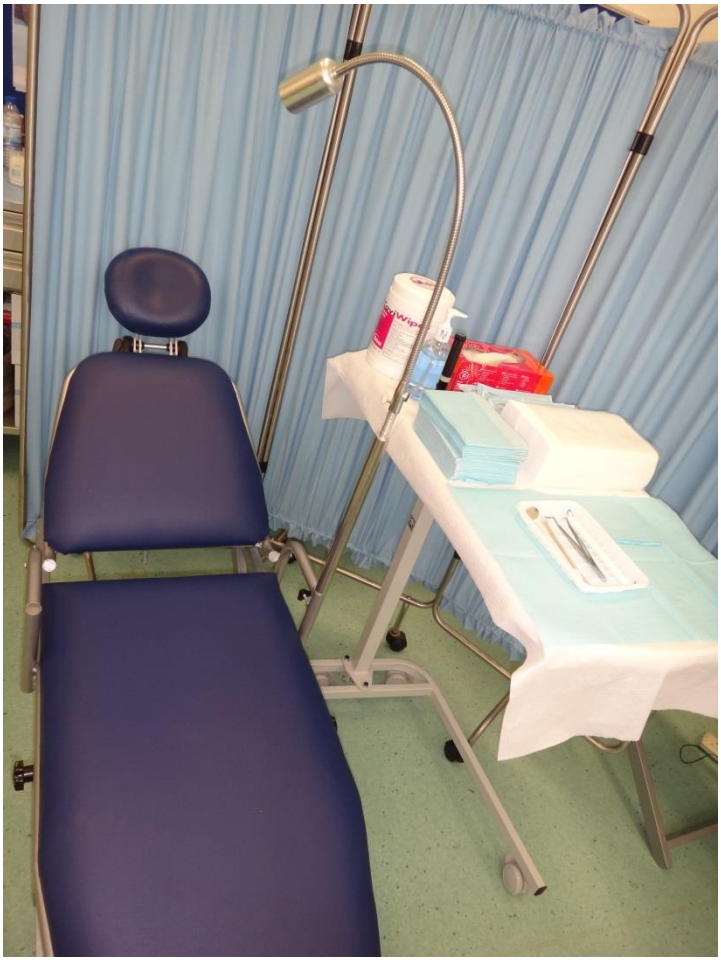

Figure 1: Portable dental chair used to examine the children.

2.3.3 Cross Infection Control

National Institute for Clinical Excellence (NICE) guidelines were followed for cross infection measures during the examinations [138]:

- Hands were decontaminated immediately before and after examining each patient. This was done by using alcohol hand rubs or hand washing.

- Alcohol hand rubs were used preferably, while liquid soap and water were used if the hands were visibly soiled with body fluids.
- Gloves were used as a single use items for each candidate since there was contact with oral mucosal surfaces and saliva. Gloves were worn immediately before patient contact and removed after completing the examination.
- Alternative to natural rubber latex gloves were available for patients with history of latex allergy
- Gloves were discarded immediately by the examiner into waste disposable bags
- All instruments were disposable. The gloves were discarded immediately by the examiner into waste disposable bags. However, the sharp instruments were placed in the sharp container.

2.3.4 Indices

The following indices were used:

1. Angle malocclusion classification and primary molar terminal plane relationship

This was used to record the various molar relationships in each individual. For the permanent dentition, the classification is based on where the buccal groove of the mandibular first

molar contacts the mesiobuccal cusp of the maxillary first molar: on the cusp (Class I, normal occlusion); distal to the cusp (Class II); or mesial to the cusp (Class III) [139]. However, the primary molars are classified as flush terminal plane, distal step or mesial step according to the relationship of the distal surfaces of the primary second molars to each other [140].

2. Caries Index: dmft/DMFT

This index was used to examine the dentition status of the child. Both primary and permanent teeth were examined and given a specific code as in D (decayed), M (missing) and F (filled). The WHO criteria was followed to correctly record the findings [136]. Met Need Index (MNI), an indication of treatment received by an individual is determined using the ratio of the mean missing (M) plus filled (F) teeth to mean decayed, missing and filled teeth (DMF) that is M+F/DMF. While Restorative Index (RI) which reflects the restorative care of those who have suffered the disease is measured by the ratio of filled (F) to filled plus decayed teeth (F+D) percent that is F/F+D percent as described by Jackson [141].

3. Simplified Oral Hygiene Index of Greene and Vermillion

This index is a combination of debris index (i.e Plaque and calculus). Six Index teeth were examined (buccal and lingual surfaces of each) and scored according to specific criteria from 0 to 3. The scores ranges from zero, which is absence of debris to 3, which is debris covering more than two thirds of the examined tooth surface [142]. This index was used for permanent dentition, however for primary dentition a separate record was done, where the presence of gingivitis, calculus and debris was marked as present or absent.

4. Erosion Index

Erosion was measured using the erosion index that was modified by Walker et al [143]. In regards to the permanent dentition, both labial and palatal surfaces of the upper incisors and occlusal surfaces

of the first permanent molars were assessed. However, in the primary dentition, only the primary incisors were assessed. The highest score from the below list is marked (Table1):

Table 1: Erosion Index

Code	Depth	Area of surface affected
0	Normal	normal
1	Enamel only	Less than 1/3 of surface involved
2	Enamel and dentine	1/3 up to 2/3 of surface involved
3	Enamel dentine and pulp	2/3 or more of surface involved
9	Assessment cannot be made	Assessment cannot be made

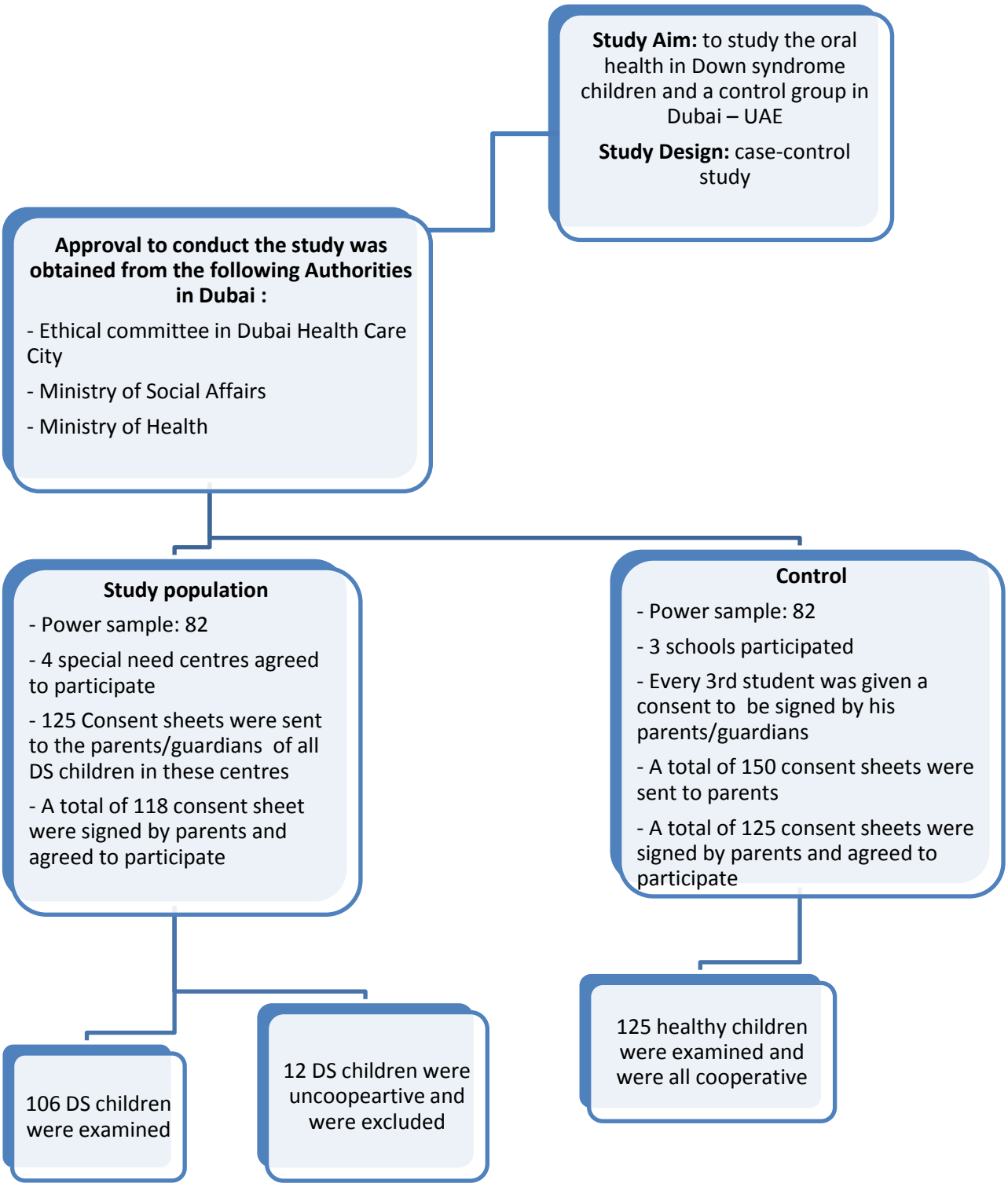

Figure 2: Study methodology summary flowchart.

2.4 Statistical Analysis

The collected data from the data sheet were transferred to computer spreadsheets and analysed using computerized Statistical Package for Social Sciences (SPSS, version 20, Chicago, SPSS Inc). Descriptive statistics were performed for general description of the data. Chi-square and Exact Fisher test were performed to examine differences between categorical data and t-test was performed to compare continuous variable. The level of statistical significance was set at 5%.

2.5 Ethical Considerations

This study was conducted in full conformance with principles of the "Declaration of Helsinki", Good Clinical Practice (GCP), and within the laws and regulations of the UAE/DHCC. The ethical approval was obtained from the Research Ethics Review Committee in Dubai Healthcare City (Appendix VIII).

3. Results

3.1 Study Sample Characteristics

The characteristics of the 106 children with Down Syndrome (DS) and 125 healthy controls are shown in Table 2. Demographical data about their nationality; gender, dentition and age were described.

Children with DS had an average age of (9.3 ± 2.8), where the control group had an average age of (11.7 ± 4.4). For gender distribution, 63(59.4%) of children with DS were males compared to 55 (44%) males in the control group. Non- locals had more DS children than locals 60(56.6%) and 46 (43.4%) with p-value less than 0.001. The dentition distribution was comparable between children with DS to the healthy control (Table 2).

Table 2: Demographic characteristics and type of dentition among children with DS and healthy subjects

Variable	Categories	Control Nr (%)	DS Nr (%)	Total Nr (%)
Number		125	106	231
Nationality	Local	85(68)	46(43.4)	131(56.7)
	Non-local	40(32)	60(56.6)	100(45.9)
Gender	Male	55(44)	63(59.4)	118(51.1)
	Female	70(56)	43(40.6)	113(48.9)
Dentition	Primary	13(10.4)	22(20.8)	35(15.2)
	Permanent	36(28.8)	31(29.2)	67(29)
	Mixed	76(60.8)	53(50)	129(55.8)

3.2 Dental Caries

Prevalence

The overall occurrence of dental caries among children with DS and healthy controls were equal as it was 57.6% (57/106) in the DS group where as for the healthy controls was 57.6% (72/125). The prevalence of caries in the primary dentition among children with DS was 62.8% (49/78) while for the healthy control it was 70.5% (62/88). On the same context the prevalence of caries in the permanent dentition among children with DS was 28.6% (24/84) while for the healthy controls was 17.9 (20/112) as shown in Figure 3.

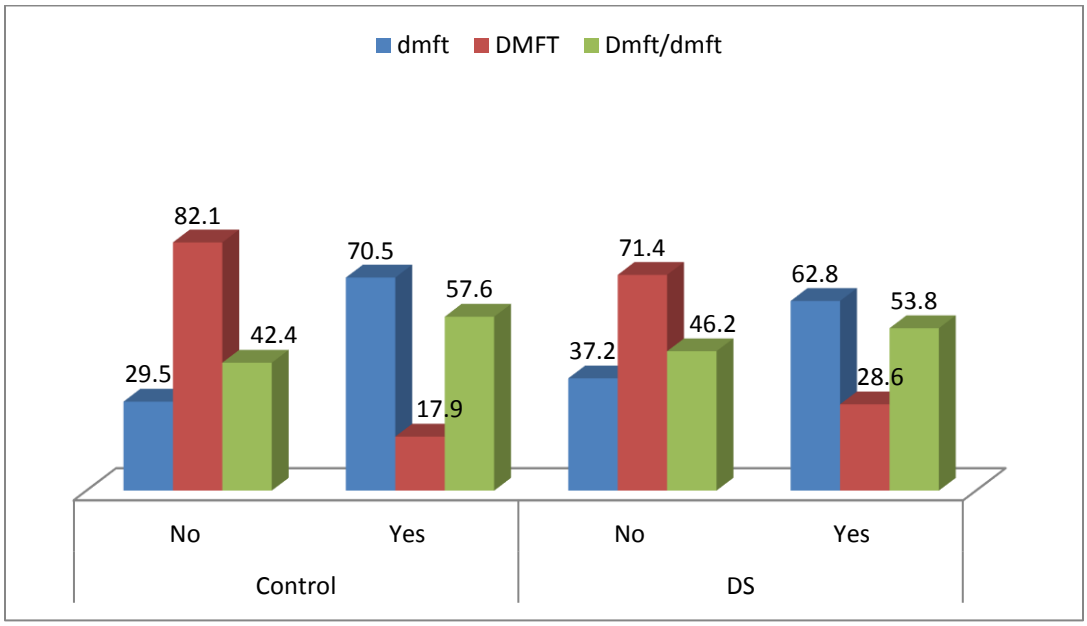

Figure 3: Prevalence of caries in DS and control.

