Original Article

Implications of Down's syndrome on oral health status in patients: A prevalence-based study

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Abstract

Background: Down syndrome which is also known as "trisomy 21" is the commonest chromosomal defect that has been associated with intellectual disability or impairment. Clinically, it has been characterized by the generalized presence of hypotonic musculature, variety of neurobiological alterations, numerous respiratory diseases, and significantly higher risk of developing infection along with various dental abnormalities and oro-facial dysmorphological changes. Periodontal diseases are the most prominent oral health issue among individuals diagnosed with Down Syndrome. **Aim:** The objective of the present prevalence analysis was to study the implications of Down's syndrome on oral health status among patients. **Materials and Methods:** This was a descriptive and cross-sectional prevalence analysis conducted within a duration of 1 year. A total of 100 children diagnosed with Down syndrome (aged between 5 and 16 years) were selected as the study sample. Inclusion criteria were (a) cytogenetic positive trisomy 21, (b) cooperative behavior, and (c) written informed consent obtained from the legal care-takers. Exclusion criteria were (a) any debilitating form of systemic diseases, (b) any other disability, and (c) extremely uncooperative children. The gingival health status was assessed using gingival index (GI) [Loe and Silness], calculus index (CI) [Ramfjord], and plaque index (PI) [Silness and Loe]. Information involving the practice of oral hygiene maintenance, diet plans, and parental educational status was derived from each parent. Based upon their intelligence quotient (I. Q.) values, the subjects were classified into three groups: a) mild (I. Q. level = 50 to 70), b) moderate (I. Q. level = 35 to 50), and c) severe (I. Q. level ≤35). Statistical analysis was performed using the statistical software tool Statistical Package for Social Sciences (SPSS) version 20.0. Qualitative data were recorded as frequencies, and percentages and quantitative data were recorded as mean and standard deviation values. All categorical outcomes were analyzed by means of the Chi-square test. The quantitative outcomes of Calculus Index, Gingival Index, and Plaque Index were analyzed by either student's *t*-test or one-way analysis of variance (ANOVA). Significance was set at a cut-off value of $P < 0.05$. **Results:** Down syndromic children between 12 and 16 years were reported to have statistically significant higher Calculus Index, Gingival Index, and Plaque Index values in comparison with younger age syndromic children ($P < 0.01$). Those with severe mental retardation had significantly higher Plaque Index ($P < 0.001$) and Gingival Index ($P < 0.04$) values when compared with those with mild and moderate mental retardation. No significant difference in comparing Calculus Index was noted. **Conclusion:** Higher age group children with Down syndrome require close monitoring by parents for assisting in maintaining oral hygiene practices just as in younger age group children.

Keywords: Calculus, Down, gingival, hygiene, index, oral, plaque, syndrome

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Introduction

Down syndrome is a genetic disease resulting due to the partial or complete occurrence of triple copies of chromosome

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number 21.[1] It is also known as "Trisomy 21." This chromosomal defect has been found to have a strong association with maternal age, especially among the advanced-aged females.[2] Chromosome 21 is the smallest among all human chromosomes and belongs to the G chromosome group that are primarily responsible for somatic growth and development of the heart, epicanthal folds, lens, iris, phalanges, metacarpals, paranasal sinuses, dermatoglyphic patterns on soles and palms, maintain tonicity of muscles along with the elasticity of cartilage and tendon, determining the proportional size between trunk and limbs, proportion of cranial width, reproductive organs, heart, and pelvis. It also determines the shape of the auricle, both quantity as well as the quality of hair, tooth size, neurocranial bony thickness along with the development of intellect and intelligence. The presence of an extra copy of chromosome 21 results in manifestation in form of disorders of metabolism, defects of internal organs, dimorphism of teeth, and typical morphological or phenotypic traits with varying amounts of mental deficiency or retardation.[3-6]

This syndrome shows a characteristic and destructive craniofacial morphological phenotype that can be recognized easily. One of the peculiar clinical phenotypes among such subjects comprises developmental abnormalities affecting the craniofacial skeletal framework.[1]

