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Cariogram as an Educational Tool for Reducing the Caries Risk among the Differently Abled Children - Case Series

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Abstract: ***Background*** *Cariogram as an effective tool for assessing caries risk, has been demonstrated in many studies. But its application in special children has not been reported.* ***Aim*** *To assess the effectiveness of Cariogram as an oral health educational tool in reducing caries risk of differently-abled subjects.* ***Settings and Design*** *Dental College, Case series.* ***Methods and Material*** *Eight disabled children were enrolled in the study. As a health educational tools Cariogram was used to educate caregivers about interplay of various risk factors in causing dental caries. Followed by tailored diet counseling and oral health advice were delivered. Intervention was given as per Cariogram's instructions. Changes in oral health maintenance and caries risk were assessed after six weeks.* ***Resulst*** *There was significant reduction in caries risk after six weeks of intervention in all subjects.* ***Conclusion*** *Cariogram software could be used as an effective health educational tool.*

Keywords*: Cariogram, Disabled children, Caries risk, Educational tool*

I. Introduction

"Differently abled" is a wider term which includes all those who suffer from malformations, deformities and other deficiencies - physical or mental which prevent them functioning at optimum level. The definition of differently abled given by the United Nations is: "A person unable to ensure by himself or herself, wholly or partly, the necessities of normal individual and / or social life as a result of deficiency, either congenital or not, in his or her physical or mental capabilities"[1].

Roughly, 10 percent of the world's population is mentally or physically disabled. According to the recent WHO estimate the figure may be higher. By the end of the last century there was an estimated 800 million disabled people of whom 250 million were children. The most prevalent forms of disability are physical impairment, chronic illness, mental retardation. The recent National Sample Survey Organization report suggests that the number of disabled persons in the India is estimated to be 18.49 million, accounting for about 1.8% of the total population, while the mentally retarded population amounted to 0.44 million individuals [2].

Common oral problems, such as tooth decay or gum disease, affect all children. However, children with disabilities and other special needs have more oral health problems than the general population. Data indicate that people who have some or other disability have more untreated caries and a higher prevalence of gingivitis and other periodontal diseases than the general population [2]. The prevalence of untreated dental caries is higher in these people due to high carbohydrate diet, poor oral hygiene, inadequate brushing, sometimes dry mouth, apertognathia, and other oral syndromes. This could be accompanied by oral habits like mouth breathing, lip biting, thumb sucking. Children with disabilities may have impaired cognitive abilities, behavioral problems, impaired mobility, neuromuscular problems, uncontrolled body movements, gastroesophageal reflux, or seizures [2].

Despite the dramatic decline in caries prevalence over the past 30 years, caries remains one of the most common & important aspects of dental practice. Low prevalence and skewed distribution of disease have led some investigators to argue for a high risk targeted approach to diagnose and treat dental caries [3]. Using the high risk approach, the goal would be to identify highly susceptible persons such as disabled subjects, and to use efficacious tailor made individualized preventive measures to diminish their risk. Over the past few decades, several researches have dwelt on caries risk assessment and to predict which individuals would develop caries in the near future, thereby enabling targeted preventive measures [4].

Various models far predicting caries risk have been developed with good results. One such model is the Cariogram developed by in 1996 by Brathal et al [5]. This Cariogram model is a graphical picture illustrating in an interactive way the patient's risk for developing new caries, simultaneously expressing to what extent different etiological factors of caries affect the caries risk for that particular patient and provides target preventive strategies for those individuals. Cariogram was drawn up to emphasize the fact that caries can be controlled by several different means.

Kidd states that, "Changing patient's behavior is cornerstone of preventive treatment" [6]. Therefore patient education emphasize on knowledge of risk factors and measures to avoid them. Knowledge of risk factors gives the patient an opportunity to reflect over his/her situation and an option to take a personal responsibility for their future oral health. In this context, Cariogram can be used as an effective patient education tool. The patient's own Cariogram profile can be used to explain how best the futuristic occurrence of new carious lesions can be avoided by modifying the existing different risk factors.

