

Prevalence and Severity of Dental Caries Among 3-6 Year Old Anganwadi Children of District Faridabad using International Dental Caries Detection and Assessment System II

**Meenakshi Chopra¹, Charu Mohan Marya², Sachin Chand³, Abhinav Bhargava⁴,
Shilpa Kamra⁵, Neetu Gupta⁶**

¹Reader, Department of Public Health Dentistry, SGT Dental College, Hospital and Research Institute, SGT University, Gurugram, Haryana, India

²Professor & HOD and Principal, Department of Public Health Dentistry, Sudha Rustagi College of Dental Sciences and Research, Faridabad, Haryana, India

³Associate Professor, Department of Public Health Dentistry, SGT Dental College, Hospital and Research Institute, SGT University, Gurugram, Haryana, India

⁴Senior Lecturer, Department of Public Health Dentistry, SGT Dental College, Hospital and Research Institute, SGT University, Gurugram, Haryana, India

⁵Senior Lecturer, Department of Periodontology, SGT Dental College, Hospital and Research Institute, SGT University, Gurugram, Haryana, India

⁶Senior Lecturer, Department of Orthodontics, Sudha Rustagi College of Dental Sciences and Research, Faridabad, Haryana, India

E-mail: ¹chopra2486@gmail.com

Corresponding Author Name: Dr. Meenakshi Chopra

E-mail: chopra2486@gmail.com

Abstract

Aim: To assess the prevalence and severity of dental caries in the primary (deciduous) dentition of 3-6 year old children attending Anganwadi centers of District Faridabad using the diagnostic criteria of the International Dental Caries Detection and Assessment System (ICDAS) II.

Materials and Method: A cross-sectional study was conducted among 3-6 year old Anganwadi children using criteria of the ICDAS. Clinical examinations of 350 children were conducted by single examiner who was previously trained in the ICDA and the intra examiner kappa values was found to be ≥ 0.79 for all codes of ICDAS. For the analysis, the SPSS, version-14 was used. The ICDAS II codes were converted into: the d-component consisted of (a) d₂₋₃ component comprising ICDAS II codes 2, 3; (b) d₄₋₆ component comprising ICDAS II codes 4, 5, 6; (c) d₂₋₆ component comprising ICDAS II codes 2-6. The prevalence of different ICDAS II codes and d₂₋₃(enamel caries), d₄₋₆ (dental caries) & d₂₋₆(enamel and dental caries) were compared across different age groups and gender using <http://annalsofsrcb.ro>

chi-square test. To compare the severity of the disease among different age groups and gender, ANOVA and unpaired Student's t-test was used respectively.

Results: The prevalence of dental caries among Anganwadi children was found to be 38.0%. The prevalence of d_{2-3s} (enamel lesions), d_{4-6s} (dentinal lesions), and d_{2-6s} (enamel and dentinal lesions) in the present study was 21.4%, 23.1% and 40.6% respectively. The mean score d_{2-3s} (enamel lesions), d_{4-6s} (dentinal lesions), and d_{2-6s} (enamel and dentinal lesions) in present study was 0.68 ± 1.57 , 0.43 ± 1.07 and 1.66 ± 3.12 respectively. Among males and females, only the mean number of surfaces affected from code 3 (Localized Enamel Breakdown) was found to be significantly more among males as compared to females. The prevalence of d_{2-3s} (ICDAS II score 2-3, enamel lesions) was found to be significantly more among males as compare to females (p -value <0.05)

Conclusion: Caries prevalence was low in preschool children attending Anganwadi centers but there was accumulation of unmet needs due to poor access to dental services. So, there is need of appropriate preventive approaches to reduce the burden of disease.