These patients often have comorbidities or complications that involve multiple organ systems. The most common are the cardiovascular complications and risk factors that impact cardiovascular event incidence.[7]

Hypoplastic mid-facial development is the primary deformity of the skeleton which affects structures in the orofacial complex. These mid-facial defects give rise to the ill-development of paranasal sinuses, which results in a sloped forehead and flattened facial features.[2]

Numerous studies have reported poor oral hygiene due to poorly maintained oral hygiene practices due to which there is the occurrence of poor periodontal health.[8] Also, subjects suffering from Down syndrome ubiquitously demonstrate a high prevalence rate of periodontitis when compared to patients This may be due to altered immunological status in patients with Down syndrome which might be responsible for the development of periodontal diseases which are more prevalent among these subjects in spite of the similarity in plaque indices scores reported from both healthy control subjects as well as patients with Down syndrome.[9-11] Dental caries has been found to be the most prevalent oral disease affecting children with mental retardation all over the world. Treatment of dental diseases or problems is the most neglected health need among disabled persons.[12]

Periodontal health in Down syndrome patients is affected by a variety of factors of which systemic factors include dysfunctions of neutrophils and T lymphocytes, increase in inflammation-inducing mediators, and gingival hyperinnervation, whereas local factors include the habit of breathing through the mouth, the morphology of teeth, inadequate oral hygiene, and composition of oral biofilm microflora.[13]

Among soft-tissue defects, macroglossia has been reported from subjects suffering from Down syndrome. This abnormality of the tongue has been attributed to abnormalities in lymphatic drainage.[14]

A total of 34% of patients affected with Down syndrome report congenitally missing teeth of which the most frequent are third molars, then second premolars, and incisors.[15]

Patients with Down syndrome show a significant amount of staired or shelf-like palate demonstrative of narrow width, short depth, and lesser height. The most important factors found in these subjects that are associated with malocclusion are anterior open bite, spacing between teeth, temporomandibular joint dysfunctioning, deviation along the midline, bruxism of teeth, agenesis of teeth, delay in tooth eruption, thrusting of the tongue, hypotonic temporomandibular joint ligaments, platybasia, reduced development of mid-facial complex, and altered skeletal jaw inter-relationships.[16]

Mental retardation has been defined as per the "American Association of Mental Deficiency (or AAMD)" as a defect or insufficiency in the theoretical type of intelligence which may be either congenital or acquired in the early phase of life." It has classified mental retardation into fourtypes based upon an individual's Intelligence Quotient (IQ) into- a) Mild, b) Moderate, c) Severe, and d) Profound type of mental retardation. An individual can be categorized as being suffering from a mild form of mental retardation if his or her IQ score is ranging between 50 and 40; b) Moderate type: If the mental retardation ranges between 35 and 40; c) Severe type: If it ranges between 20 and 35, and d) Profound type: If the IQ score ranges between 20 and 25.[17]

Most subjects diagnosed with Down syndrome are classified as "traumatic mental retardation" though they suffer from both motors along with cognitive development. Decreased development in motor skills among patients with Down syndrome is the result of hypotonic musculature.[18,19]

It has been estimated that there is a prevalence of 8.72 subjects who are diagnosed with Down syndrome per 10,000 population every year.[20]

Thus, based upon the above background, the aim of the current study was determined to study the prevalence of clinical implications of Down syndrome on oral health status.

Materials and Methods

This was a descriptive and cross-sectional analytical study that was conducted for a period of 1 year i.e. from January 2020 to

December 2020. It included children diagnosed with Down Syndrome who were attending various specialized institutions designated for individuals with special needs. At the time of conducting this study, a total of 100 children suffering from Down syndrome (age range between 5 and 16 years) were selected as study participants. Inclusion criteria incorporated for subject inclusion were (a) cytogenetic confirmation of trisomy 21; (b) appropriate cooperative behavior by selected children, and (c) written informed consent obtained from the subject's legal guardians, whereas exclusion criteria for this study were (a) debilitating systemic diseases; (b) any other disability causing the condition, and (c) Down syndromic children who were extremely uncooperative.