The caries risk among young people decreased from high (75%) to medium (49%) after dental health instruction & visual presentation of caries risk profile by Cariogram [7]. Zukhanovic Amila et al demonstrated that the cariogram model can be successfully used in determining caries risk profiles for 12 year old children of different socio-economic status & can be used in developing preventive strategy for reducing caries risk children[8].

The benefits derived from this model in terms of improving the oral health of high-risk group such as differently abled children have not been well studied. The purpose of this study was to evaluate the changes of the caries risk & weighted impact of different etiological factors on the caries risk after intervention (tailored diet counseling, oral health instructions, preventive & curative treatments) in differently abled children.

II. Methodology

An informal experimental study was conducted with the aim to assess the effectiveness of Cariogram as an oral health education tool among 7- 21 year old differently abled subjects from selected special school of Bangaluru city.

Permission to conduct the study was obtained from the school authorities. The study proposal was submitted for approval and clearance was obtained from Institutional Review Board for Human Ethics, M.S. Ramaiah dental college and Hospital- Bangalore. Written informed consent was obtained from the parents/guardian participating in the study before the beginning of examination. Source of the study subjects was "Nanna Mane Special Academy" a special school for disabled children in Bengaluru city, India. 7- 21 year old 8 differently abled children participated in the study; children who are un-cooperative in an oral inspection & intervention were excluded. Prior to conducting the study, the investigator was calibrated for clinical examination under the guidance of the Professor in order to minimize the intra examiner variability. Parents/guardian of each participants was interviewed to gather the information regarding oral hygiene habits, particularly any type of systemic or chronic illness that could directly or indirectly affect oral health, frequency of tooth brushing and the use of fluoridated toothpaste and mouthwashes.

A specially prepared and pretested proforma, exclusively designed for recording all the relevant data pertaining to general information, clinical findings, salivary parameters along with the microbiological investigations. The caries experience was assessed using DMFT index described in WHO Oral Health Survey [9] and plaque amount was assessed using plaque index – Silness and Loe plaque index [10]. Since participants were in mix dentition phase, permanent 1st molar was taken as substitute for 1st premolar. To examine dietary habits, one-week diet history was recorded, and then number of meals and snacks were taken into consideration for seven consecutive days including one weekend. Even a small snack - a biscuit or a sweet was considered. However, a snack of sugar-free and starch free ('tooth-safe') products, or water, was not be taken into consideration. One-week diet chart also used to assess consumption of Fermentable carbohydrates (mainly sucrose, glucose, fructose, and cooked starches, which can be broken down rapidly by salivary amylase to fermentable sugars).

Clinical examination of the study subjects was done after obtaining the general information, following this saliva sample was collected. The examination was conducted on the dental chair. All the parents were given clear instructions to refrain children from eating for one hour before collection of saliva. After recording the general information, unstimulated whole saliva was collected after clinical examination. A sterile disposable syringe (without needle) was used to collect 1 ml of saliva from the serum vial and immediately transported to the Microbiological laboratory, where it was processed. pH indicator strips were used to check saliva buffer capacity. Mutans streptococci bacterial count was interpreted as: 0= Very low, < 104 CFU/ml; 1=Low, > 104-105 CFU/ml; 2=Moderate, >105 to 5 x 105 CFU/ml; and 3=High, >5x105 to 106 CFU/ml

Data obtained from the each individual assigned a value on a scale from 0 to 3 (0 to 2 for some factors) according to predetermined criteria. 0 is the most favorable score and the maximum '3' indicates an unfavorable risk. The variables that make up the Cariogram and the values assigned to them are shown in Table 1. In the present study, a Cariogram chart was drawn up for each of the individuals examined, score for Clinical Judgment was assign as '1' in all cases in order to give a standard value. All the assigned values entered into Cariogram software. Which gave a pie chart for each participant, with the data expressed as percentages of 'Caries risk' and 'Chance to avoid caries'.