Key Words: ICDAS, Dental caries, Anganwadi children

I. INTRODUCTION

Early childhood caries (ECC) is a serious socio-behavioral and dental problem that afflicts infants and toddlers.^{1,3} ECC can rapidly destroy the primary dentition of toddlers and small children and if left untreated, can lead to pain, acute infection, nutritional insufficiencies, learning and speech problems. Dental caries in primary dentition not only deteriorates quality of life of young children but it can also affect the permanent dentition.^{17,24,25} Dental caries is a serious public health problem especially in socially disadvantaged groups in both developed and developing countries, with India being no exception.^{5,6,21} In a developing country like India, the government has initiated a programme known as the Integrated Child Development Scheme (ICDS) which is intended to deliver a package of basic health services to children less than six years of age. Under the ICDS, there is a social worker known as an Anganwadi Worker for a population of 1000 people, with responsibilities of organizing informal, preschool education in Anganwadi Centers for children of 3 to 5 years of age.⁷ But the dental health of preschool children has been neglected in official health policies, since it is not considered an important part of their well-being or general health status.^{2,9,20,22} The preschool period is very important in respect to oral health because oral health of an individual is developed in this period and again preventive factors established during this age will determine the person's dental health for many years to come. To assess the burden of the dental caries in Indian preschool children, all of the previous surveys practically used the DMFT/S Index where only teeth or surfaces with cavitated lesions extending into the dentin have been counted.^{14,16,27} With the emergence of minimally invasive treatment modalities which helps in the remineralization of teeth, a need was felt for the diagnosis of the caries at initial level (non-cavitated lesions) so that at early stage preventive measures could be taken. An evidence based criteria which would permit standardized caries detection and diagnosis in different environments and circumstances led to the development of International Caries Detection and Assessment System (ICDAS).⁴ ICDAS integrates several new criteria systems for caries detection. It was designed to detect six stages of the carious process, ranging from the early clinically visible

changes in enamel caused by carious demineralization to extensive cavitation.^{11,18,19} ICDAS was divided into sections covering coronal caries (pits and fissures, mesial-distal, and buccal-lingual), root caries, and caries-associated-with-restorations and sealants (CARS). Also, the coordinating committee developed a full protocol for examination to ensure that all conditions were specified in the criteria (for example, cleaning and drying of tooth surfaces). After conducting thorough review of literature, a paucity of data was found on the dental caries experience among 3-6 year old children attending Anganwadi centers of District Faridabad. Thus, the present study was conducted to assess the prevalence and severity of dental caries in the primary (deciduous) dentition of 3-6 year old children attending Anganwadi centers of District Faridabad using the diagnostic criteria of the ICDAS II.

II. MATERIALS AND METHOD

A cross-sectional study was carried out among 3-6 year old Anganwadi children of District Faridabad from December 2013-February 2014. Before conducting the study, ethical approval was obtained from Institutional Ethical Committee of 'Sudha Rustagi College of Dental Sciences & Research, Faridabad'. Permission to examine the children and record their personal data was also obtained from the respective Primary Health Centers and Community Health Centers. Written informed consent was obtained from the parents prior to examination of each subject. The sample size was estimated on the basis of 40% prevalence of dental caries among 3-6 year old children (as found in pilot study) with 5% absolute precision, alpha error as 5% and beta error as 20% and final sample size was estimated to be 370. To obtain the required sample size, a stratified cluster sampling technique with Anganwadi as the primary sampling unit. Out of total 407 Anganwadis, there were 184(45%), 98(24%), 125(31%) Anganwadis in Faridabad (Urban), Faridabad (Rural) and Ballabhgarh respectively. Using proportionate stratified sampling technique the respective number of Anganwadis of Faridabad (Urban), Faridabad (Rural) and Ballabhgarh was calculated as 9, 5, and 4 respectively. Although it was predicated that 20 children will be selected but we did not find even 20 children in some Anganwadi or some parents did not allow clinical examination of their parents, so final sample size achieved was 350. Inclusion criteria included children aged 3-6 years who were present in the Anganwadi on the day of examination and presence of fully erupted primary dentition. Exclusion criteria included children whose parents did not give the consent or either parent were not present and children with special needs that prohibited an oral examination. The data collection included a combination of clinical examination and questionnaire. Questionnaire was administered to the parents or legal guardians of the children to explore the variables related to oral hygiene habits, dietary habits and education level of parents. The clinical examination of all the subjects at the Anganwadis was done by a single examiner for the assessment of Dental caries using ICDAS II. The subjects were seated on a chair with back rest and the examiner performed the examination standing in front of the chair, in a room under natural lighting with the aid of plane mouth mirror & Community Periodontal Index probe. The teeth were cleaned with the help of gauze piece prior to clinical examination. All readings were recorded on a specially prepared form. The intra-examiner variability was checked by performing repeat examination on 10% randomly selected subjects and the intra examiner kappa co-efficient values for different codes of ICDAS criteria were calculated to be ≥ 0.79 . The ICDAS II criteria used in the study is given in

Annexure 1. For the Statistical analysis, the SPSS, version-14 (IBM, USA) was used. The ICDAS II codes were converted into: The d-component consisted of:

- (a) d₂₋₃ component comprising ICDAS II codes 2, 3;
- (b) d₄₋₆ component comprising ICDAS II codes 4, 5, 6;
- (c) d₂₋₆ component comprising ICDAS II codes 2-6.