DMFT/dmft Caries Index

Tables 3 and 4 demonstrate the caries status of the sample population. The mean numbers of the decayed component of DMFT in DS children was significantly higher than that in healthy children (2.73 ± 0.22 vs. 1.65 ± 2.46, p value = 0.01). There was a clear statistical significant difference in caries experience amongst DS children compared to the healthy controls as measured by DMFT/dmft in all age groups which is shown in Tables 3 and 4. The mean number of DMFT in DS children was significantly higher than that in healthy children (3.32 ± 4.62 vs. 2.16 ± 2.86, p value= 0.02). The dmft scores were highest among the youngest age groups in DS with primary dentition compared to their controls.

In regards to the treatment of the decayed teeth (fillings), Children in the DS group received more treatment than their controls in all age groups; however, this was not shown to be statistically significant.

The restorative care and the treatment received in both study groups had been represented by the Restorative Index (RI) and the Met Need index (MNI) in Table 3 and 4. Looking at different age and dentition groups, DS children in the mixed dentition had the least RI and MNI scores compared to the primary dentition as shown in Table 4: A, B. Surprisingly, DS children in the primary dentition group had the highest RI and MNI scores (RI= 27% and 40% respectively) as shown in Table 4: A.

Table 3: Caries status, Restorative Index and Met Treatment Index in DS and control children (Mean values in both permanent and mixed dentition)

	Control	DS	
	n = 112	n = 84	p-value
DMFT index	2.16 ± 2.89	3.32 ± 4.62	0.021
Decayed	1.65 ± 2.46	2.73 ± 0.22	0.018
Missing	0.29 ± 0.83	0.48 ± 1.62	0.269
Filled	0.22 ± 0.61	1.0 ± 0.41	0.076
Restorative Index (RI)	11.76%	26.81%	-
Met Need Index (MNI)	23.6%	35.6%	-

Table 4: Proportion of patients with decayed, missing, filled teeth along with mean dmft and DMFT averages (± standard deviation) among children and adolescents in both healthy and DS groups by type of dentition

(A) Primary Dentition

	Control	DS
	n = 13	n = 22
dmft index	2.69 ± 3.04	4 ± 4.74
decayed	2.69 ± 3.33	3.09 ± 4.62
missing	0	0.91 ± 3.11
filled	0.07 ± 0.27	1.14 ± 0.64
Restorative Index (RI)	2.52%	27%
Met Need Index (MNI)	2.54%	40%

Table 4: Continued

(B) Mixed Dentition

	Control	DS
	n = 76	n = 53
dmft index	2.78 ± 2.93	3.32 ± 3.97
decayed	2.05 ± 2.58	2.96 ± 3.96
missing	0.6 ± 1.36	0.58 ± 1.68
filled	0.31 ± 0.73	0.06 ± 0.23
Restorative Index (RI)	13.1%	2%
Met Need Index (MNI)	34%	18%
DMFT	0.22 ± 0.58	0.55 ± 1.07
Decayed	0.15 ± 0.56	0.28 ± 1
Missing	0.13 ± 0.14	0.08 ± 0.55
Filled	0.03 ± 0.16	0.04 ± 0.19
Restorative Index (RI)	16.7%	12.5%
Met Need Index (MNI)	51.6%	30%

Table 4: Continued

(A) Permanent Dentition

	Control	DS
	n = 36	n = 31
DMFT index	0.27 ± 0.61	1.81 ± 3.9
Decayed	1	2
Missing	3	0
Filled	2	1
Restorative Index (RI)	67%	100%
Met Need Index (MNI)	83.3%	33.3%

3.3 Oral Hygiene Status

Oral Hygiene Index Score (OHI-S) was calculated for children in the mixed and permanent dentition and was not significantly different between children with DS compared with the controls (1.36 ± 1.16 vs 1.42 ± 1.14). Calculus Index was found to be significantly higher among children with DS 0.25(0.52) compared with healthy controls 0.07 ± 0.27 (p-value < 0.004). On the other hand, the proportion of debris was significantly lower among children with DS 79(74.5%) compared with 110(88%) of the healthy controls (p-value = 0.007). Conversely, the percentage of children with calculus was significantly higher among children with DS 32(76.2%) compared with that of healthy controls 10(8%) with p-value less than 0.001. The proportion of gingivitis was found to be comparable between children with DS compared with that of the healthy controls 65.4% and 70.4% respectively (p-value = 0.252). These results are summarized in Table 5 and Figure 2.

Table 5: Oral hygiene status in DS children and control

Index	Control		DS	
	Nr	SD ±	± SD	P-value
Debris-index	111/85	1.38 ± 1.08	1.15 ± 0.93	0.107
Calculus-index	111/87	0.07 ± 0.27	0.25 ± 0.52	0.004
Oral-Hygiene-index	111/86	1.42 ± 1.44	1.36 ± 1.16	0.693

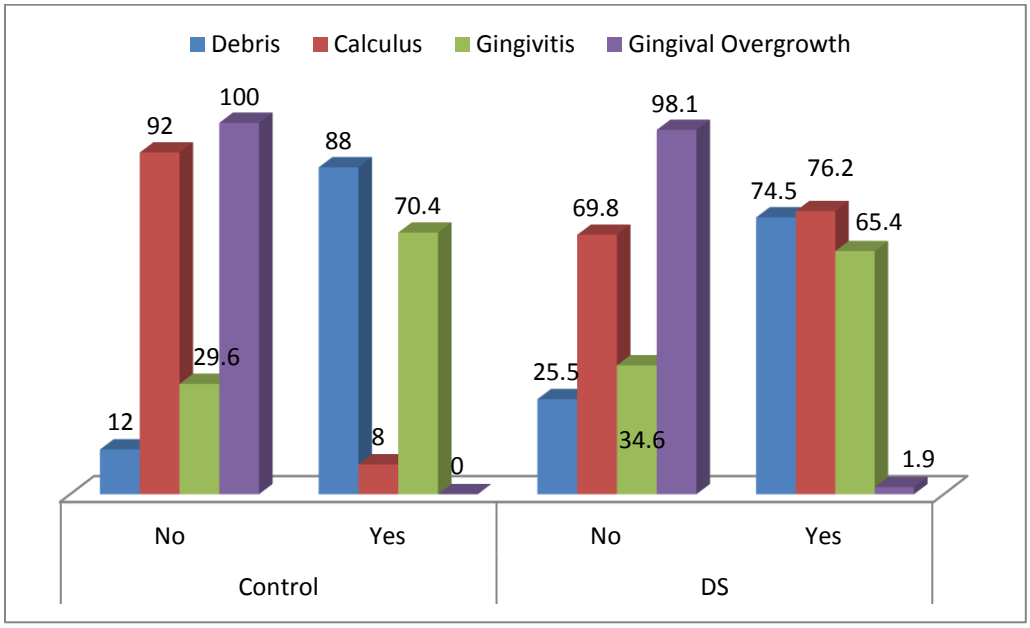

Figure 4: Distribution of debris, calculus and gingivitis in children with DS and control.

3.4 Occlusal Anomalies

Open bite was more frequent among children with DS 42 (40%) compared with healthy controls, 14 (11.2%) and p-value was 0.001. There was a significant difference between the proportion of deep bite among children with DS compared to the proportion among healthy controls 10 (9.4%) and 23 (18.4%) respectively, p-value was 0.039. The proportions of posterior crossbite and scissor bite were significantly higher among children with DS compared with healthy controls 52 (49.1%) and 10 (9.5%) versus 35 (28%) and 3(2.4%) respectively (p-value < 0.02). In relation to spacing between teeth, it was found that the proportion of anterior spacing was significantly higher among children with DS 48(45.3%) compared with that of the healthy controls 40(32%) (P-value 0.026). Consistently, the proportion of posterior spacing was significantly higher among children with DS compared with that among healthy controls, 22(20.8%) and 10(8%) respectively (p-value = 0.004) (Table 6).

Regarding molar Angle classification, the proportion of Class I was more likely among healthy controls 68(54.4%) compared with children with DS 4(3.8%) as Class I. The same outcome applied to Class II, as the proportion of Class II was lower among children with DS 7(6.6%) compared with proportion of healthy controls with Class II, 28(22.4%). Conversely, proportion of Class III was found higher among children with DS compared to the healthy controls 70(66%) and 14(11.2%) respectively (p-value < 0.001) (Figure 5). On the other side, primary molar relationship in DS individuals were found to have higher occurrence of mesial step relationship compared to the control group (13.3% vs. 4%).

The proportion of trauma was found to be significantly higher among children with DS 12(11.3%) compared with that of healthy controls 4(3.2%) (P-value < 0.015). The mean value of positive

overjet between children with DS and controls was significantly lower 1.51 ± 1.59 mm and 3.39 ± 2.2 mm respectively (p-value < 0.001) (Table 6).

Table 6: Occlusal anomalies and traumatic dental injuries in DS children and control

Anomalies	Control	DS	
	Nr (%)	Nr (%)	P-value
Vertical			
open bite	14(11.2)	63(60)	0.001
deep bite	23(18.4)	96(90.6)	0.039
Transverse			
crossbite	35(28)	54(50.9)	0.001
scissor bite	3(2.4)	95(90.5)	0.02
Spacing			
anterior spacing	40(32)	58(54.7)	0.026
posterior spacing	10(8)	84(79.2)	0.004
Trauma	4(3.2)	94(88.7)	0.015

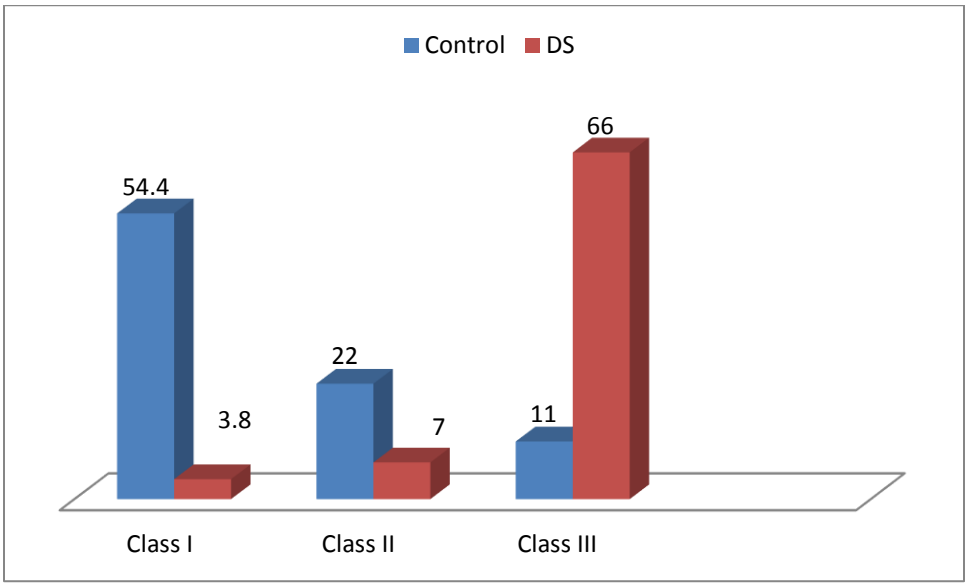

Figure 5: Distribution of molar Angle malocclusion classification in DS and control.

3.5 Dentofacial Anomalies

Children with DS had shown higher proportion of high shovel shape incisors, high arched plate, microdontia, nipple appearance of canine tip, Tongue thrust and lymphadenopathy compared with that among healthy controls (Table 7). A single case of transposition of canine was found among DS group. An example of the anomalies found in the study population are shown in Figure 6,7,8,9,10.