Table 1. Caries-related factors according to the Cariogram

Factor	Information to be collected	Cariogram score
Caries experience	DMFT, new caries experience	0=DMFT 0 1=DMFT 1 2=DMFT 2 3=DMFT >3
Related general diseases	Medical history, medications	0 = no disease, healthy 1 = A general disease which can indirectly influence the caries process to a mild degree. E.g. physically or mentally handicapped, chronic medications. 2 = A general disease which can indirectly influence the caries process to a high degree. e. g. bedridden patient.
Diet content	Diet history (or lactobacillus test): quality of diet	0=Very low fermentable carbohydrate, Extremely good diet from caries perspective. Exposure to sugar only once in a day. 1=Low fermentable carbohydrate, appropriate diet, exposure to the sugar twice in a day. 2=Moderate fermentable carbohydrate, relatively high content of sugar. Exposure to sugar thrice in a day. 3=High fermentable carbohydrate, inappropriate diet, exposure to sugar > 3 times in a day.
Diet frequency	Quantity of dietary intake	0= maximum 3 meals per day[including snacks] 1=maximum 5 meals per day 2=maximum 7 meals per day 3=more than 7 meals per day
Amount of plaque	Silness-Löe plaque index	0 = No plaque 1 = The plaque may be seen in situ only after application of disclosing solution or by using the probe on the tooth surface. A thin film of plaque adhering to the free gingival margin and adjacent area of the tooth 2 = Moderate accumulation deposits within the gingival pocket, or the tooth and gingival margin which can be seen with naked eye 3 = Abundance of soft matter within the gingival pocket and/or on tooth and gingival margin
Streptococcus mutans	SM Strip mutans test	0= Very low, < 104 CFU/ml 1=Low, > 104-105 CFU/ml 2=Moderate, >105 to 5 x 105 CFU/ml 3=High, >5x105 to 106 CFU/ml
Fluoride program	Fluoride exposure	0=Receives "maximum" fluoride program (fluoride tablets, tooth paste, topical fluoride application) 1= Additional fluoride measures (other than tooth paste) 2= Fluoride tooth paste only 3= Avoiding fluorides, no fluoride.
Saliva secretion rate	Unstimulated saliva	0=More than 0.7. ml/min 1=0.5 – 0.7 ml/min 2=0.3- 0.5ml/min 3=Very low< 0.3mi/min
Saliva buffering capacity	pH strips	0=Adequate [strip green] 1=Reduced, [strip yellow] 2=Low [red strip]
Clinical judgement	Opinion of dental examiner; the examiner's own clinical and personal score for the individual patient	0: More positive 1: Normal setting 2: Worse 3: Very high caries risk

Table 2. Shows the interventions aimed to reduce the dark blue, red and light blue sectors of Cariogram

Sectors of Cariogram	Intervention
Dark blue sector	Health education
Red sector	Oral prophylaxis and elimination of plaque retentive areas
Light blue sector	Fluoride therapy

All parents/guardians of disabled subjects received their educational counseling, assisted along with pictorial representation of the caries risk assessment of the individual risk factors and their effect on caries risk profile. Health education was based on Health Belief Model [12-14]. Component of health education based on Health Belief Model are given in table 3.

Table 3. Components of health education based on Health Belief Model and their description

Components	Description
Susceptibility:	My child could develop dental caries.
Severity:	Dental caries is a serious disease and can lead to pain, halitosis, loss of teeth, which may affect my child's life
Beneficial:	There are specific things I can do, such as recommended brushing method, restriction on between meal snacking, routine dental visit, prescribed home care regimens, which will prevent dental caries.
Benefit Outweigh Barriers:	It is worth the extra time I spend to take care my child's teeth and mouth to be free of the threat of dental caries.

The basic education revolved around the Cariogram interpretation of risk factors and includes counseling about General information about oral anatomy and dental anatomy.Caries as a disease.

Role of carbohydrates as and their impact on dental caries. Mid meal snacking and their impact on dental caries.

General oral hygiene practices – ways and means Fluoride and their importance.

For all subjects based on their clinical findings treatment was provided. The treatment was mainly concentrated on removal of plaque, calculus and eliminating plaque retentive areas by oral prophylaxis and restoration of untreated dental caries. Oral prophylaxis included, scaling, root planing, reshaping and polishing of old plaque retentive restorations, restoring the dental caries with Type-9 GIC material. For the further clinical treatments subjects were referred to the respective specialists. Topical fluoride in the form of fluoride varnish (Bifluorid 12) was applied. Parents were advised to use fluoridated tooth paste for their children routinely. Parents/guardians were instructed to revisit after six weeks for the follow-up.