The prevalence and severity of different ICDAS II codes and d₂₋₃ (enamel caries), d₄₋₆ (dentinal caries) & d₂₋₆ (enamel and dentinal caries) were calculated as frequencies and means respectively. Age wise and gender wise comparison of frequencies and mean number of surfaces were performed using chi-square test, ANOVA and unpaired Students t-test.

ANNEXURE 1: ICDAS (INTERNATIONAL CARIES DETECTION ASSESSMENT SYSTEM)

Criteria for detection of caries

Code	Criteria
0	Sound tooth surface, with no visual changes indicative of caries.
1	Not included in this study.
2	Distinct visual change in enamel. When wet, there is a carious opacity (white spot lesion) and / or brown carious discoloration which is wider than the natural fissure / pit.
3	Initial localized enamel breakdown, without clinically visual signs of dentinal involvement.
4	Underlying dark shadow from dentin, with or without enamel breakdown.
5	Distinct cavity with visible dentin cavitation in opaque or discolored enamel with exposed dentin in the examiner's judgment.
6	Extensive distinct cavity with clearly visible dentin. The cavity is both deep and wide. Dentin is clearly visible on both the walls and at the base. An extensive cavity involves at least half of a tooth surface, possibly reaching the pulp.

III. RESULTS

Among 350 Anganwadi children, 151 (43.1%) subjects were males and 199 (56.90%) were females. Table 1 is showing distribution of anganwadi children among different age groups and gender.

TABLE 1: Distribution of Anganwadi children by Age and Gender

AGE		GENDER		Total
		Male	Female	
3 year	n	29	25	54
	%	53.7	46.3	100
4 year	n	39	38	77
	%	50.6	49.4	100
5 year	n	64	109	173
	%	37	63	100
6 year	n	19	27	46
	%	41.3	58.7	100
Total	n	151	199	350
	%	43.1	56.9	100

p-value	0.073
---------	-------

Socio-demographic profile of the subjects-

Among 350 Anganwadi children, parents of majority of (mothers: 52.90%; fathers: 48.00%) subjects had education up to primary level. Mothers of majority (87.10%) of subjects were unemployed and fathers of majority (31.10%) of subjects had unskilled occupation. Out of all Anganwadi children, 325 (92.30%) subjects were on vegetarian diet and 27 (7.70%) subjects were on mixed diet.

ICDAS II Score

Prevalence of different codes of ICDAS II-

The prevalence of code 2 (Distinct Visual Change in Enamel), code 3 (Localized Enamel Breakdown), code 4 (Underlying Dark Shadow from Dentin), code 5 (Distinct Cavity with Visible Dentin) and code 6 (Extensive Distinct Cavity with Visible Dentin) among Anganwadi children was 2 (1.20%), 75 (21.40%), 5 (9.3 %), 52 (14.90%) and 17 (4.90%) respectively. Age wise and gender wise distribution of Anganwadi children according to the prevalence of ICDAS II scores is given in Table 2.

TABLE 2: Age-wise and Gender-wise distribution of Anganwadi children according to prevalence of different codes of ICDAS II