Table 7: Dentofacial anomalies in DS children and control

Anomalies	Control	DS	
	Nr (%)	Nr (%)	P-value
Shovel shape incisors	0	19(18.1)	0.001
High arched palate	42(33.6)	99(93.4)	0.001
Microdontia	1(0.8)	48(45.3)	0.001
Nipple appearance of canine	1(0.8)	40(37.7)	0.001
Tongue thrust	2(1.6)	37(34.9)	0.001
Lymphadenopathy	5(4)	17(16)	0.002

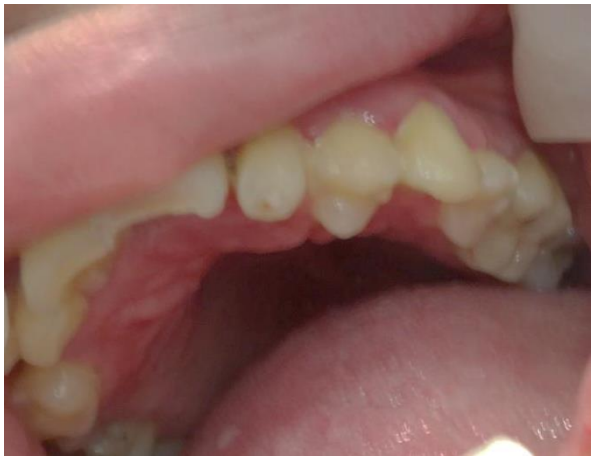

Figure 6: Transposition of upper canine**.**

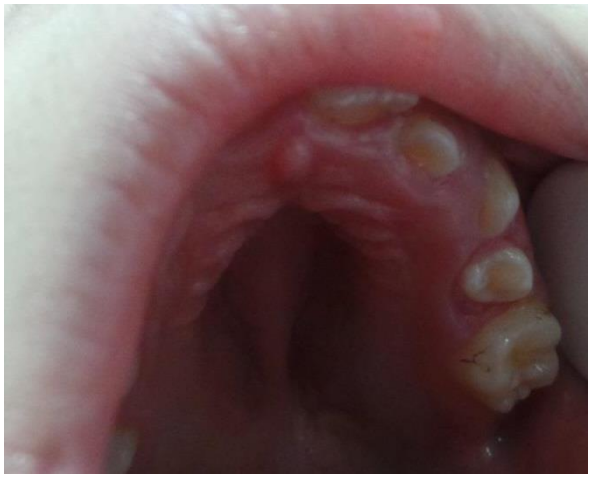

Figure 7: Microdontia of upper second premolar.

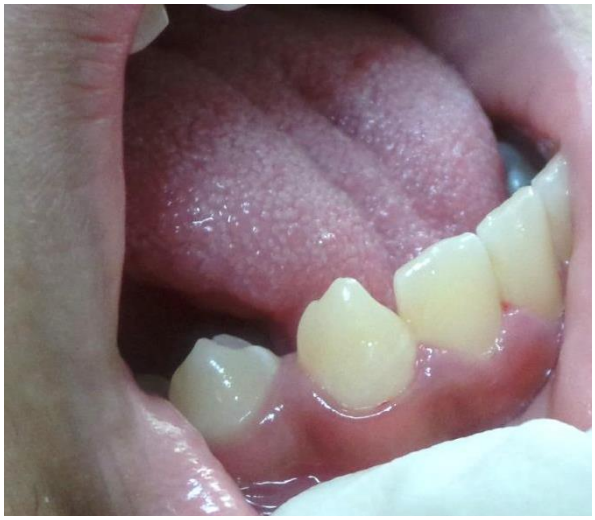

Figure 8: Nipple appearance of the lower canine

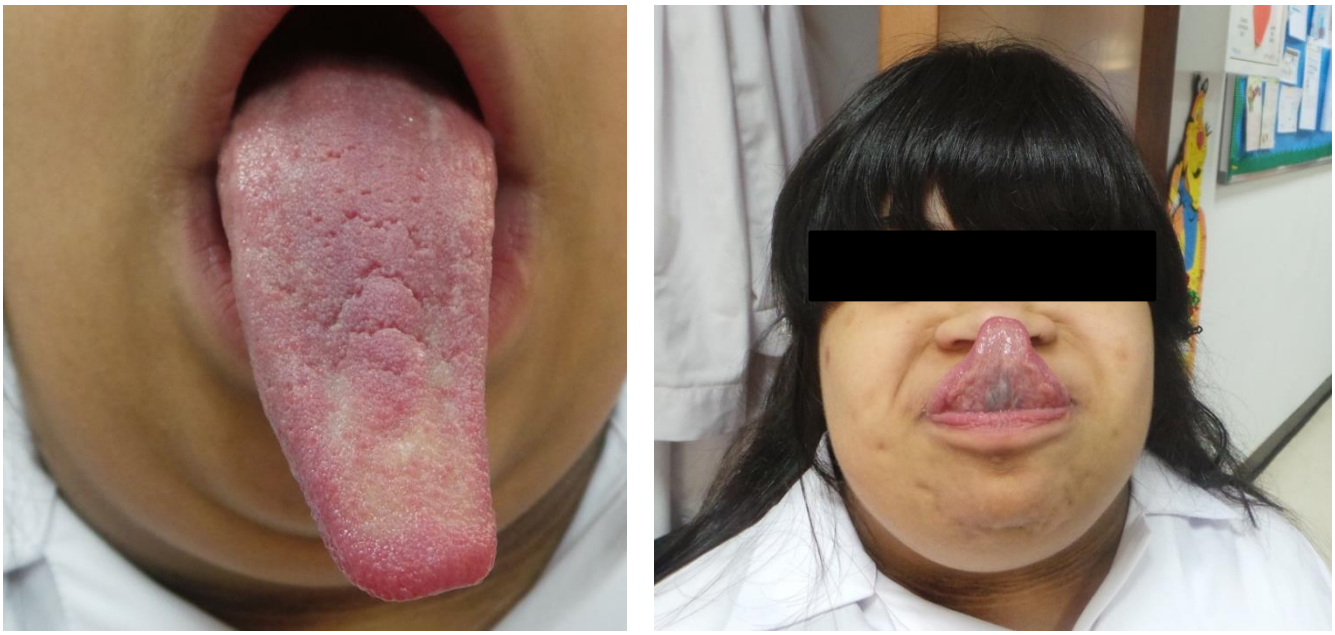

Figure 9: (Left) Fissured Tongue, (Right) Gorlin Sign.

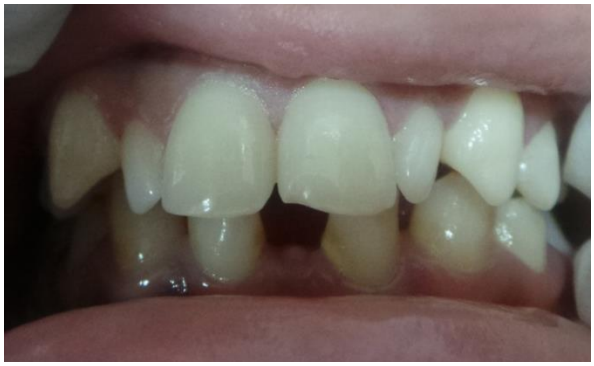

Figure 10: Peg shaped upper lateral incisors and clinically absent lower central incisors.

3.6 Oral Soft Tissues

In Table 8, children with DS had significantly higher proportion of all the conditions listed. The controls scored zero for all the listed conditions.

Table 8: Oral soft tissues findings in DS children and control

Condition	Control	DS	
	Nr (%)	Nr (%)	P-value
Atrophy of tongue	0	8(7.5)	0.002
Median rhomboid glossitis	0	0	-
Geographic tongue	0	9(8.5)	0.001
Fissure tongue	0	72(67.9)	0.001
Irritation fibroma	0	1(1)	0.454
Angular cheilitis	0	23(21.7)	0.001
Macroglossia	1(0.8)	49(46.2)	0.001
Ulcer	0	3(2.8)	0.096
Trauma to soft tissue/lip	0	3(2.8)	0.096
Drooling	0	25(23.6)	0.001

3.7 Medical Conditions

According to the medical history that was obtained from the children's medical file in the schools, DS children had variable conditions. The cardiac conditions were more common, where 24 % of DS sample had a history of cardiac anomalies. The cardiac conditions varied from atrioventricular septal defect, mitral valve cleft and patent ductus arteriosus. Other medical conditions reported in the medical history were hypothyroidism (10%), epilepsy (5%) and recurrent ear infection (4%). Also, there was a single case of thoracolumbar scoliosis among DS children.

3.8 Erosion

According to the pyramid graph (Figure 11), the severity of erosion was significantly higher among DS children compared to healthy control (p-value=0.006). The proportion of DS children with erosion was 34% vs. 15.3% in the control group. The percentage of DS children with erosion into enamel only was 19.8 %(21/106) compared to 11.3 %(14/125) in the control group. The percentage of erosion into enamel and dentine was 12.3% (13/106) in DS children vs. 4% (5/125) in healthy children. In addition, the percentage of severe erosion, which is into enamel, dentine and pulp, was 0% in the control group compared to 1.9% (2/106) in DS group.

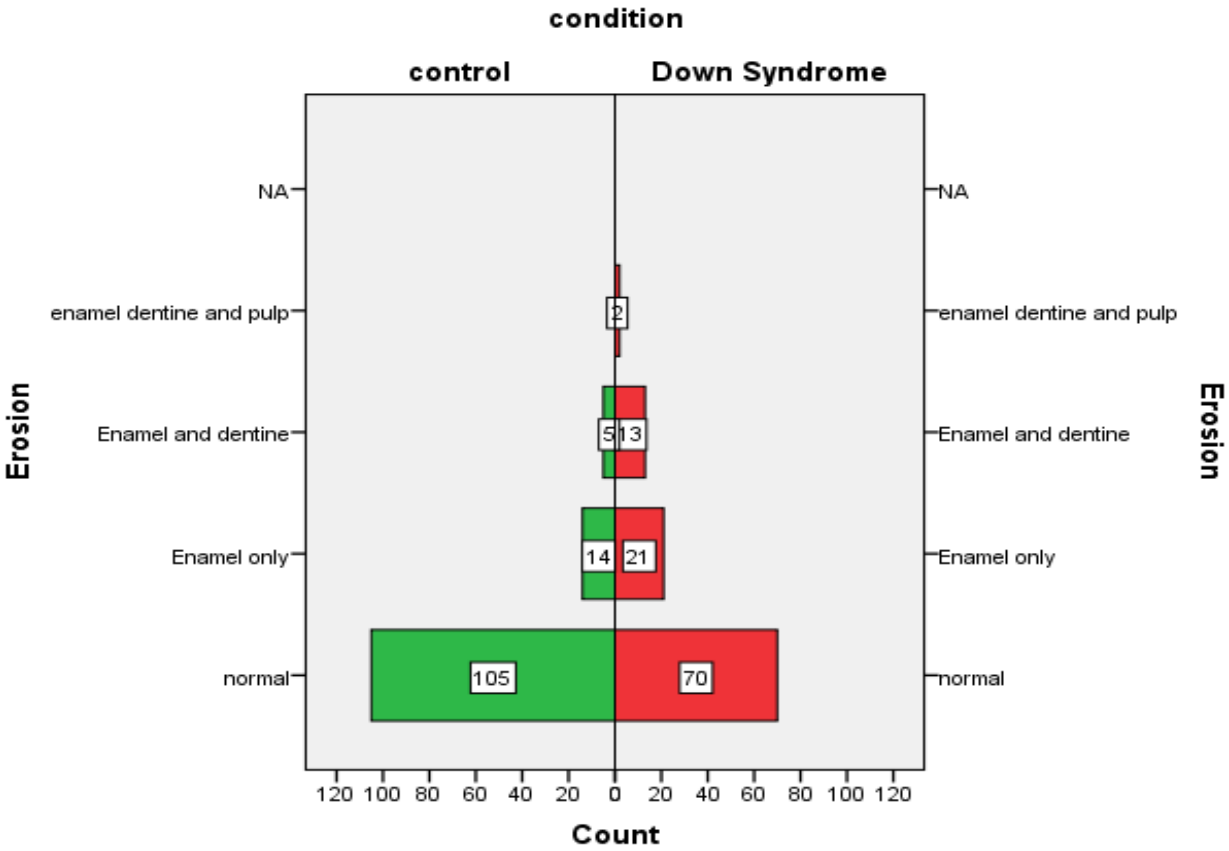

Figure 11: Erosion severity in DS children and control group.

4. Discussion

As the life expectancy of DS individuals is improving and the prevalence is increasing [1], it is of a great benefit to understand the oral health problems experienced by this group. Since there is no central DS registry data in the UAE particularly in Dubai, an accurate estimate of the percentage of DS is difficult. The only generated data suggests that DS incidence in Dubai was 1 in every 319 live birth among UAE nationals and 1 in 602 live births among non-nationals [12], which is the highest in the Middle East region due to increased maternal age and consanguineous marriages. This study provided an opportunity to assess the oral health problems among DS children in Dubai who are enrolled in special centres.

The sample used in this study presented a fair distribution with respect to age and sex. The males (63 out of 106, 59%) in the DS group were more than females (43 out of 106, 41%), which might reflect the higher occurrence of DS in males as reported by a study conducted in Sharjah city and other parts of the world [3,16,144]. In regards to the geographic distribution, the special needs centres were from different areas in Dubai and the control group were matched accordingly. This wide distribution allowed us to cover Dubai as a whole city instead of a particular area. A sample size calculation was done prior to data collection to make sure sufficient number of children was included. This might have strengthened the validity of the results and made them applicable to the neighbouring cities in the UAE. A total of 106 DS individuals along with 125 controls were examined which exceeded the calculated sample size.