Ethical approval for conducting this study was obtained from the appropriate Research and Ethics Committee of the institute. Following this, before performing a clinical examination, appropriate and well-documented consent for participation in this study was obtained from both parents or legal heads.

Clinical oral examination was performed by a single calibrated examiner in the selected institutions using the following armamentarium: artificial light source, ordinary mouth mirror, and William's periodontal probe. The gingival health status of the selected study subjects was evaluated using the gingival index (GI) as Loe and Silness, whereas the calculus index (CI) described by Ramfjord, and plaque index (PI) by Silness and Loe was used to determine the oral hygiene status. Before performing oral health examination, demographic data was derived from all subjects regarding a person's date of birth, age, schooling; gender, and address.

Information involving oral hygiene maintenance practices, diet-related information, and parental educational level was obtained from each participant's parents.

Intelligence Quotient (I. Q.) levels of each subject were recorded which were determined by assessment of selected children suffering from Down syndrome. Based upon their intelligence quotient (I. Q.) values, the children were categorized into three groups: a) Mild (I.Q. level = 50–70), b) Moderate (I. Q. level = 35–50), and c) Severe (I. Q. level ≤ 35).

Statistical analysis was performed using the statistical software tool Statistical Package for Social Sciences (SPSS) version 20.0 for marking the entry of data and its subsequent, statistical analysis. Qualitative data were recorded in form of frequencies and percentages, whereas quantitative data were recorded in form of mean and standard deviation. All categorical outcomes were analyzed using the Chi-square test, whereas quantitative outcomes (Calculus Index, Gingival Index, and Plaque Index) were analyzed by utilizing either student's *t*-test or one-way analysis of variance (ANOVA) wherever appropriate.

Socio-demographic characteristics and clinical variables such as age, gender, frequency of brushing of teeth, parental educational background, and the level of IQ, and indicators of oral hygiene (Calculus Index, Plaque Index, and Gingival Index) were recorded and analyzed. A significant cut-off value of $P < 0.05$ was fixed.

Results

A total of 100 study participants aged between 6 and 16 years with a mean age of 09.52 ± 1.78 were included as the study sample. Approximately two-thirds (65.2%) of the study subjects were of the male gender. Whereas most of these subjects (68.2%) were found to suffer from a moderate level of mental retardation.

(I) Profile of study participants with Down Syndrome:

Approximate 64% of the study participants (n = 64) had reported regular brushing of teeth either once daily (n = 47) or twice daily (n = 53). The most commonly used device for cleaning teeth were a toothbrush (65.2%), which was followed by the use of digit (13.7%) and neem sticks (21.1%).

(II) Oral health status of study participants:

On average, the calculus index (CI), plaque index (PI), and gingival index (GI) of the entire study population were found to be 0.65 ± 0.51, 1.76 ± 0.78, and 1.58 ± 0.68, respectively. No significant statistical difference among genders was found ($P > 0.05$). The 12 to 16 years age range was found to have statistically significantly greater Calculus Index, Gingival Index, and Plaque Index scores when compared to younger age study subjects ($P < 0.01$) [Table 1]. The subjects with severe mental retardation had significantly higher Plaque Index ($P < 0.001$) and Gingival Index ($P < 0.04$) scores when compared to subjects with mild and moderate mental retardation although no significant differences on comparison of Calculus Index were observed [Table 2 and Graph I].