Age and Gender		Prevalence of different codes of ICDAS II				
		Code 2	Code 3	Code 4	Code 5	Code 6
3 year (N=54)	n	0	11	5	2	2
	%	0	20.4	9.3	3.7	3.7
4 year (N=77)	n	0	18	8	11	5
	%	0	23.4	10.4	14.3	6.5
5 year (N=173)	n	2	35	11	32	6
	%	1.2	20.2	6.4	18.5	3.5
6 year (N=46)	n	0	11	1	7	4
	%	0	23.9	2.2	15.2	8.7
Total (N=350)	n	2	75	25	52	17
	%	0.6	21.4	7.1	14.9	4.9
p ^a -value		0.56	0.91	0.32	0.06	0.42
Male (N=151)	n	1	39	11	26	7
	%	0.7	25.8	7.3	17.6	4.6
Female (N=199)	n	1	36	14	26	10
	%	0.5	18.1	7	13.1	5
Total (N=350)	n	2	75	25	52	17
	%	0.6	21.4	7.1	14.9	4.9
p ^a -value		0.84	0.08	0.92	0.27	0.86

^achi-square test

Mean number of tooth surfaces affected according to different codes of ICDAS II-

The Mean number of tooth surfaces having code 2, code 3, code 4, code 5 and code 6 was 0.01±0.12, 0.67±1.56, 0.25±1.09, 0.57±2.40 and 0.15±0.82 respectively. Mean number of surfaces affected

according to different codes of ICDAS II among various age groups and gender is given in Table 3. Among males and females, only the mean number of surfaces affected from code 3 (Localized Enamel Breakdown) was found to be significantly more among males as compared to females.

TABLE 3: Mean number of surfaces affected according to different codes of ICDAS II among various Age groups and Gender

Age and Gender		Mean number of surfaces affected according to different codes of ICDAS II				
		Code 2	Code 3	Code 4	Code 5	Code 6
3 year (N=54)	Mean	0	0.7	0.22	0.13	0.07
	S.D	0	1.59	0.74	0.72	0.42
4 year (N=77)	Mean	0	0.71	0.45	0.57	0.23
	S.D	0	1.58	1.54	2.14	1.07
5 year (N=173)	Mean	0.02	0.61	0.24	0.76	0.1
	S.D	0.17	1.53	1.07	3.01	0.6
6 year (N=46)	Mean	0	0.8	0.02	0.39	0.3
	S.D	0	1.61	0.14	1.04	1.2
Total	Mean	0.01	0.67	0.25	0.57	0.15
	S.D	0.12	1.56	1.09	2.4	0.82
p ^b -value		0.6	0.88	0.18	0.37	0.31
Male (N=151)	Mean	0.01	0.81	0.3	0.66	0.17
	S.D	0.16	1.63	1.25	1.93	0.86
Female (N=199)	Mean	0.01	0.57	0.22	0.51	0.14
	S.D	0.07	1.49	0.94	2.7	0.86
Total (N=350)	Mean	0.01	0.67	0.25	0.57	0.15
	S.D	0.12	1.56	1.09	2.4	0.82
p ^b -value		0.200	0.030*	0.180	0.390	0.560

^bOne-Way Analysis of Variance test *p value<0.05

Prevalence of combined codes of ICDAS II i.e. d_{2-3s}, d_{4-6s}, d_{2-6s}

The prevalence of d_{2-3s} (ICDAS II score 2-3, enamel lesions), d_{4-6s} (ICDAS II score 4-6, dentinal lesions) and d_{2-6s} (ICDAS II score 2-6, enamel and dentinal lesions) among Anganwadi children was 76 (21.7%), 81 (23.1%) and 142 (40.6%) respectively. Age-wise and gender-wise distribution of Anganwadi children according to severity of disease is shown in Table 4. The prevalence of d_{2-3s} (ICDAS II score 2-3, enamel lesions) was found to be significantly more among males as compare to females (p-value<0.05)

Descriptive of combined codes of ICDAS II i.e. d_{2-3s}, d_{4-6s}, d_{2-6s}

The Mean score of d_{2-3s}, d_{4-6s} and d_{2-6s} among Anganwadi children was 0.68±1.57, 0.43±1.07 and 1.66±3.12 respectively. Descriptive of combined codes of ICDAS II among different age groups and gender is shown in Table 5.