4.1 Dental Caries

This current study used the dmft/DMFT index to detect dental caries, according to WHO standards [136]. Several studies stated that this method is efficient to detect dental cavities, but not the non-cavitated lesions [96,145,146]. Of course, the inclusion of non-cavitated lesions would give a better idea of disease prevalence which means a better understanding of treatment needs [147]. However, the dmft/DMFT index was used in this study due to the large sample size and its objectivity. Additionally, the WHO criteria of caries diagnosis [136] are still the standard in epidemiological studies and is use allowed comparison of this study results with national and international studies. Also, using radiographs to detect non-cavitated lesions for screening purposes would not be ethical nor practical.

In this study, the mean number of the decayed component of DMFT in DS children was higher than the value in healthy children (2.73 ± 0.22 vs. 1.65 ± 2.46, p value = 0.01). The mean number of DMFT in DS children was significantly higher than that in healthy children (3.32 ± 4.62 vs. 2.16 ± 2.86, p value= 0.02). Additionally, the mean DMFT/dmft was found to be higher in DS compared to healthy children in all age groups and dentition types especially in the primary dentition (4 ± 4.74) and has a clear statistical significance. This study findings are consistent with a previous study conducted in Sharjah [16]. In Sharjah the mean number of the decayed component of DMFT in DS patients was almost twice as high as that in healthy controls (13.2 ± 0.84 vs 7.4 ± 3.94), which is even higher than the finding in this current study.

The prevalence of caries in DS children varied in the literature and the findings are conflicting. Some studies reported lower caries rate [120,121], while others reported either similar [124,125]or higher caries rate [16,17]. An older study reported dramatically lower caries rate in DS individuals compared to healthy children. This old study used institutionalized population whose diet was controlled and probably low in cariogenic foods [121]. Today, most DS children are raised at home and only attend special needs schools and might have higher exposure to cariogenic foods. Also, lower caries rate

in DS children is explained to be as a result of several factors such as increased spacing between teeth, delayed eruption of the teeth , possible different salivary chemical content, hypodontia, microdontia and flatter teeth due to bruxism [8,24,45,56].

A high caries rate among DS children in Dubai is not surprizing because they seem to follow the normal caries pattern reported by a recent dental survey among healthy children. The latter survey in the U.A.E found that the prevalence of dental caries among healthy school children was 76.1% and the average dmfs score was 10.2 [148]. This high prevalence of dental disease in U.A.E might be attributed to cultural factors [149] such as strong family cohesion and the involvement of extended family members in taking care of the child, high sugary diet and lack of dental visits [150]. Likewise, Studies conducted in neighbouring countries also reported high decay rate among DS children and young adults [17,151,152].

The Met Need Index (MNI) and Restorative Index (RI) were calculated from the mean dmft/DMFT of the studied DS sample and were high compared with healthy control subjects (Table 3). This means that the restorative treatment needs of the studied DS children in the present study were more addressed compared to the control group. These values were inconsistent with the results found in Sharjah and other studies [16–18,126,151], as the MNI and RI were lower for the DS sample. This difference could be because DS children in Dubai might have better access to dental clinics than those in Sharjah. Also, The Ministry of Health in Dubai provides free dental treatment for special needs children who are holders of a special needs medical card. Moreover, the children recruited for this study are all in special need centres which might imply a high socio-economic status of their parents making them more able to afford dental treatment. In addition, some literature suggest that due to the nature of their complex medical condition, DS parents tend to be more concerned about their children's dental health and seek dental advice earlier [45]. However,

the fact that we were unable to recruit DS children who are not in the special need centres might bias this finding because we are not aware of their dental health status and treatment needs.

This study was able to demonstrate that despite the higher percentage of treatment received among DS children; they still had a higher caries rate compared to healthy children. The author suggests that a lot of factors might contribute to this including cultural habits, lack of parental awareness on the importance of prevention and regular dental follow up, parental neglect, long waiting lists for dental treatment especially in the government hospitals and lack of sufficient general anaesthesia facilities and paediatric dental specialists often needed for the comprehensive treatment of DS patients. Further studies into the aforementioned factors and their possible contribution, is necessary in order to help shed some light on this dilemma.

4.2 Oral Hygiene Status

Since periodontal disease is a significant oral health problem in people with DS, it is very important to understand the status of oral hygiene in this population. The proportion of debris was significantly lower among children with DS 79(74.5%) compared with 110(88%) of the healthy controls (p-value = 0.007). DS children have flatter occlusal surfaces, which facilitate oral hygiene and self-cleaning, eliminating debris that serve as a substrate for oral bacteria [45]. The DS group attended special needs centres. As part of these centres' usual routine, the caregivers either supervise or carry out tooth brushing for the DS children. This might have contributed to the lower debris index measured in the study group. On the other hand, Calculus Index was found to be significantly higher among children with DS (0.25 ± 0.52) compared with healthy controls (0.07 ± 0.27) (p-value < 0.004). The higher calculus in DS might be attributed to the high calcium content in their saliva [2].

The proportion of gingivitis was found to be 65.4%, although less than the control group, gingivitis was present in more than half of the DS sample. It has been reported that gingivitis in DS develops more rapidly and is more extensive around deciduous teeth compared to healthy children [131]. In addition, DS subjects have other factors that aggravate the periodontal disease such as abnormalities in host defence particularly leucocyte response, defective connective tissue and altered vascularisation [132]. Periodontal disease is of a great concern in DS subjects because it has a progressive pattern and children can present with marginal gingivitis, gingival recession, advanced periodontitis and pocket formation. Pocket formation has been reported in 36% of DS children below the age of 6 years [129].

The hallmark of managing periodontal disease in DS subjects is prevention. A comprehensive preventive dental program is needed to promote better oral hygiene, prevent the development of periodontal disease and halt its progression. DS children must be always screened for periodontal disease and early, aggressive treatment is needed. They may be needed to be seen more often for scaling and root planning.

4.3 Occlusal Anomalies

DS children have unique occlusal and dentofacial anomalies that are present frequently and might lead to improper functioning and ads up to the complexity of their condition. In the present study, DS subjects had significantly higher proportion of open bite (40% vs. 11.2%), crossbite (42% vs. 28%), scissor bite (9.5% vs. 2.4%), anterior spacing (45.3% vs 32%) and posterior spacing (20.8% vs. 8%). These findings are confirmed by another study, where Soares et al found an incidence of 39% posterior crossbite and 26% anterior crossbite in DS patients [45]. More to add, the DS sample studied in Sharjah had similar findings [16].

It is well nestablished that Class III malocclusion is more common in DS children, due to underdevelopment of the midface and mandibular prognathism [45,99]. This typical malocclusion was confirmed in our study, where DS subjects had significantly higher Class III malocclusion (66%) compared to controls (11.2%). Additionally, Primary molar relationship in DS individuals was found to have higher occurrence of mesial step relationship compared to the control group (13.3% vs. 4%). Due to the small number of subjects with primary dentition, no statistical significance was found in the latter finding. This mesial step relationship explains the Class III malocclusion later on in DS children, as mesial step relationship may progress to a Class III during the molar transition with continued mandibular growth [153].

4.4 Dentofacial Anomalies

In this study, DS individuals had remarkably increased frequencies of shovel shape incisors, high arched palate, microdontia, nipple appearance of canine tip, tongue thrust and lymphadenopathy compared to controls. These findings were also reported in the literature along with other findings such as dentinogenesis imperfecta, taurodontia, peg shaped teeth, impacted teeth, dens evaginatus and talon cusp [16,45,89].

Other dental anomalies reported in DS individuals are hypodontia, delayed eruption, supernumerary teeth and ectopic eruption. Unfortunately, these anomalies were not investigated in this study as radiographs are needed to confirm their presence or absence. Hypodontia prevalence is reported to be around 60% in DS children [103,104]. Third molar agenesis was found to be around 4 times greater in DS than controls [154]. The latter is followed by mandibular central incisors, maxillary lateral incisors, maxillary second premolars and mandibular second molars [102]. The pattern of hypodontia in DS is thought to be associated with peripheral nervous system abnormalities and abnormal cartilaginous tissues [102,154].

4.5 Oral Soft Tissues

DS sample in this study had significantly higher proportion of geographic tongue, atrophy of the tongue, fissure tongue, irritation fibroma, angular cheilitis, macroglossia, ulcers, trauma to soft tissues and drooling compared to healthy controls. Fissured tongue was found in 67% of DS children in this study. Fissured tongue is a non-pathological variation of the normal tongue and often seen in DS individual. Fissured tongue is asymptomatic , often associated with geographic tongue and the only clinical relevance it plays is that it acts as bacterial reservoir and causes glossitis [94]. However, Desai reported that expressive language of children with DS is commonly more delayed than receptive language which might be due to several factors including the relatively large tongue in a small oral cavity [3].

Other findings related to the tongue in DS individuals is relative macroglossia, where the tongue gives the impression of being large due to muscle weakness and low position in the mouth [45,76]. Macroglossia within DS subjects in this study is found in 46.2%, which is similar to the incidence in other studies (11-60%) [16,45,76].

4.6 Medical Conditions

It is very important to note the medical conditions in DS individuals especially those that may impinge on oral care such as congenital heart defects, epilepsy and cervical spine abnormalities. Congenital heart defects are very frequent in DS individuals, they occur in 40-60% of all DS children [44].The percentage of DS children with cardiac conditions in our sample was 24%. The dentist must always have an up to date cardiac status and follow the most current subacute bacterial endocarditis antimicrobial prophylaxis protocol prior to any procedure [47].

Other conditions are also found in the study DS subjects such as hypothyroidism (10%), recurrent ear infection (4%) and one case of thoracolumbar scoliosis. Hypothyrodism is reported in DS children and is associated with underdevelopment of the bones and teeth as well as delayed tooth eruption [45,69]. Ear-nose-throat (ENT) infections are frequent in DS children and some factors such as immune defects, altered anatomy, hypotonia and macroglossia play an important role in these infections [64,65]. Epilepsy rates in DS were reported to be from 1 to 13% [71] . In this study 5% of DS children were epileptic. The dental team must be trained and ready to handle seizure attacks and be aware of some antiepileptic drugs side effects on the gingiva such as Phenytoin [24,73]. Not to forget, DS individuals have a number of musculoskeletal abnormalities due to defective collagen structure that leads to increased ligamentous laxity. The major concern to the dentist is the effect on cervical spine as the incidence of atlanto-axial joint subluxation was reported to be 20% in DS individuals. However, other spinal deformities were reported in the thoracic area and were known to occur after an early surgery for heart disease [155].

4.7 Erosion

Dental erosion is a multifactorial condition that occurs due to the interaction of chemical, biological and behavioural factors [156]. Tooth wear as a result of acidic and chemical insult to the teeth are commonly noticed in DS children [53]. Erosion in DS children is related to the fact that 13.8% to 59% of DS children suffer from gastric dysfunction such as gastroesophageal reflux and vomiting [53,108,109]. In This study, the severity of erosion was significantly higher among DS children compared to healthy control (p-value=0.006).The proportion of DS children with erosion was 34% vs 15.3% in the control group. Another study also found that erosion was significantly higher in DS individuals than the normal population [107].

Erosion is often associated with other forms of tooth wear such as attrition and abrasion, hence,

the term ‘tooth wear’ is used to reflect all three conditions (erosion, attrition and abrasion) [157]. The combination of this triad (erosion, attrition and abrasion) makes the diagnosis of dental erosion more difficult, therefore careful history taking is important [158]

4.8 Study limitations

As with every study, perfection is desired, however, there are always obstacles and challenges at the time of conducting a study. The author believes that pointing out the study limitations is a good practice in order to understand the overall outcome and come up with better ways to overcome these challenges in future researches. The limitations in this current study are as follow:

- As mentioned previously, there is no central DS registry data in the United Arab Emirates, hence only DS children in special need schools and centres were invited to participate in the study. DS children who are raised at home are out of reach and cannot be tracked. This might had affected the results.
- The study population was all from Dubai city. It would have been beneficial if DS children from all around UAE participated but this was unachievable due to time limitation, number of researchers examining the children and facilities to accommodate the large number of participants.
- Since periodontal disease is a major concern in DS individuals, it would have been important to include other periodontal examination alongside the Oral Hygiene Index. Basic Periodontal Examination BPE [159] which includes probing index teeth would have been a good method however, due to the difficulties in examining some children this was not practical. Also, a high proportion of these children might have cardiac conditions and might be at risk of infective endocarditis; hence, a cardiologist consultation and

antimicrobial prophylaxis (American Heart Association guidelines are followed in the UAE) might be needed prior to probing.

5. Conclusions and Rrecommendations

- This current study had concluded that DS children in Dubai had higher caries rate compared to healthy children.

- The youngest age group among DS children with primary dentition had the highest dmft score compared to the rest.
- Despite the high caries rate among DS subjects, they received more restorations and dental treatment compared to the control, which suggests that DS children had better access to dental care than their control.
- Additionally, DS children had significantly more calculus than healthy children.
- DS population had similar occlusal anomalies to DS subjects worldwide. They had significantly higher proportion of open bite, crossbite, scissor bite, anterior spacing, and posterior spacing. In addition, they had more Class III molar relationship compared to the control.
- Other dentofacial anomalies that were more frequent in DS children were shovel shaped incisors, high arched palate, microdontia, hypodontia, nipple appearance of canine tip, tongue thrust, macroglossia and lymphadenopathy.
- Soft tissue findings in the DS group revealed higher frequencies of atrophy of the tongue, geographic tongue, fissured tongue, irritation fibroma, angular cheilitis, ulcers, trauma to soft tissue/lip and frequent drooling.
- The severity of erosion was significantly higher among DS children compared to healthy control.
- As with any DS subject, our group had several medical conditions that are of a great concern to the dentist such as cardiac conditions, hypothyroidism, epilepsy, recurrent ear infections and spinal deformities.