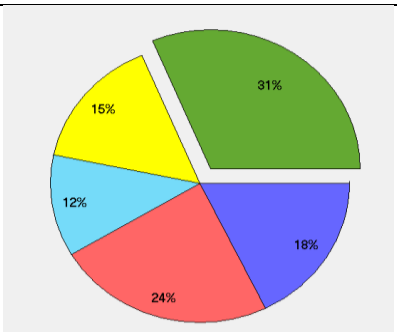
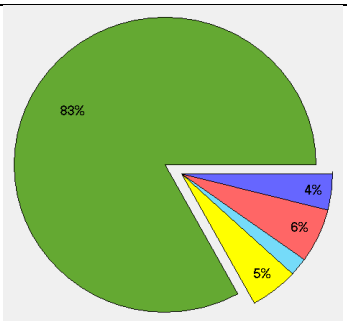
III. Result

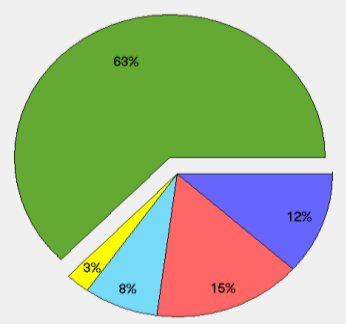
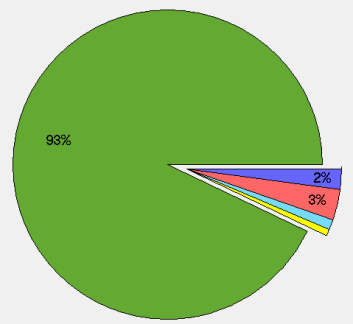
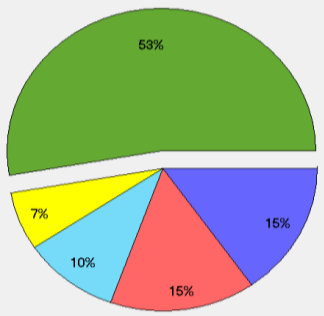
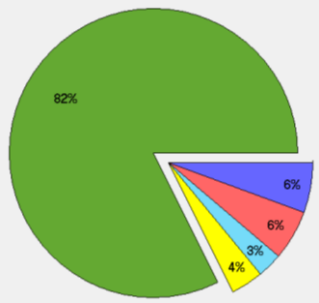
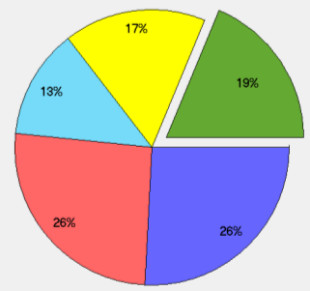
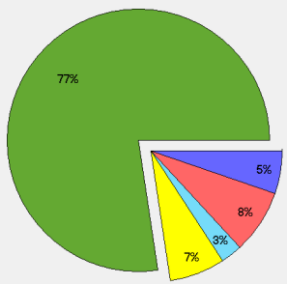
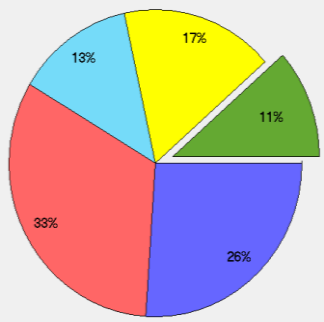
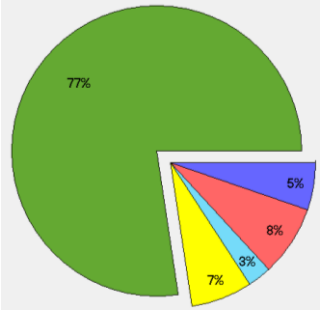
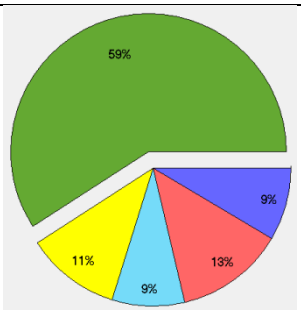
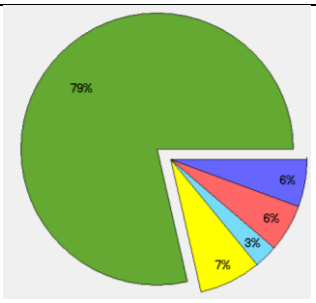
In the present study, seven male and one female disabled children were participated. Most of them are mental retardation, two were with Attention Deficit Hyper Activity Disorder, and one of them was with Downs syndrome. Their age ranged between 9-21 years.