TABLE 4: Age-wise and Gender-wise distribution of Anganwadi children according to severity of disease

Age and Gender		Prevalence among Anganwadi children according to the severity of disease		
		d2-3s	d4-6s	d2-6s
3 year (N=54)	n	11	9	18
	%	20.4	16.7	33.3
4 year (N=77)	n	18	21	32
	%	23.4	27.3	41.6
5 year (N=173)	n	36	41	72
	%	20.8	23.7	41.6
6 year (N=46)	n	11	10	20
	%	23.9	21.7	43.5
Total (N=350)	n	76	81	142
	%	21.7	23.1	40.6
p ^a -value		0.941	0.553	0.695
Male (N=151)	n	40	38	68
	%	26.5	25.2	45
Female (N=199)	n	36	43	74
	%	18.1	21.1	36.7
Total (N=350)	n	76	81	142
	%	21.7	22.9	40.3
p ^a -value		0.040*	0.256	0.085

^achi-square test *p value<0.05

TABLE 5: Descriptive of combined codes of ICDAS II among different age groups and Gender

Age and Gender	Descriptive of combined codes of ICDAS II			
		d _{2-3s}	d _{4-6s}	d _{2-6s}
3 year (N=54)	Mean	0.7	0.43	1.13
	S.D	1.59	1.07	1.84
4 year (N=77)	Mean	0.71	1.26	1.97
	S.D	1.58	2.84	3.26
5 year (N=173)	Mean	0.63	1.09	1.72
	S.D	1.55	3.35	3.56
6 year (N=46)	Mean	0.8	0.72	1.52
	S.D	1.61	1.72	2.17
Total (N=350)	Mean	0.68	0.98	1.66
	S.D	1.57	2.861	3.128
p ^b -value		0.91	0.31	0.479
Male (n=151)	Mean	0.82	1.12	1.94
	S.D	1.633	2.532	2.869
Female (N=199)	Mean	0.58	0.87	1.45
	S.D	1.515	3.016	3.303

p ^b -value	0.36	0.218	0.203
-----------------------	------	-------	-------

^bOne-Way Analysis of Variance test

IV. DISCUSSION

The present study was conducted to assess the prevalence and severity of dental caries in the primary (deciduous) dentition of 3-5 year old children attending Anganwadi centers of District Faridabad using the diagnostic criteria of the International Dental Caries Detection and Assessment System (ICDAS) II. The traditional methods used for caries detection either measures at level of cavitation, one digit codes or requires computer programmes for analyzing the data. ICDAS II consists of a two-digit codes system which allows accurate recording of the severity of carious lesion by detecting the carious lesions at very early stage (non-cavitated stage) to frank cavitation. Guidelines on how to analyze the data obtained through ICDAS II were not found, based on available epidemiological data from previous published studies, the two digit system was converted into one-digit system and used the defs index to accommodate various combination scores.¹ According to the ICDAS II manual (ICDAS Coordinating Committee, 2009), the codes 1 and 3 can be detected only in dry conditions while caries codes 2, 4, 5 and 6 can be assessed in wet conditions.¹⁰ As the present study was conducted in field conditions, it was not possible to record code 1 that is why it was not included in the study. For caries code 3 (cavity confined to the enamel), the ICDAS II manual reports that this type of lesion is detected after drying the tooth, but, in case of doubt, the WHO probe can be used gently across the surface to confirm the visual assessment. This means that, even without compressed air, code 3 can be detected by sliding the ball end of the WHO probe along the suspected area.¹³

Demographic Data:

The socioeconomic variables are hypothesized to have a potential effect on dental caries, thus the importance of these factors could not be ruled out in determining the dental caries of preschool children attending Anganwadis. In our study, mothers of 80% children had education up to primary or secondary level and fathers of 77% children had education up to primary and secondary level. Mothers of 87% children were unemployed and fathers of 52% children were having semi-skilled and unskilled occupation. No relevant comparison can be done due to lack of reporting among existing studies related to parent's educational level and occupation.

ICDAS Scores:

The overall prevalence of dental caries among Anganwadi children was 41.6% whereas in the study conducted by Joseph et al, a prevalence of 61% was reported among 6 year old children in Alpes, Maritimes, France; Amorim et al reported a 95.6% prevalence among primary dentition of deprived Brazilian young population and study by Cadavid et al reported the a caries prevalence of 74.7% in primary dentition of Colombian population.^{15,1,2} The low prevalence of dental caries in the present study could be due to younger age group, lesser number of years of exposure to oral cavity and Haryana being the higher fluoride belt according to national oral health survey and fluoride mapping (2002-2003). In the present study, prevalence of code 3 among Anganwadi children was higher (21.40%) than other codes 2, 4, 5 and 6 and the prevalence of code 3 was higher among 4 year children

and males. Our results are consistent with study conducted by Cadavid et al.² In their study, there was significant prevalence of localized enamel breakdown due to caries (code 3) but the greatest prevalence was of code 2. The prevalence of d_{2-3s} (enamel lesions), d_{4-6s} (dentinal lesions), and d_{2-6s} (enamel and dentinal lesions) in our study was 21.7%, 23.1% and 40.6% respectively whereas study conducted by Cadavid et al, the prevalence of d_{2-3s} (enamel lesions) was 74.3% which was very high in comparison to the present study.² This might be due to difference in the dietary patterns and fluoride levels in water among two populations. The mean score d_{2-3s} (enamel lesions), d_{4-6s} (dentinal lesions), and d_{2-6s} (enamel and dentinal lesions) in present study was 0.98 ± 2.68 , 0.43 ± 1.07 and 1.66 ± 3.12 respectively which was much lower than the study conducted by Amorim et al, mean score of d_{4-6s} was 7.3 ± 9.2 and d_{2-6s} was 13.8 ± 10.9 , study conducted by Honkala et al mean score of d_{2-3s} was 5.0 & mean d_{4-6s} was 3.4 among school children with mixed dentition of southeast Estonia.^{1,8} In the present study, no significant relationship of prevalence and mean score of dental caries with age were found similarly to the finding of Gaidhane et al and Wendt LK.^{6,26} In the present study, statistically significant gender wise difference was not found with respect to between prevalence and mean score of ICDAS codes, d_{4-6s} (dentinal lesions), and d_{2-6s} (enamel and dentinal lesions) except mean score of code 3 and prevalence of d_{2-3s} (enamel lesions) where males were more affected than females similarly to the finding of Ismail et al where as differing from those of Schroth et al.^{12,23} In the present study, the prevalence of individual codes were compared, then the prevalence of code 3 (non-cavitated lesions) was found to be more but when d_{2-3s} (enamel lesions), d_{4-6s} (dentinal lesions), were compared then the prevalence of d_{4-6s} (dentinal lesions) was found to be more prevalent than d_{2-3s} (enamel lesions). Prevalence of more ICDAS II-code 3 in the primary dentition shows that using ICDAS II can lead to overvaluation of the seriousness of dental caries experience.

V. CONCLUSION

Although caries prevalence was low in preschool children attending Anganwadi children but access to dental health services was poor. This shows that the current preventive dental health policy has many inconsistencies and deficiencies regarding access, efficacy and continuity of the services and special programs for the preschool children. The inclusion of preschool and young children in the prevention programs could decrease the risk for dental caries and minimize the need for invasive and painful treatment procedures. Our findings highlight the need for a policy revision in order to include early childhood in dental preventive strategies, and to define appropriate preventive approaches.

REFERENCES

1. Amorim RG, Figueiredo MJ, Leal SC, Mulder J, Frencken JE. Caries experience in a child population in a deprived area of Brazil, using ICDAS II. *Rodrigo Clin Oral Invest* 2012;16:513–520
2. Cadavid AS, Lince CM, Jaramillo MC. Dental caries in the primary dentition of a Colombian population according to the ICDAS criteria. *Braz Oral Res.* 2010;24:211-216.