Looking at the outcome of this study, the following recommendations are suggested for future research:

- To present the findings of this study to the newly restructured Federal Ministry of Health and Community Prevention.
- To investigate the health care system provided for DS children including general anaesthesia facilities, dental appointments, dental follow ups and waiting lists.
- To focus on parental awareness programs that stress the importance of oral health of special needs children.
- To establish proper prevention and community oral health care programs that target special needs children in Dubai.
- To suggest establishing data registry for DS children in the United Arab Emirates. This will help in epidemiological studies and the provision of comprehensive oral healthcare for these children.
- To conduct a similar study to include all DS children in The United Arab Emirates to have a better understanding of their oral health and treatment needs.

6. Bibliography

1. Frydman A, Nowzari H. Down syndrome-associated periodontitis: a critical review of the

literature. Compend Contin Educ Dent. 2012;33(5):356–61.

2. Davidovich E, Aframian DJ, Shapira J, Peretz B. A comparison of the sialochemistry, oral pH, and oral health status of Down syndrome children to healthy children. Int J Paediatr Dent. 2010;20(4):235–41.

3. Desai SS. Down syndrome: a review of the literature. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1997;84(3):279–85.

4. Prakash A, Raghuwanshi B, Hameed A. Down syndrome- diagnosis and guidelines of dental and orthodontic management. orthodontics. 2013;40–3.

5. Cohen I. Health care guidelines for individuals with Down syndrome. Down Syndr Q. 1996;1(2).

6. Khocht A, Janal M, Turner B. Periodontal health in down syndrome: Contributions of mental disability, personal, and professional dental care. Spec Care Dent. 2010;30(3):118–23.

7. Pilcher E. Dental Care for the Patient with Down Syndrome. Down Syndr Res Pract [Internet]. 1998;5(3):111–6. Available from: http://www.down-syndrome.org/reviews/84/

8. Areias CM, Sampaio-Maia B, Guimaraes H, Melo P, Andrade D. Caries in Portuguese children with Down syndrome. Clinics. 2011;66(7):1183–6.

9. Parker SE, Mai CT, Canfield M a., Rickard R, Wang Y, Meyer RE, et al. Updated national birth prevalence estimates for selected birth defects in the United States, 2004-2006. Birth Defects Res Part A - Clin Mol Teratol. 2010;88(12):1008–16.

10. Niazi MA, Al-Mazyad AS, Al-Husain MA, Al-Mofada SM, Al-Zamil FA KT. Down's syndrome in Saudi Arabia: incidence and cytogenetics. Hum Hered. 1995;45(2):65–9.

11. Isaac GS, Krishnamurty PS, Reddy YR AY. Down's syndrome in Hyderabad, India. ActaAnthropogenet. 1985;9(4):256–60.

12. Murthy SK, Malhotra AK, Mani S, Shara ME a, Al-Rowaished EEM, Naveed S, et al. Incidence of Down syndrome in Dubai, UAE. Med Princ Pract. 2006;16(1):25–8.

13. Alsakarna BK OE. Dentofacial Changes and Oral Health Status in Individuals with Down Syndrome in Jordan - Cross Sectional Study. Pakistan Oral Dent J. 2010;30(1):159–61.

14. Booth KVP. Health disparities and intellectual disabilities: Lessons from individuals with down syndrome. Dev Disabil Res Rev. 2011;17:32–5.

15. Hashemi Z, Hajizamani A BE. Oral Health Status of a Sample of Disabled Population in Iran. Oral Heal Oral Epidemiol. 2012;1(1):23–8.

16. Jaber MA. Oral Health Condition and Treatment Needs of a Group of UAE Children with Down Syndrome. Ibnosina J Med Biomed Sci. 2010;2(2):62–71.

17. Al-maweri S, Al-sufyani G. Dental caries and treatment needs of Yemeni children with down syndrome. Dent Res J (Isfahan). 2013;11(6):631–6.

18. Jain M. A Paired Comparison among Siblings of Common Parents About Dental Care with and without Down Syndrome. Pesqui Bras Odontopediatria Clin Integr. 2010;10(1):9–14.

19. U.S. Department of Health and Human Services. Oral Health in America: A Report of the Surgeon General. US Dep Heal Hum Serv Natl Inst Dent Craniofacial Res Natl Institutes Heal. 2000;

20. Alkhadra TA. Prevalence of Dental Caries and Oral Hygiene Status among Down's Syndrome Patients in Riyadh. Pakistan Oral Dent J. 2011;31(1):113–5.

21. Zacharias M, Np C, Gp H, Sivalingam P, Rj W, Carson N. Anesthetic Management in a Down Syndrome Patient. Int Student Iournal Nurse Anesth. 2010;18(1):19–23.

22. Lee C, Luginbuehl I, Bissonnette B ML. Pediatric disorders. Anesthesia and Co-Existing Disease. 5th ed. Stoelting R DS, editor. Philadelphia: Churchill Livingstone; 2008. 611-612 p.

23. Källén B. Epidemiology of Human Congenital Malformations. Vol. 189, Journal of anatomy. 2014. 45-60 p.

24. Fiske J, Shafik HH. Down's syndrome and oral care. Dent Update. 2001;28(3):148–56.

25. Down JL. Observations on an ethnic classification of idiots. 1866. Ment Retard. 1995;33(1):54–6.

26. What is Down Syndrome? Natl Down Syndr Soc [Internet]. 2015; Available from: http://www.ndss.org/Down-Syndrome/What-Is-Down-Syndrome/

27. NHS. Down's syndrome - Diagnosis. UK Natl Heal Serv [Internet]. 2015; Available from: http://www.nhs.uk/Conditions/downs-syndrome/Pages/diagnosis.aspx

28. Morris JK, Alberman E. Trends in Down's syndrome live births and antenatal diagnoses in England and Wales from 1989 to 2008: analysis of data from the National Down Syndrome Cytogenetic Register. Bmj. 2009;339(3):3794–3794.

29. Lissauer T, Clayden G. Illustrated Textbook of Paediatrics. London: Mosby; 1998.

30. Cocchi G, Gualdi S, Bower C, Halliday J, Jonsson B, Myrelid A, et al. International trends of Down syndrome 1993-2004: Births in relation to maternal age and terminations of pregnancies. Birth Defects Res A Clin Mol Teratol. 2010;88(6):474–9.

31. Soediono B. Sleep Disordered Breathing in Children. Vol. 53, Journal of Chemical Information and Modeling. 1989. 160 p.

32. Saperstein A, Nicholas S. Pediatric and adolescent sports medicine. Vol. 43, Pediatric clinics of North America. 1996. 1013-1033 p.

33. Weijerman ME, de Winter JP. Clinical practice. The care of children with Down syndrome. Eur J Pediatr. 2010;169(12):1445–52.

34. Kallen K. Down's syndrome and maternal smoking in early pregnancy. Genet Epidemiol. 1997;14(1):77–84.

35. Blomberg MI, Källén B. Maternal obesity and morbid obesity: The risk for birth defects in the offspring. Birth Defects Res Part A - Clin Mol Teratol. 2010;88(August 2009):35–40.

36. Gustafsson J, Anneren G, Ericsson UB, Svanberg L IS. Thyroid antibodies are not a risk factor for pregnancies with Down syndrome. Prenat Diagn. 1995;15:451–4.

37. Vassy C. From a genetic innovation to mass health programmes: the diffusion of Down's Syndrome prenatal screening and diagnostic techniques in France. Soc Sci Med. 2006;63(8):2041–51.

38. Reddy UM, Mennuti MT. Incorporating first-trimester Down syndrome studies into prenatal screening: executive summary of the National Institute of Child Health and Human Development workshop. Obstet Gynecol. 2006;107(1):167–73.

39. Malone FD, Canick JA, Ball RH, Nyberg DA, Comstock CH, Bukowski R, et al. First-Trimester or Second-Trimester Screening, or Both, for Down's Syndrome. N Engl J Med. 2005;353(19):2001–11.

40. American College of Obstetricians and Gynecologists. ACOG Practice Bulletin No. 27: Clinical Management Guidelines for Obstetrician-Gynecologists. Prenatal diagnosis of fetal chromosomal abnormalities. Obs Gynecol. 2001;97(5-1):1–12.

41. Skotko BG. Prenatally diagnosed Down syndrome: Mothers who continued their pregnancies evaluate their health care providers. Am J Obstet Gynecol. 2005;192(3):670–7.

42. pueschel S. Ethical issues pretaining to prenatal diagnosis of Down syndrome, in Down syndrome: A review of current knowledge. Rondal J NL, editor. London: Whorr Publishers Ltd.; 1999. 170-177 p.

43. Siffel C, Correa A, Cragan J, Alverson CJ. Prenatal diagnosis, pregnancy terminations and prevalence of down syndrome in Atlanta. Birth Defects Res Part A - Clin Mol Teratol. 2004;70:565–71.

44. Charleton PM, Dennis J, Marder E. Medical management of children with Down syndrome. Paediatr Child Health (Oxford). 2014;24(8):362–9.

45. Macho V, Coelho A, Areias C, Macedo P, Andrade D. Craniofacial features and specific oral characteristics of Down syndrome children. Oral Health Dent Manag. 2014;13(2):408–11.

46. Freeman SB, Taft LF, Dooley KJ, Allran K, Sherman SL, Hassold TJ, et al. Population-based study of congenital heart defects in Down syndrome. Am J Med Genet. 1998;80(3):213–7.

47. Nice. Prophylaxis against infective endocarditis NG64. Evid Based Dent. 2008;9(2):37–8.

48. American Heart Association. What Is Infective Endocarditis ? Am Hear Assoc. 2015;1.

49. Bull M. American Academy of Pediatrics: Health supervision for children with Down syndrome. Pediatrics. 2001;107(2):442–9.

50. Brockmeyer D. Down syndrome and craniovertebral instability. Topic review and treatment recommendations. Pediatr Neurosurg. 1999;31(2):71–7.

51. Article O. Dentofacial Anomalies and Oral Hygiene Status in Mentally Challenged Children : A Survey. J indian Acad Oral Med Radiol. 2011;23(March):51–3.

52. Odeh M, Hershkovits M, Bornstein J, Loberant N, Blumenthal M, Ophir E. Congenital absence of salivary glands in Down syndrome. Arch Dis Child. 2013;98(10):781–3.

53. Abanto J, Ciamponi AL, Francischini E, Murakami C, de Rezende NPM, Gallottini M. Medical problems and oral care of patients with Down syndrome: a literature review. Spec Care Dentist. 2011;31(6):197–203.

54. Cremers MJG, Beijer HJM. No relation between general laxity and atlantoaxial instability in children with Down syndrome. J Pediatr Orthop. 1993;(3):318–21.

55. Rogers PT CM. Medical Care in Down Syndrome: A Preventative Medicine Approach. New York: Marcel Dekker Inc; 1993.

56. Määttä T, Tervo-Määttä T, Taanila A, Kaski M, Iivanainen M. Mental health, behaviour and intellectual abilities of people with Down syndrome. Down Syndr Res Pract. 2006;11(1):37–43.

57. Burke SW, French HG, Roberts JM, Johnston CE, Whitecloud III TS, Edmunds Jr. JO. Chronic atlanto-axial instability in Down syndrome. J Bone Jt Surg - Am Vol. 1985;67(9):1356–60.

58. Mitchell V, Howard R, Facer E. Down's syndrome and anaesthesia. Paediatr Anaesth. 1995;5(6):379–84.

59. Unkel JH, Edwards JS, Piscitelli WP, Tye GW. Dental surgery and anesthetic precautions of a patient with Down syndrome and juvenile rheumatoid arthritis: a case report. Pediatr Dent. 2012;34(7):517–20.

60. Caird MS, Wills BPD, Dormans JP. Down syndrome in children: the role of the orthopaedic surgeon. J Am Acad Orthop Surg. 2006;14:610–9.

61. Mik G, Gholve P a, Scher DM, Widmann RF, Green DW. Down syndrome: orthopedic issues. Curr Opin Pediatr. 2008;20(1):30–6.

62. Birrer RB. The Special Olympics athlete: evaluation and clearance for participation. Clin Pediatr. 2004;43(9):777–82.

63. Davidson M a. Primary Care for Children and Adolescents with Down Syndrome. Pediatr Clin North Am. 2008;55(5):1099–111.

64. Kusters M, Verstegen RHJ, Gemen EFA, De Vries E. Intrinsic defect of the immune system in children with Down syndrome: A review. Clin Exp Immunol. 2009;156(2):189–93.

65. Liston A, Enders A, Siggs OM. Unravelling the association of partial T-cell immunodeficiency and immune dysregulation. Nat Rev Immunol. 2008;8(7):545–58.