(III) Sociodemographic characteristics and oral hygiene status:

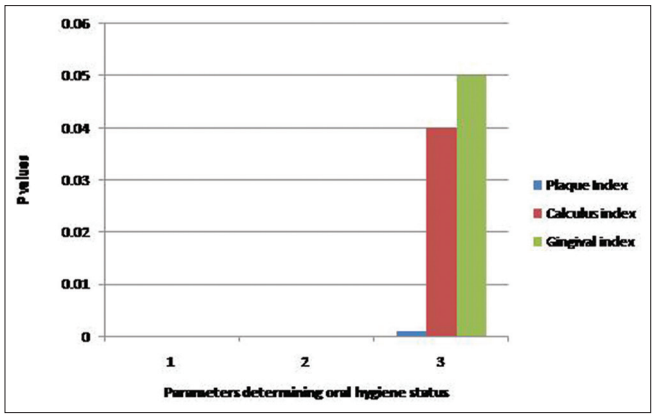
Step-wise multiple linear regression analysis showed that the best predictive indicators for Calculus Index were subject's age and maternal education level (43% variance). The independent predictive indicators of Plaque

Table 1: Table demonstrating oral health status of Down syndrome affected children in the study

Parameters for studying oral hygiene status	6-12 years (mean±SD)	12-16 years (mean±SD)	*P*
Calculus Index	0.45±0.01	0.75±0.21	
Plaque Index	1.06±0.65	3.86±0.89	<0.01
Gingival Index	1.04±0.08	2.07±0.71	

Table 2: Table demonstrating levels of mental retardation and oral hygiene parameters studied

Oral hygiene parameters	*P* on comparing mental retardation levels)
Plaque Index	<0.001
Calculus Index	<0.04
Gingival Index	>0.05



Graph 1: Graph demonstrating oral hygiene status parameters studied and their *P* values after comparison with various levels of mental retardation

Index (32.1% variance) were intelligence quotient level, subject's age, and paternal education level, wereas the best indicators suggestive for Gingival Index were found to be subject's age, intelligence quotient level, and maternal educational status (23.6% variance).

Discussion

Down syndrome is the most commonly found autosomal dominant trait among humans. It was first discovered in 1895 by Lejeuine.[3] However, it is named after John Langdon Down who first described it in 1866. This genetic defect occurs during organogenesis during the first trimester of pregnancy.

The most common genetic cause of intellectual disability in Down syndrome is caused by a partial or complete triplication of the human chromosome 21. Oxidative stress (OS) is one of the most important neuropathological processes responsible for the cognitive alterations and the deficits in neuronal function in Down syndrome. Brain tissue can be more susceptible to undergoing elevated levels of OS than other tissues because it is rich in fatty acids which are ideal biomolecules for peroxidation processes, it contains low concentrations of antioxidant enzymes, and it is also characterized by a high aerobic metabolic rate.[21]

In our study, the majority of study participants suffered from moderate levels of mental retardation (68.2%). Our data demonstrates a higher percentage of subjects with a moderate degree of mental retardation when compared to other studies as described in the following text.

Amira *et al*.[22] in 2019 in their cross-sectional analysis of 174 subjects suffering from Down syndrome aged above 14 years reported that only 8.6% of the studied sample suffered from a severe type of gingivitis, whereas 47.2%, 40.8%, and 3.4% of the studied sample suffered from mild, moderate, and no clinical gingivitis.

Shukla *et al*. (2014) in their prevalence cross-sectional study analysis reported that 82% of the studied sample size was male. On analyzing the Intelligence Quotient (IQ) score, it was seen that 52% of the subjects suffered from mild levels of mental disability, whereas 31% had a moderate level disability score. A total of 22% of Down syndrome patients had both speech as well as hearing problems. A total of 12% of the study population had teeth missing, whereas 15% exhibited both speech along with hearing defects. A total of 16% of Down syndrome patients had Community Periodontal Index for treatment Needs (CPITN) Score of 4 which was indicative of complicated treatment needs. A total of 97% of the affected subjects had class III type of malocclusion. A total of 14% had fracture teeth of the anterior quadrant variety, namely the central incisors were the most commonly affected. A total of 90% of affected individuals had hyper-brachycephalic and brachycephalic varieties of head shapes. Fracture of maxillary incisor teeth has been reported by various other investigators as well.[23]

A total of 64% of the study participants had reported a regular brushing habit either once or twice daily. Subjects falling under the 12 to 16 years age group were found to have higher Calculus Index, Gingival Index, and Plaque Index scores when compared to younger age patients with extremely significant *P* value (<0.01). Those suffering from the severe grade of mental retardation had statistically significant ($P < 0.001$) Plaque Index and Gingival Index ($P < 0.04$) scores on comparing with patients diagnosed with mild and moderate mental retardation. However, no significant differences in comparing Calculus Index were noted. Our findings have been supported by numerous investigators as describe below.