3. Douglass JM, Tinanoff N, Tang JM, Altman DS. Dental caries patterns and oral health behaviors in Arizona infants and toddlers. *Community Dent Oral Epidemiol* 2001;29:14-22.
4. Ekstrand KR, Ricketts DN, Kidd EA. Reproducibility and accuracy of three methods for assessment of demineralization depth of the occlusal surface: an in vitro examination. *Caries Res* 1997;31:224-231.
5. Fyffe HE, Deery C, Nugent ZJ, Nuttall NM, Pitts NB. Effect of diagnostic threshold on the validity and reliability of epidemiological caries diagnosis using the Dundee Selectable Threshold Method for caries diagnosis (DSTM). *Community Dent Oral Epidemiol* 2000;28:42-51.
6. Gaidhane AM, Patil M, Khatib N, Zodpey S, Zahiruddin SQ. Prevalence and determinant of early childhood caries among the children attending the Anganwadis of Wardha district, India. *Indian J Dent Res* 2013;24:199-205.
7. Gunay H, Dmoch-Bockhorn K, Gunay Y, Geurtsen W. Effect on caries experience of a long-term preventive program for mothers and children starting during pregnancy. *Clin Oral Investig* 1998;2:137-142.
8. Honkala E, Runnel R, Honkala S, Olak J, Vahlberg T et al. Measuring Dental Caries in the Mixed Dentition by ICDAS. *Int J Dent*. 2011;1-6
9. ICDAS Coordinating Committee (2009) Criteria manual, revised in December and July 2009. ICDAS website
10. International Caries Detection and Assessment System Coordinating Committee. Appendix Criteria Manual on “International Caries Detection and Assessment System (ICDAS II)”. Available from: https://www.icdas.org/uploads/ICDAS%20Criteria%20Manual%20Revised%202009_2.pdf.
11. Ismail AI, Brodeur J-M, Gagnon P, Payette M, Picard D, Hamalian T, et al. Prevalence of non-cavitated and cavitated carious lesions in a random sample of 7–9 yearold school children in Montreal, Quebec. *Community Dent Oral Epidemiol* 1992;20:250–255.
12. Ismail AI, Lim S, Sohn W, Willem JM. Determinants of early childhood caries in low-income African American young children. *Pediatr Dent* 2008;30:289-296.
13. Ismail AI, Sohn W, Tellez M, Willem JM, Betz J, Lepkowski J. Risk indicators for dental caries using the International Caries Detection and Assessment System (ICDAS). *Community Dent Oral Epidemiol* 2008;36:55-68.
14. Ismail AI. Visual and visuo-tactile detection of dental caries. *J Dent Res* 2004;82:56–66.
15. Joseph C, Velly AM, Pierre A, Bourgeois D, Muller-Bolla M. Dental health of 6-year-old children in Alpes Maritimes, France. *Eur Arc Paediatr Dent* 2011;12:256-263.
16. Klein M, Palmer CE. “Studies on dental caries. Familial resemblance in the caries experience of siblings,” *Public Health Report* 1938;53:1353–1364.
17. Nunn ME, Brannstein NS, Krall keye EA, Dietrich T, Garcia RI, Henshaw MM. Healthy eating Index is a predictor of Early Childhood Caries. *J Dent Res* 2009;88:361-366.
18. Shivakumar K, Prasad S, Chandu G. International Caries Detection and Assessment System: A new paradigm in detection of dental caries. *J Conserv Dent* 2009;12(1):10-6.
19. Pitts NB, Fyffe HE. The effect of varying diagnostic thresholds upon clinical caries data for a low prevalence group. *J Dent Res* 1988;67:592–596.

20. Pitts NB. 'ICDAS' - an international system for caries detection and assessment being developed to facilitate caries epidemiology, research and appropriate clinical management. *Community Dent Health* 2004;22:193-198.
21. Postma TC, Ayo-Yusuf OA, van Wyk PJ. Socio-demographic correlates of early childhood caries prevalence and severity in a developing country- South Africa. *Int Dent J* 2008;58:91-97.
22. Ricketts DN, Ekstrand KR, Kidd EA, Larsen T. Relating visual and radiographic ranked scoring systems for occlusal caries detection to histological and microbiological evidence. *Oper Dent* 2002;27:231-237.
23. Schroth RJ, Cheba V. Determining the prevalence and risk factors for early childhood caries in a community dental health clinic. *Pediatr Dent* 2007;29:387-396.
24. Sohn W, Ismail A, Amaya A, Lepkowski J. Determinants of dental care visits among low-income African-American children. *J Am Dent Assoc* 2007; 138:309-318
25. Tsubouchi J, Tsubouchi M, Maynard RJ, Domoto PK, Weinstein P. A study of dental caries and risk factors among Native American infants. *ASDC J Dent Child* 1995;62:283-287.
26. Wendt LK, Hallonsten AL, Koch G. Dental caries in 1-2 year old children living in Sweden. *Swed dent J* 1991;15:1-6.
27. World Health Organization, *Oral Health Surveys-Basic Methods*, WHO, Geneva, Switzerland, 4th ed, 1997.