66. Cunningham-Rundles C. Autoimmune manifestations in common variable immunodeficiency. J Clin Immunol. 2008;28 Suppl 1:S42–5.

67. Contestabile A, Benfenati F, Gasparini L. Communication breaks-Down: From neurodevelopment defects to cognitive disabilities in Down syndrome. Prog Neurobiol. 2010;91(1):1–22.

68. Noble SE, Leyland K, Findlay CA, Clark CE, Redfern J, Mackenzie JM, et al. School based screening for hypothyroidism in Down's syndrome by dried blood spot TSH measurement. Arch Dis Child. 2000;82(1):27–31.

69. Thiel R, Fowkes SW. Down syndrome and thyroid dysfunction: should nutritional support be the first-line treatment? Med Hypotheses. 2007;69(4):809–15.

70. Corbett J a. Retardation and developmental disabilities. Behav Res Ther. 1974;12(2):362.

71. Hayashi M, Iwamoto H, Suzuki H KY. Epilepsy in childhood Down syndrome. Brain Dev. 1984;6(1):37–44.

72. Pueschel SM, Louis S, McKnight P. Seizure disorders in Down syndrome. Arch Neurol. 1991;48(1825777):318–20.

73. Scully C, Cawson R. Medical problems in Dentistry. 4th ed. Oxford: Wright; 1998.

74. Alió J, Lorenzo J, Iglesias MC, Manso FJ, Ramíreze EM. Longitudinal maxillary growth in Down syndrome patients. Angle Orthod. 2011;81:253–9.

75. van Gameren-Oosterom HBM, Fekkes M, Buitendijk SE, Mohangoo AD, Bruil J, Van Wouwe JP. Development, problem behavior, and quality of life in a population based sample of eight-year-old children with Down syndrome. PLoS One. 2011;6(7):218.

76. Oliveira ACB, Paiva SM, Campos MR, Czeresnia D. Factors associated with malocclusions in children and adolescents with Down syndrome. Am J Orthod Dentofac Orthop. 2008;133(4):1–8.

77. Tierney NM, Pollard BJ, Doran BR. Obstructive sleep apnoea. Anaesthesia. 1989;44(3):235–7.

78. Fitzgerald D a, Paul A, Richmond C. Severity of obstructive apnoea in children with Down syndrome who snore. Arch Dis Child. 2007;92(5):423–5.

79. Uong EC, McDonough JM T-KC. Magnetic resonance imaging of the upper airway in children with Down syndrome. Am J Respir Crit Care Med. 2001;163:731–6.

80. Prabhat K, Verma S, Maheshwari S, Sharma N. Role of oral health professional in pediatric obstructive sleep apnea. Natl J Maxillofac Surg. 2010;1(1):35.

81. Fidler DJ. The Emerging Down Syndrome Behavioral Phenotype in Early Childhood. Infants Young Child. 2005;18(2):86–103.

82. Newton T. Dentist/patient communication: A review. Dent Updat. 1995;22:118–22.

83. Down's Syndrome: Your Questions Answered [Internet]. Down's Syndrome Association. 2000. Available from: https://www.downs-syndrome.org.uk

84. Wilson MD. Special considerations for patients with Down syndrome. Okla Dent Assoc J. 1994;184:24–5.

85. Priosti PA, Blascovi-assis SM, Cymrot R, Vianna DL, Caromano FA. Grip strength and manual dexterity in Down Syndrome children. 2013;278–85.

86. Oredugba F a. Oral health condition and treatment needs of a group of Nigerian individuals with Down syndrome. Downs Syndr Res Pract. 2007;12(1):72–6.

87. Sdcep. Prevention and Management of Dental Caries in Children. Scottish Dent Clin Eff Program [Internet]. 2010;(April). Available from: www.sdcep.org.uk/index.aspx?o=2866?

88. Jesuino FAS, Valladares-Neto J. Craniofacial morphological differences between down syndrome and maxillary defi ciency children. Eur J Orthod. 2013;35(1):124–30.

89. Sekerci AE, Cantekin K, Aydinbelge M. Prevalence of Dental Anomalies in the Permanent Dentition of Children with Down Syndrome. J Dent Child. 2014;81(2):78–83.

90. Alan M, Bittencourt V. Dental and skeletal characteristics of patients with Down Syndrome. Rev Gauch Odontol. 2013;61(1):121–6.

91. Faulks D, Colladc V, Mazille M, Veyrune J, Hennequin M. Masticatory dysfunction in persons with Down's syndrome. Part 1: aetiology and incidence. J Oral Rehabil. 2008;35(11):854–62.

92. Weiss L, Chen LT. A scanning electron microscopic study of fissured tongue. Blood. 1974;43(5):665–91.

93. Pindborg JJ. Atlas of Diseases of the Oral Mucosa. 2nd ed. Copenhagen: Munksgaard; 1973. 176 p.

94. Goswami M, Verma A, Verma M. Benign migratory glossitis with fissured tongue. J Indian Soc Pedod Prev Dent. 2012;30(2):173–5.

95. Gise E, Lange L NC. Tongue movements in 4 and 5 year old Down's syndrome children during eating: a comparison ith normal children. Am J Occup Ther. 1984;38:660–5.

96. Hennequin M, Allison PJ, Veyrune JL. Prevalence of oral health problems in a group of individuals with Down syndrome in France. Dev Med Child Neurol. 2000;42:691–8.

97. Carlstedt K, Henningsson G, McAllister A, Dahllöf G. Long-term effects of palatal plate therapy on oral motor function in children with Down syndrome evaluated by video registration. Acta Odontol Scand. 2001;59(2):63–8.

98. Carlstedt K, Henningsson G, Dahllöf G. A four-year longitudinal study of palatal plate therapy in children with Down syndrome: effects on oral motor function, articulation and communication preferences. Acta Odontol Scand. 2003;61(1):39–46.

99. Musich DR. Orthodontic intervention and patients with Down syndrome. Angle Orthod. 2006;76:734–5.

100. Westerman GH, Johnson R, Cohen MM. Variations of Palatal Dimensions in Patients with Down's Syndrome. J Dent Res. 1974;54(4):767–72.

101. de Moraes MEL, de Moraes LC, Dotto GN, Dotto PP, dos Santos LRDA. Dental anomalies in patients with down syndrome. Braz Dent J. 2007;18(4):346–50.

102. Bjorn GR IK. Tooth agenesis in Down syndrome. Am J Med Cener. 1995;55:466–71.

103. Suri S, Tompson BD, Atenafu E. Prevalence and patterns of permanent tooth agenesis in Down syndrome and their association with craniofacial morphology. Angle Orthod. 2011;81(2):260–9.

104. Acerbi A. Prevalence of numeric anomalies in the permanent dentition of patients with Down syndrome. Spec Care Dent. 2001;75–8.

105. Levander E, Malmgren O. Evaluation of the risk of root resorption during orthodontic treatment: A study of upper incisors. Eur J Orthod. 1988;10(1):30–8.

106. Miamoto CB, Pereira LJ, Ramos-Jorge ML, Marques LS. Prevalence and predictive factors of sleep bruxism in children with and without cognitive impairment. Braz Oral Res. 2011;25(5):439–45.

107. Bell EJ, Kaidonis J, Townsend GC. Tooth wear in children with Down syndrome. Aust Dent J. 2002;47(1):30–5.

108. Mitchell RB, Call E, Kelly J. Ear, nose and throat disorders in children with Down syndrome. Laryngoscope. 2003;113(2):259–63.

109. Zárate N, Mearin F, Hidalgo A, Malagelada JR. Prospective evaluation of esophageal motor dysfunction in Down's syndrome. Am J Gastroenterol. 2001;96(6):1718–24.

110. Hurlbutt M. Dental Caries: A ph-mediated disease. 2010;9–15.

111. barrett W. The septic theory of dental caries. Am Dent Assoc Trans. 1885;24:204–12.

112. Holst D. Causes and prevention of dental caries: a perspective on cases and incidence. Oral Health Prev Dent. 2005;3(1):9–14.

113. Keyes PH. Recent advances in dental caries research. Bacteriology. 1962;12:43–64.

114. Marsh PD. Are dental diseases examples of ecological catastrophes? Microbiology. 2003;149(2):279–94.

115. Bradshaw DJ, Lynch RJM. Diet and the microbial aetiology of dental caries: new paradigms. Int

Dent J. 2013;63 Suppl 2:64–72.

116. Bradshaw DJ, McKee a S, Marsh PD. Effects of carbohydrate pulses and pH on population shifts within oral microbial communities in vitro. J Dent Res. 1989;68(9):1298–302.

117. Anderson C a., Curzon MEJ, Van Loveren C, Tatsi C, Duggal MS. Sucrose and dental caries: A review of the evidence. Obes Rev. 2009;10(SUPPL. 1):41–54.

118. Animireddy D, Reddy Bekkem VT, Vallala P, Kotha SB, Ankireddy S, Mohammad N. Evaluation of pH, buffering capacity, viscosity and flow rate levels of saliva in caries-free, minimal caries and nursing caries children: An in vivo study. Contemp Clin Dent. 2014;5(3):324–8.

119. Siqueira WL, Bermejo PR, Mustacchi Z, Nicolau J. Buffer capacity, pH, and flow rate in saliva of children aged 2-60 months with Down syndrome. Clin Oral Investig. 2005;9(1):26–9.

120. Macho V, Palha M, Macedo AP, Ribeiro O, Andrade C. Comparative study between dental caries prevalence of Down syndrome children and their siblings. Spec Care Dentist. 2013;33(1):2–7.

121. Creighton WE, Wells HB, Carie EDE, In D, Juveniles I, In MEN, et al. Dental Caries Experience in Institutionalized Mongoloid and Nonmongoloid Children in North Carolina and Oregon. J Dent Res. 1964;45(1):66–75.

122. Shapira J SA. Caries levels, strep mutans counts, salivary ph and periodontal treatment needs of adult Down syndrome patients. Spec Care Dent. 1991;11(6):248–51.

123. Areias C, Sampaio-Maia B, Macho V, Leal I, Melo P, de Andrade C. Does the chemistry in the saliva of Down syndrome children explain their low caries prevalence? Eur J Paediatr Dent. 2013;14(1):23–6.

124. Fung K, Allison PJ. A comparison of caries rates in non-institutionalized individuals with and without Down syndrome. Spec Care Dentist. 2005;25(6):302–10.

125. Guaré RDO, Ciamponi AL, Romano MM. Behavioral and physiological changes in children with Down syndrome using mechanical and chemomechanical (Carisolv) caries removal methods. Spec Care Dentist. 2008;28(5):195–200.

126. Fung K, Lawrence H, Allison P. A paired analysis of correlates of dental restorative care in siblings with and without Down syndrome. Spec Care Dentist. 2008;28(3):85–91.

127. Randell DM, Harth S, Seow WK. Preventive dental health practices of non-institutionalized Down syndrome children: a controlled study. J Clin Pediatr Dent. 1992;16(3):225–9.

128. Adams DA, Barrington EP, Caton J, Genco RJ, Goodman SF, Hildebrand CN, et al. Parameters of Care Supplement. J Periodontol. 2000;71(5):847–83.

129. Reuland-Bosma W, Dijk J. Periodontal disease in Down's syndrome: a review. J Clin Periodontol. 1986;13(1):64–73.

130. Barnett ML, Press KP, Friedman D, Sonnenberg EM. The prevalence of periodontitis and dental caries in a Down's syndrome population. J Periodontol. 1986;57(5):288–93.

131. Reuland-Bosma W, van Dijk J, van der Weele L. Experimental gingivitis around deciduous teeth in children with Down's syndrome. J Clin Periodontol. 1986;13(4):294–300.

132. Reuland-Bosma W, Liem RS, Jansen HW, van Dijk LJ, van der Weele LT. Morphological aspects of the gingiva in children with Down's syndrome during experimental gingivitis. J Clin

Periodontol. 1988;15(5):293–302.

133. Leroy R, Declerck D. Oral health care utilization in children with disabilities. Clin Oral Investig. 2013;17(8):1855–61.

134. Jokic N, Majstorovic M, Bakarcic D, Katalinic A, Szirovicza L. Dental caries in disabled children. Coll Antropol. 2007;31(1):321–4.

135. Al-Sufyani GA, Al-Maweri SA, Al-Ghashm AA, Al-Soneidar WA. Oral hygiene and gingival health status of children with Down syndrome in Yemen: A cross-sectional study. J Int Soc Prev Community Dent. 2014;4(2):82–6.

136. WHO Oral Health Surveys - Basic methods. Dentition status and criteria for diagnosis and coding (caries). 4th ed. Geneva: WHO; 1997.

137. Emslie RD. The 621 periodontal probe. Int Dent J. 1980;30:287–8.

138. Prevention and control of healthcare-associated infections in primary. NICE Clin Guidel 139. 2012;

139. Angle EH. Classification of malocclusion. Dent Cosm. 1899;41:248–64.

140. Burdi Ar MR. Developmenet of the dentition and the occlusion. In: Moyers RE, editor. Handbook of Orthodontics. 4ed ed. Chicago, London: Year Book Medical Publishers; 1988. 99-146 p.