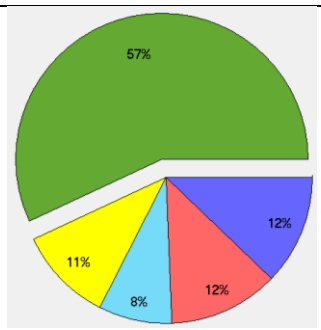
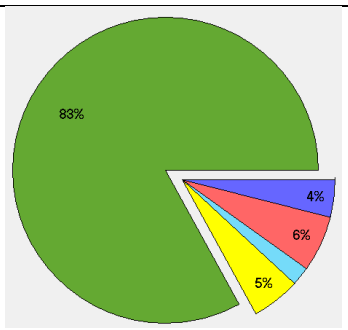
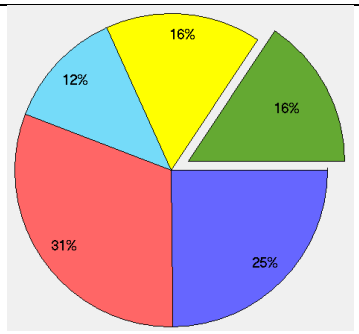
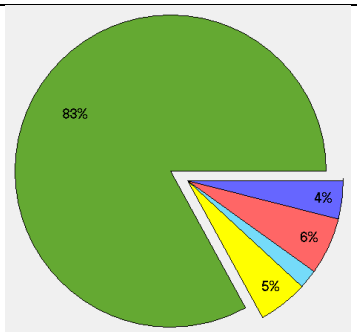
Table 4. Describes demographic details of participants

Patient No.	Age (years)	Gender	Medical history
1	10	Male	Attention deficit hyper activity disorder
2	17	Male	Down's syndrome
3	12	Male	Mental retardation, Atrial Septal Defect
4	21	female	Mental retardation
5	13	Male	Mental retardation
6	9	Male	Attention deficit hyper activity disorder
7	21	Male	Mental retardation
8	16	Male	Mental retardation

Table 5. Before and after treatment pie diagrams of participants as per Cariogram

Patient No.	Pie diagram of before treatment	Pie diagram of after treatment
1		

2	 63% 12% 3% 8% 15%	 93% 2% 3%
3	 53% 7% 15% 10% 15%	 82% 6% 6% 3% 4%
4	 17% 19% 13% 26% 26%	 77% 5% 8% 3% 7%
5	 13% 17% 11% 33% 26%	 77% 5% 8% 3% 7%
6	 59% 9% 11% 13% 9%	 79% 6% 6% 3% 7%

7		
8		

IV. Discussion

"Differently abled" is a wider term which includes all those who suffer from malformations, deformities and other deficiencies - physical or mental which prevent them functioning at optimum level. Roughly 10 percent of the world's population is mentally or physically disabled. Data indicate that people who have some or other disability have more untreated caries and a higher prevalence of gingivitis and other periodontal diseases than the general population [2-4, 7, 11]. The prevalence of untreated dental caries is higher in these people due to high carbohydrate diet, poor oral hygiene, inadequate brushing, sometimes dry mouth, apertognathia, and other oral syndromes. A study of 3- 14 year old disabled showed that disabled children had the poor oral status and high caries rate. Many other studies here and elsewhere showed similar, obvious connection between disabilities and high values of caries prevalence [15-21].

The present study was conducted to find the solution for the prevention of dental caries in disabled children. Dental caries could be controlled by strict oral hygiene measures, diet modifications and fluoride therapy. For this to implemented parents/guardians' role is crucial. To be effective, care takers should be equipped with though knowledge and attitude towards maintenance of oral hygiene and good diet practice of their child. Knowledge of risk factors gives the parents an opportunity to reflect over their child's situation and an option to take a personal responsibility for their child's future oral health. In this context Cariogram can be used as an effective educational tool.