Al Bandary H. Al Jameel *et al*.[24] conducted a study to examine the perceptions of mother on the oral health issues experienced by their children with Down syndrome. It was concluded that the predominant oral health–related problem reported by mothers was difficulty in speaking. Mothers also reported that tooth decay and toothache were problems that had undesirable effects on different aspects of their children's QoL including performing daily activities, emotional wellbeing, and social relationships.

Leah I. Stein Duker *et al*.[25] investigated the oral care experiences and challenges encountered by children with Down syndrome. It was found that the children with Down syndrome experienced difficulties and barriers to care in both the home and dental office settings.

Ghadah *et al*. (2014) in their study on Yemenese children diagnosed to be suffering from Down syndrome demonstrated that there was a wide presence of poorly maintained oral hygiene and gingival health. Mean Calculus Index, Plaque Index, and Gingival Index scores of the studied population were recorded as 0.58 ± 0.61, 1.45 ± 0.57, and 1.54 ± 0.64, respectively which were much higher than those of the healthy control subjects.[26]

Jain *et al*.[27] (2009) investigated oral health status among subjects diagnosed with Down syndrome. It was observed that the most

important predictors for oral health status in these individuals were a) low Intelligence Quotient (IQ) level and b) low educational level. Also, 37.3% of the studied Down syndrome sample was found to be affected with severe mental retardation. A total of 60% of the study subjects were suffering from cerebral palsy. However, no deep periodontal pockets were found in the studied population. In contrast, 22.7% of the individuals had shallow periodontal pockets. There are conflicting reports on the occurrence of dental caries in children suffering from Down syndrome.

Oredugka and Akindayomi (2008) reported that 83.3% of affected patients with Down syndrome have class I Angle malocclusion, whereas 11.1% and 5.6% had class II and III Angles malocclusion. A total of 16.7% of affected individuals had hypoplastic enamel.[28]

Wilson (1999) reported the occurrence of microdontia in 46% of Down syndrome patients.[14]

Ondarza and his coworkers in 1995 reported a higher prevalence of malalignment in both primary as well as permanent dentitions among individuals with Down syndrome. Most often involved teeth reported were incisors (both central and lateral) and canine. Both anterior as well posterior crowding of teeth was seen, especially affecting the maxilla due to its underdevelopment.[29]

Jesse R. Willis *et al*.[30] conducted a study to evaluate the oral microbiome in down syndrome and its impact on oral health. It was found that there was a significant difference in the overall composition of oral microflora of Down syndrome patients and non-Down syndrome individuals. Down syndrome is associated with low salivary pH and less diverse oral microbiomes, which were characterized by lower levels of *Alloprevotella, Atopobium*, Candidatus Saccharimonas, and higher amounts of Kingella, Staphylococcus, Gemella, Cardiobacterium, Rothia, Actinobacillus, and greater prevalence of Candida.

Implications for clinical practice

Patients with Down syndrome are predisposed to characteristic deficiencies in oral function although these vary between individuals. The development of functional difficulties is not inevitable if these problems are recognized and managed at an early age and if there is a longitudinal follow-up as the person develops. Techniques of feeding can be taught to parents that help to establish normal oral praxis in the first years of life. The treatment of these patients must involve a multidisciplinary approach, including a pediatrician, a dietician, a speech therapist, a physiotherapist, an ergotherapist, and a dentist.[31]

Conclusion

In the present study, it was found that the oral hygiene status of children with Down Syndrome was extremely poor and was influenced by factors such as patient's ages intelligence quotient (I. Q.) level, and parental educational level. Thus, programs pertaining to oral health promotion should be initiated at institutions for children with special needs, and parents of these children should be educated.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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