141. D. J. measuring restorataive dental care in communities. Br Dent J. 1973;134:358–8.

142. Greene JC VJ. The Simplified Oral Hygiene Index. J Am Dent Assoc. 1964;68:7–13.

143. Walker A, Gregory J, Bradnock G, Nunn J, White D. National Diet and Nutrition Survey: Young People Age 4-18 Years. Volume 2: Report of the oral health survey. London: The Stationary Office; 2000.

144. Hennequin M, Faulks D, Veyrune IJ BP. Significance of oral health in persons with Down Syndrome: a literatre review. Dev MEd Child Neurol. 1999;41:275–83.

145. GM. D. “Department of health, British Association for the study of community Dentistry, Delivering better oral health: an evidence-based toolkit for prevention” (second edition). Dep Heal London Dent Updat. 2008;35:460–2.

146. Allison P, Hennequin M, Faulks D. Dental care access among individuals with Down syndrome in France. Vol. 20, Special care in dentistry : official publication of the American Association of Hospital Dentists, the Academy of Dentistry for the Handicapped, and the American Society for Geriatric Dentistry. 2000. p. 28–34.

147. Shore S, Lightfoot T, Ansell P. Oral disease in children with Down syndrome: causes and prevention. Community Pract [Internet]. 2010;83(2):18–21. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20222361

148. Hashim R, Thomson WM, Ayers KMS, Lewsey JD, Awad M. Dental caries experience and use of dental services among preschool children in Ajman, UAE. Int J Paediatr Dent. 2006;16(4):257–62.

149. Pine CM, Adair PM, Burnside G, Nicoll AD, Gillett A, Aida Borges-Yáñez S, et al. Barriers to the treatment of childhood caries perceived by dentists working in different countries. Community Dent Health. 2004;21(1 SUPPL.):112–20.

150. Kowash MB. Severity of early childhood caries in preschool children attending Al-Ain Dental

Centre, United Arab Emirates. Eur Arch Paediatr Dent. 2015;16(4):319–24.

151. Asokan S, Muthu MS, Sivakumar N. Dental caries prevalence and treatment needs of Down syndrome children in Chennai, India. Indian J Dent Res. 2008;19(3):224–9.

152. Shyama M, Al-Mutawa SA, Morris RE, Sugathan T, Honkala E, Shyama M; Al-Mutawa SA; Morris RE; Sugathan T; Honkala E. Dental caries experience of disabled children and young adults in Kuwait. Community Dent Health. 2001;18(3):181–6.

153. Moyers R. Handbook of Orthodontics. 3rd editio. Mosley, Year Book.Chicago; 1973.

154. Lomholt JF, Russell BG, Stoltze K, Kjaer I. Third molar agenesis in Down syndrome. Acta Odontol Scand. 2002;60(3):151–4.

155. Dimar JR, Carreon LY. Spinal Deformity in Down Syndrome. Spine Deform. 2012;

156. Lussi A, Jaeggi T. Erosion:diagnosis and risk factors. Clin Oral Investig. 2008;12 Suppl 1:5–13.

157. Huew R, Waterhouse PJ, Moynihan PJ, Maguire A. Dental erosion among 12 year-old Libyan schoolchildren. Community Dent Health. 2012;29(4):279–83.

158. O'Sullivan E, Barry S, Milosevic A, Brock G. Diagnosis, Prevention and Management of Dental Erosion. RCS Guidel. 2013;

159. British Society of Periodontology. Basic Periodontal Examination (BPE). 2011;1–2.

7. Appendix

Appendix I: Letter of approval from the Ministry of Social Affairs – Dubai

Appendix II: Letter of approval from the Ministry of Health – Dubai

Appendix III, IV, V & VI: Study Consent sheets to be signed by parents/legal guardians

Appendix VII: Data sheet

Appendix VIII: Ethical approval from the Research Ethics Review Committee in Dubai Healthcare City, Dubai, UAE

Appendix I

UNITED ARAB EMIRATES
MINISTRY OF SOCIAL AFFAIRS

الإمارات العربية المتحدة
وزارة الشؤون الإجتماعية

التاريخ : 09/إبريل /2014
المرجع : ر/ت/م/ 2014/34

السادة / مراكز المعاقين الحكومية والخاصة المحترمين ،،،

تحية طيبة وبعد،،،

الموضوع : دراسة حول صحة الفم والأسنان للأطفال الغير معاقين والأطفال المعاقين

تهديكم إدارة رعاية وتأهيل المعاقين أطيب التمنيات ، وبالإشارة إلى الموضوع أعلاه ، تقوم الطبيبتان بتول غيث وهيفاء الهاشمي بإجراء دراسة علمية للوقوف على مشاكل صحة الفم والأسنان التي تواجهها فئة المعاقين، من أجل وضع الحلول المناسبة من خلال برنامج طبي متكامل وتلبية احتياجاتهم العلاجية والوقائية وزيادة الوعي لدى الأهالي وتشجيعهم على العناية بصحة الفم والأسنان لأطفالهم .

يرجى التكرم بتسهيل المهمة للطبيبتين المذكورتين أعلاه، وتوفير كافة ما يحتجن إليه من معلومات لتحقيق أهداف الدراسة المرجوة ، والارتقاء بالخدمات الطبية المقدمة للمعاقين في هذا المجال.

شاكرين لكم حسن تعاونكم الدائم معنا

وتفضلوا بقبول فائق الاحترام والتقدير ،،،

وفاء حمد بن سليمان

مدير إدارة رعاية وتأهيل المعاقين

www.msa.gov.ae

أبوظبي ◆ هاتف: 9333 642 2 971+ ◆ فاكس: 9449 642 2 971+ ◆ ص.ب 261 ◆ الإمارات العربية المتحدة
دبي ◆ هاتف: 7777 263 4 971+ ◆ فاكس: 4882 263 4 971+ ◆ ص.ب 4409 ◆ الإمارات العربية المتحدة
ABU DHABI ◆ TEL.: +971 2 642 9333 ◆ FAX: +971 2 642 9449 ◆ P.O. BOX 261 ◆ UNITED ARAB EMIRATES
DUBAI ◆ TEL.: +971 4 263 7777 ◆ FAX: +971 4 263 4882 ◆ P.O. BOX 4409 ◆ UNITED ARAB EMIRATES

Appendix II

UNITED ARAB EMIRATES
MINISTRY OF HEALTH

الإمارات العربية المتحدة
وزارة الصحة

التاريخ: 2014/04/14م
الرقم: و.ص.ط/2014/64
قسم المتابعة والتنسيق

السيد/ د. ديفيد راي المحترم

عميد وبرفسور طب الفم – كلية دبي لطب الأسنان

تحية طيبة وبعد ،،

الموضوع : الموافقة لإجراء دراسة
حول صحة الفم والأسنان في المدارس الحكومية بإمارة دبي

نهديكم أطيب التمنيات ونتمنى لكم دوام التوفيق والتقدم.

كما أننا نشكر لكم سعيكم في إجراء دراسة للبحث عن مشاكل صحة الفم والأسنان في المدارس الحكومية، وبما أن هذه الدراسة سيكون لها الأثر الإيجابي لمعرفة أسباب ونسبة انتشار مشاكل صحة الفم والأسنان ووضع برنامج طبي متكامل لصحة الفم والأسنان يتضمن الإجراءات العلاجية والوقائية ومساعدة الأهالي على تفهم أهمية الجانب الوقائي وتشجيع أطفالهم على العناية بصحة الفم والأسنان فإنه لا مانع لدينا من إجراء هذه الدراسة على أن يتم تزويد إدارة الصحة المدرسية بنتائج البحث الميداني والإحصائيات وتحليل النتائج للإستفادة منها لوضع الخطط المستقبلية للصحة المدرسية وخاصة قسم صحة الفم والأسنان.

الرجاء التواصل مع الدكتورة ماجدة – نائب مدير ادارة الصحة المدرسية على هاتف .6770169-050

شاكرين لكم حسن تعاونكم معنا ،،
وتفضلوا بقبول فائق الاحترام والتقدير ،،،

ناصر خليفه البلوشي
مدير منطقة دبي الطبية بالإنابة

www.moh.gov.ae

Appendix III

(Down syndrome children)

Consent for research:

Research Title: Dental Caries Experience and Oral Health in Down syndrome Children in Dubai-UAE

Dear parents\guardian:

We are a group of paediatric dentists from Dubai School of Dental Medicine currently studying the oral health condition in healthy children and special needs children with Down syndrome in Dubai-the United Arab Emirates. Recognizing the oral health problems in this group of children will help us structure a proper dental program according to their treatment needs. We will be visiting the schools and special needs centres to conduct a clinical dental check-up that will take an average of ten minutes depending on the child's cooperation and it is free of charge. You will be provided with a copy of your child's dental examination results. The collected data will be used for research purposes only and your child's information will be kept confidential (The data will be scanned and saved in the electronic file dedicated for the research data on Dubai School of Dental Medicine server). Your child's voluntary participation will serve a great value to the community. This research will provide base line data to be used by the health care providers for the planning of the preventive and curative needs of Down syndrome children and help the families of the children with Down syndrome to understand the importance of preventing oral disease.

- If you are interested to participate, please sign below.
- If the child's brother or sister (healthy) would like to participate as well for comparison, Please fill a **separate** consent form and questionnaire.
- Kindly note that only signed forms with complete answers will be eligible to participate.
- Only children who meet the study's inclusion criteria will be included.
- The child's medical records maybe reviewed to obtain necessary information which will be kept confidential.
- The parent can withdraw their child from the study at any time without any liability on their part and withdrawal will not affect any treatment they receive.
- The data of the child will be destroyed upon withdrawal from the study.
- The child's information will be written in the data sheet for the purpose of collecting data. After confirmation of completeness of data the name will be coded.

I have read and understood the above information and:
☐ Agree

For my child (Name: ----------) to participate.

The data might be used for future research projects provided that your child's identity will not be revealed. Approval by Research Ethics Review Committee in Dubai HealthCare City will be obtained for any future use of your child's information.
☐ Agree
☐ Disagree

Name _____

Relationship to child _____

Contact number – mobile: _____

Signature _____

For inquires please call:

Dr Batool Ghaith: 052-7776684

Rim Turki : 04-4248624

This research study has been approved by the Research Ethics Review Committee in Dubai Healthcare City, Dubai, and UAE

(أطفال متلازمة داون)

عنوان البحث :صحة الفم والاسنان متلازمة داون في مدينة دبي.

عزيزي ولي الأمر :

نحن مجموعة أخصائيين (طب أسنان الأطفال من كليه دبي لطب الأسنان ، نجري دراسه حول صحة الفم و الأسنان لدى الأطفال الأصحاء و الأطفال الذين يعانون من متلازمة داون على مستوى دوله الإمارات العربية المتحدة .

الهدف الأساسي من هذه الدراسة: التعرف على مشاكل صحة الفم و الأسنان التي تواجهها هذه الفئة في مجتمعنا، وكيفية وضع الحلول المناسبة عن طريق هيكلة برنامج طبي متكامل لصحة الفم والأسنان يلبي احتياجاتهم العلاجية والوقائية و مساعدة الاهالي على تفهم اهمية الجانب الوقائي و تشجيعهم على العنايه بصحة الفم و الاسنان لاطفالهم.

كما هو معلوم فإن أي دراسة بحث تستلزم وجود أشخاص ينضمون ويشتركون في الدراسة ،لذا سنقوم بزيارة المدارس و مراكز ذوي الإحتياجات الخاصة(وإجراء فحص أسنان مجاني للأطفال وتسليم نتائج الفحص لكل طفل ، علماً بأن هذا الفحص سيستغرق بمعدل العشرة دقائق اعتمادا على تعاون طفلكم، البيانات التي سيتم رصدها ستسخدم لهذا البحث ،مع الإحتفاظ بسريه تامه للمعلومات الشخصية لطفلك(حيث ان المعلومات سوف تحفظ في الملف الالكتروني الخاص بالبحث الجاري في كلية دبي لطب الاسنان) . علماً بأن لجنة البحوث الطبية وافقت على هذه الدراسة مسبقاً.

مشاركة طفلك في هذه الدراسةهو عمل تطوعي ويعتبر خطوة فعالة نحو مجتمع واعي و صحي.

- اذا كنت ترغب في المشاركة الرجاء التوقيع أدناه
- من دواعي سرورنا مشاركة أبناؤكم الأخرون في الاستبيان ،ويفضل **ملء إستمارة أخرى** لكل طفل.
- يرجى العلم بان الاستمارات الموقعة و الاستبيانات الكاملة هي التي ستكون مؤهلة للمشاركة في الدراسة.
- الأطفال المستوفون لشروط البحث سوف يتم ادراجهم في هذه الدراسة.
- قد نحتاج لمراجعه الملف الطبي لطفلك للحصول على المعلومات اللازمه ،حيث سيتم ذلك بخصوصيه تامه.
- ولي الامر له الحق باخراج طفله من الدراسة في اي وقت من غير اية تبعات.
- في حالة انسحاب الطفل من الدراسة سوف يتم التخلص من المعلومات بشكل نهائي .
- معلومات الطفل ستكون مكتوبة على ورقة البيانات و الاستبيان لغرض جمع البيانات ، بعد التأكد من اكتمال البينات اسم الطفل و بياناته ستكون مشفرة

لقد قرات وفهمت المعلومات أعلاه , و : ☐ أوافق

بمشاركة طفلي (.....) في هذه الدراسة .