In the present study, the Cariogram model was used to predict caries risk and as a health education aid in educating parents/caregiver of disabled children. The advantage of the Cariogram model is that it detects and defines caries-risk of individuals under precise and constant criteria. It is a useful pedagogic tool for dentists, dental hygienists and assistants in discussions with patients/care givers.

In the present study 50% of the subjects had moderate and 50% had high risk for caries development. The dominant caries risk sector in all the subjects was bacteria, followed by diet, susceptibility, and circumstances. Their brushing habits were satisfactory but because of their dietary habits and poor motor control over brushing, the oral hygiene was poor. These factors intern had significant impact on the bacterial sector. The second largest risk factor after bacteria was diet. Since dietary habits of disabled would be unpredictable, a seven days diet chart was considered for evaluating diet frequency and contents. In view of the fact that, subjects were uncooperative and not able to follow the instructions for stimulated saliva collection, un-stimulated saliva was considered for salivary flow rate, buffer capacity and micribiological assessment. As per Brathol et al, in measuring the saliva flow rate, one can either choose un-stimulated or stimulated saliva secretion. They are often but not always co-related [5].

Preliminary measures and interpretations as highlighted by Cariogram as per the particular subjects' caries risk factors were analyzed and necessary steps to improve the green sector or to reduce the caries risk in near future were undertaken. Interventions were addressed to each sectors and related factors to improve the

green sectors. To reduce dark blue sector or to address factors related to Diet, Health education based on health belief model and tailored dietary advice were considered. Health education module was prepared on the bases of constructs and concepts of Health Belief Model. Visual aid power point slides were prepared to use as a health education aid. Brushing technique was demonstrated using teeth model and brush. Diet chart was analyzed for cariogenic diet amount, frequency, and consistency. Tailored dietary advice was delivered based on the individual assessment.

To reduce the red sector, interventions aimed to reduce the plaque score and elimination of plaque retentive areas such as professional oral prophylaxis, restoration of decayed teeth and examining old restoration for plaque retentive areas and secondary caries followed by necessary treatment were undertaken. For restoration of decayed teeth GIC- type 9 cement was chosen. GIC is moisture friendly and also relies fluoride over a period of time which were requirements for the restorative material of choice for disabled children. GIC address both problem of moisture control and risk of secondary caries around restoration. To reduce light yellow sector of susceptibility, professionally applied topical fluoride therapy, Fluoride varnish was chosen. As there were risk of aspiration, problem in following instructions and isolation, fluoride varnish was opted as a topical fluoride therapy.

In the present study, improvement in chance of avoidance was significant in all the subjects. This could be attributed to effectiveness of health education, tailored dietary advice, and provision as per the Cariogram instructions. Adding to the above, follow-up period was six weeks after the intervention which could have also influenced the better results.

Main strengths of the study are, health education was based on sound scientific theory, Health Belief Model, which is well suited for changing risk-seeking behaviours. Power point presentation to explain role of diet on dental caries and oral hygiene maintenance; to show the subjects specific risk factors Cariogram software was used. In addition to these diet analysis was made on seven-days diet chart followed by tailor-made dietary advice was provided.

Follow-up period was short to assess the chance in caries risk profile. Follow-up period of six week was chosen with purpose to assess the improvement in oral hygiene maintenance procedures, so that, reinforcing and correcting oral hygiene measures and dietary advice as soon as possible for better improvement in attitude of care-givers. At this stage parents/guardians could be motivated by presenting improvements in the green sector of Cariogram. In addition to the above limitation, involvement of school staff in the health education was lacking, which could have added in improvement of the oral hygiene and maintenance of dietary habits of disabled subjects. To overcome above limitations a randomized controlled trial with larger sample size and long term follow-up have to be conducted to assess the effectiveness of Cariogram as an health educational aid in reducing caries risk of disabled subjects. In addition, school authorities also should be included in health education, as disabled subjects spend their considerable time in school/institute for disabled persons.

V. Conclusion

Cariogram software could be used as an effective health educational tool in changing the parents'/caregivers' attitude and behaviours towards good oral hygiene and dietary habit maintenance.

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