يمكن أن تستخدم البيانات للمشاريع البحثية في المستقبل شريطة أن هوية طفلك لن يتم التعرف عليها. البيانات التي سيتم رصدها ستستخدم للبحوث المستقبلية مع الاحتفاظ بسرية تامة للمعلومات الشخصية لطفلك، مع العلم بأنه ستؤخذ موافقة أخرى من قبل لجنة مراجعة أخلاقيات البحوث العلمية في مدينة دبي الطبية للدراسة المستقبلية

☐ أوافق ☐ لا أوافق

اسم ولي الأمر: التوقيع :

رقم الهاتف المتحرك :

التاريخ :

شاكرين لكم تعاونك معنا .....

للاستفسار ارجو الاتصال على الارقام التالية:

د.بتول الغيث : 052-7776684

ريم تركي: 04- 4248624,

تمت الموافقة على هذه الدراسة البحثية من قبل لجنة مراجعة أخلاقيات البحث العلمي في مدينة دبي الطبية ، دبي ، الامارات العربية المتحدة

Appendix V

(Healthy children)

Consent for research:

Research Title: Dental Caries Experience and Oral Health in Down syndrome Children in Dubai-UAE

Dear parents\guardian:

We are a group of paediatric dentists from Dubai School of Dental Medicine currently studying the oral health of healthy children and special needs children in the United Arab Emirates. Recognizing the oral health problems in this group of children will help us structure a proper dental program according to their treatment needs. We will be visiting the schools and special needs centres to conduct a clinical dental check-up that will take an average of ten minutes depending on the child's and it is free of charge. You will be provided with a copy of your child's dental examination results. The collected data will be used for this research only and your child's information will be kept confidential (The data will be scanned and save in the electronic file dedicated for the research data on Dubai School of Dental Medicine server). This study will provide base line data to be used by the health care providers for the planning of the preventive and curative needs of CP children and help the families of the children with CP to understand the importance of preventing oral disease for CP children. Your child's voluntary participation will serve a great value to the community.

- If you are interested to participate, please sign below
- Kindly note that only signed forms with complete answers will be eligible to participate.
- Only children who meet the study's inclusion criteria will be included.
- The child's medical records maybe reviewed to obtain necessary information which will be kept confidential.
- The parent can withdraw their child from the study at any time without any liability on their part and withdrawal will not affect any treatment they receive.
- The data of the child will be destroyed upon withdrawal from the study.
- The child's information will be written in the data sheet and questionnaire for the purpose of collecting data. After confirmation of completeness of data the name will be coded.

I have read and understood the above information and:
☐ Agree
For my child (Name: ----------) to participate.

The data might be used for future research projects provided that your child's identity will not be revealed. Approval by Research Ethics Review Committee in Dubai HealthCare City will be obtained for any future use of your child's information.
☐ Agree
☐ Disagree

Name _____

Relationship to child _____

Contact number – mobile: _____
Signature _____

For inquires please call:

Dr Batool Ghaith: 052-7776684

Rim Turki : 04-4248624

This research study has been approved by the Research Ethics Review Committee in Dubai Healthcare City, Dubai, and UAE

(الاطفال الاصحاء)

عنوان البحث :صحة الفم والاسنان لاطفال متلازمة داون في مدينة دبي .

عزيزي ولي الأمر :

من كليه دبي لطب الأسنان ، نجري دراسه حول صحة الفم و الأسنان لدى الأطفال) طب أسنان الأطفال (نحن مجموعة أخصائيين الأصحاء و الأطفال من ذوي الإحتياجات الخاصة على مستوى دوله الإمارات العربية المتحدة .

الهدف الأساسي من هذه الدراسة: التعرف على مشاكل صحة الفم و الأسنان التي تواجهها هذه الفئة في مجتمعنا، وكيفية وضع الحلول المناسبة عن طريق هيكلة برنامج طبي متكامل لصحة الفم والأسنان يلبي احتياجاتهم العلاجية والوقائية.

كما هو معلوم فإن أي دراسة بحث تستلزم وجود أشخاص ينضمون ويشتركون في الدراسة ،لذا سنقوم بزيارة المدارس و مراكز ذوي الإحتياجات الخاصة(وإجراء فحص أسنان مجاني للأطفال وتسليم نتائج الفحص لكل طفل ، علماً بأن هذا الفحص سيستغرق بمعدل العشرة دقائق اعتمادا على تعاون طفلكم، البيانات التي سيتم رصدها ستسخدم لهذا البحث ،مع الإحتفاظ بسريه تامه للمعلومات الشخصية لطفلك(حيث ان المعلومات سوف تحفظ في الملف الالكتروني الخاص بالبحث الجاري في كلية دبي لطب الاسنان) .

مشاركة طفلك في هذه الدراسةهو عمل تطوعي ويعتبر خطوة فعالة نحو مجتمع واعي و صحي.

- اذا كنت ترغب في المشاركة الرجاء التوقيع أدناه
- يرجى العلم بان الاستمارات الموقعة و الاستبيانات الكاملة هي التي ستكون مؤهلة للمشاركة في الدراسة.
- الأطفال المستوفون لشروط البحث سوف يتم ادراجهم في هذه الدراسة.
- قد نحتاج لمراجعه الملف الطبي لطفلك للحصول على المعلومات اللازمه ،حيث سيتم ذلك بخصوصيه تامه.
- ولي الامر له الحق باخراج طفله من الدراسة في اي وقت من غير اية تبعات.
- في حالة انسحاب الطفل من الدراسة سوف يتم التخلص من المعلومات بشكل نهائي.
- معلومات الطفل ستكون مكتوبة على ورقة البيانات و الاستبيان لغرض جمع البيانات ، بعد التأكد من اكتمال البينات اسم الطفل و بياناته ستكون مشفرة

لقد قرات وفهمت المعلومات أعلاه , و :

☐ أوافق

بمشاركة طفلي (.....) في هذه الدراسة .

يمكن أن تستخدم البيانات للمشاريع البحثية في المستقبل شريطة أن هوية طفلك لن يتم التعرف عليها. البيانات التي سيتم رصدها ستستخدم للبحوث المستقبلية مع الاحتفاظ بسرية تامة للمعلومات الشخصية لطفلك، مع العلم بأنه ستؤخذ موافقة أخرى من قبل لجنة مراجعة أخلاقيات البحوث العلمية في مدينة دبي الطبية للدراسة المستقبلية ☐ أوافق ☐ لا أوافق

اسم ولي الأمر: التوقيع :

رقم الهاتف المتحرك : التاريخ :

شاكرين لكم تعاونك معنا.....

للا ستفسار الرجاء الاتصال على الارقام التالية:

د.بتول الغيث : 052-7776684

ريم تركي: 04- 4248624,

تمت الموافقة على هذه الدراسة البحثية من قبل لجنة مراجعة أخلاقيات البحث العلمي في مدينة دبي الطبية ، دبي ، الامارات العربية المتحدة

Appendix VII

Child's Name:	Age:	Sex:	Date:
Child's condition :		School/Area:	

	Permanent	Primary
0	sound	A
1	decayed	B
2	filled & decayed	C
3	filled, no decay	D
4	missing due caries	E
5	missing, other reason	-
6	sealant	-
7	bridge abutment, crown	G
8	unerupted	-
9	excluded	-

			E	D	C	B	A	A	B	C	D	E			
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
			E	D	C	B	A	A	B	C	D	E			

Prim. Teeth	o		d		m		f		dmf	
Perm. Teeth	O		D		M		F		DMF	

Codes for individual tooth status: small letters for primary teeth, capital letter for permanent teeth.

O = Sound tooth. , d / D = Decayed tooth. , m / M = Missed. , f / F = Filled

D=	d=
M=	m=
F=	f=
D+M+FT=	d+m+ft=

Oral Hygiene StatusOral Hygiene Status

Debris index (0,1,2,3)

6	1	6
6	1	6

Calculus Index (0,1,2,3)

6	1	6
6	1	6

Oral Hygiene Index – Simplified = PI + CI

Debris -67

	Right molar		Anterior		Left molar		Total	
	Buccal	Lingual	Labial	Labial	Buccal	Lingual	Buccal	Lingual
Upper		-		-		-		-
Lower	-		-		-			

Debris Index = (The buccal-scores) **+** (The lingual-scores) **/** (Total number of examined buccal and lingual surfaces).

Debris Index =

Calculus

	Right molar		Anterior		Left molar		Total	
	Buccal	Lingual	Labial	Labial	Buccal	Lingual	Buccal	Lingual
Upper		-		-		-		-
Lower	-		-		-			

Calculus Index = (The buccal-scores) **+** (The lingual-scores) **/** (Total number of examined buccal and lingual surfaces).

Calculus Index =

Oral Hygiene Index	=	Debris Index + Calculus Index

Gingivitis ☐ Yes ☐ No

Gingival Hyperplasia ☐ Yes ☐ No

Debris ☐ Yes ☐ No

Calculus ☐ Yes ☐ No

Occlusion anomalies

Vertical :

	Yes	No	
1. Open			bite
2. Deep			bite

Transverse

	Yes	No	
1. Crossbite			(63)
2. Scissor bite			

Angle malocclusion classification:

Class I

Class II

Class III

Primary Molar classification:

Flush Terminal Plane

Mesial step

Distal step

Spacing

	Yes	No
1. Anterior		
2. Posterior		

Overjet = ……. mm

If reverse overjet = …….. mm

Trauma – Anterior teeth

Yes ☐ No ☐

Dentofacial abnormalities

	Yes	No

1. Shovel shaped incisors		
2. High arched palate		
3. Microdontia		
4. Nippled appearance of canine tip		
5. Tongue thrust		
6. lymphadenopathy		

Soft tissue abnormalities

Oral lesion (yes / No)	Yes	No
• Atrophy of tongue papilla		
• Median rhomboid glossitis		
• Geographic tongue		
• Fissure tongue		
• Irritation fibroma		
• Angular chilitis		
• Gingival hyperplasia		
• Macroglossia		
• Ulcer		
• Trauma to soft tissue/lip		

Tooth wear Index - walker et al

Permanent Dentition

- Circle the highest score you observe (only **upper incisors –Labial + palatal** and **1st molars _ Occlusaly**) or 2nd molar

Primary Dentition

- Circle the highest score you observe (only primary **incisors**)

Code	Depth	Area of surface affected
0	Normal	normal
1	Enamel only	Less than 1/3 of surface involved
2	Enamel and dentine	1/3 up to 2/3 of surface involved
3	Enamel dentine and pulp	2/3 or more of surface involved
9	Assessment cannot be made	Assessment cannot be made

Appendix VIII

حكومة دبي
GOVERNMENT OF DUBAI

سلطة مدينة دبي الطبية
DUBAI HEALTHCARE CITY AUTHORITY

May 5th 2014

Dr. Batool Al Ghaith
Dental Trainee-Pediatric Dentistry
Dubai School of Dental Medicine
Dubai Healthcare City
Dubai, United Arab Emirates

Subject: Ethical Approval for Research Protocol

Dear Dr. Al Ghaith,

This is with reference to the initial protocol application for the research study entitled, "Dental Caries Experience and Oral Health in Down syndrome Children in Dubai-UAE-A Case Control Study" which was submitted to the Dubai Healthcare City Authority-Research Ethics Review Committee (RERC) for review and approval.

It is hereby confirmed that the RERC has reviewed the above application on March 26th 2014 and this was followed by further reviews. On May 5th 2014, the RERC members have unanimously decided to **approve your final submission which was made on March 30th, 2014.**

Please note however, that this ethical approval is conditional to the following:

1. It is at the discretion of the principal investigator to ensure that all the scientific details and background information contained within the protocol are validated and substantiated with evidence to ensure credibility of the research outcome.
2. Other regulatory approval/s, needed to conduct the study is/are to be obtained and submitted to the RERC for record keeping.
3. No deviations from or changes to the protocol are to be implemented without prior review and documented approval of the RERC.
4. The research study documentation shall be periodically subject to RERC audit.
5. Upon completion of the study, a "Final Research Study Report" will be required for submission to RERC. Consequently, any abstract/publication should also be brought to the attention of the RERC.

Kindly collect your original Ethical Approval Letter from the CPQ Office after midday on Tuesday May 6th 2014.

We congratulate you and wish you continued success in DHCC.

Best Regards,

Laheeb Al-Mutwalli
Director-Licensing Department
Center for Healthcare Planning and Quality
Dubai Healthcare City Authority

Government of Dubai
Dubai Healthcare City Authority

مركز التخطيط والجودة للخدمات الطبية
CENTER FOR HEALTHCARE PLANNING & QUALITY

www.dhcc.ae/cpq

info@cpq.dhcc.ae
P.O. Box: 505601, Dubai, U.A.E, Tel. + 97143635555, Fax + 97143624770, E-mail: info@cpq.dhcc.ae