RESEARCH ARTICLE

Comparing dental caries status using Modified International Caries Detection and Assessment System (ICDAS) and World Health Organization (WHO) indices among school children of Bhakkar, Pakistan

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Abstract

Objective: To assess and compare the dental caries status among children using two methods.

Methods: The cross-sectional study was conducted in October-November 2017 at five government and two private schools in Bhakkar, Punjab, Pakistan. It comprised children aged 11-12 years. World Health Organisation standards and the modified International Caries Detection and Assessment Systems methods were used were used to determine the dental caries status of each subject. Results of the two methods were compared at all cut-offs where appropriate, using SPSS 17.

Results: Of the 183 subjects, 101(55.2%) were boys. Those aged 12 years were 112(61.2%) while 71(38.8%) were aged 11 years. There was no statistically significant difference in values of the Decayed Missing and Filled Surface / Decayed Missing and Filled Teeth index as well as the prevalence of dental caries between two methods ($p>0.05$ each). Intra-examiner reproducibility was higher with the World Health Organisation method compared to the other index used ($p<0.05$).

Conclusion: Modified International Caries Detection and Assessment Systems method can be used in epidemiological surveys as it was found to provide results similar to the World Health Organisation criteria at cut-off point 2.

Keywords: Modified International Caries Detection and Assessment system, ICDAS, Decayed Missing and Filled Teeth, DMFT, Decayed Missing and Filled Surfaces, DMFS. (JPMA 69: 950; 2019)

Introduction

Despite being largely preventable, dental caries remain a global public health problem in the 21st century. Although a decline of this disease has been observed in most industrialised countries in the past 20 years, caries continues to be a burden in developing countries, especially amongst children. The World Health Organisation (WHO) reported that more than 200 million 12-year-old children in 188 countries had either decayed, filled or missing teeth due to caries.[1] The prevalence of 'obvious decay' among 12-year-old children in the United Kingdom was 34% in 2013, an improvement from 43% from a decade before.[2] In India, where the population is predominantly rural, the prevalence of caries among the 12-year-old segment was 53.8%.[3] These findings are somewhat similar to what was observed in 12-15-year-old Pakistan0i children in a survey conducted in 21 districts across the country where caries prevalence was reported to be 50%.[4] Additionally small-scale recent cross-sectional studies conducted in selected cities in Pakistan have also reported a considerably high caries prevalence of between 40-71% among 12-year-old children.[5,6] Nevertheless their caries experience in terms of the mean Decayed Missing Filled Teeth (DMFT) score has improved from 2.1 in 1979 to 1.38 in 2003.[4,7]

The conventional method employed globally to detect caries in epidemiological surveys is the WHO method.[8] Likewise in Pakistan, the WHO method is commonly used. Under this method, caries is recorded as present when there is an unmistakable cavity that undermined the enamel or a detectable softened floor or wall in the pits or fissure or on a smooth tooth surface. A sharp probe is sometimes utilised to confirm visual evidence of caries.[8] As only cavitated lesion is recorded, conventional dental restoration is commonly the most prescribed intervention. This treatment philosophy may impose a tremendous financial burden, especially in a

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developing country such as Pakistan; hence it may be more sensible to identify and record early enamel caries, which are mostly non-cavitated, as they can be treated via cheaper preventive measures to prevent further progression. New understanding of the dynamic process of dental caries makes it more important to use an index that can measure both very early (sub-clinical and non-cavitated) and advanced stages of caries (cavitated). This should improve the sensitivity of caries epidemiology.[9,10]

In recent years, a new system for caries detection, the International Caries Detection and Assessment System (ICDAS), has been developed. It incorporates codes ranging 0-6, where caries is coded from first visual change in enamel to an extended cavity in the dentine. The ICDAS has two main variants which are full ICDAS and modified ICDAS, and both variants differ in terms of caries classification codes. However, in comparison to the WHO method, both variants are based on a detailed visual examination and record early signs of caries which include any opacities, discolouration, and micro- cavities. These signs have been considered a reliable indicator of caries present in the tooth structure.[11] Since lesions are recorded at early stages, appropriate preventive management, such as fissure sealant or fluoride therapy, can effectively be provided. The index has been reported to have good reliability, sensitivity and specificity, and has been successfully utilised in research.[12-14]

As most local studies have used the WHO caries assessment method, it is essential to assess the equivalence of the new ICDAS index with the conventional approach to allow continuous comparison of caries trends in the population. The current study was planned to assess and compare the prevalence of dental caries using the WHO and the modified ICDAS methods.

Subjects and Methods

The cross-sectional study was conducted in October-November 2017 at five government and two private schools in Bhakkar, Punjab, Pakistan. Permission was obtained from the Executive District Officer (EDO) and the administrators of the private schools. Approval was obtained from the ethics committee of the Faculty of Dentistry, University of Malaya, Kuala Lumpur, Malaysia. The sample size was determined in the light of literature.[15] Based on the expected caries prevalence of 71%, margin of error 5% and confidence level 85%, the minimum sample size required was 171. Those included were children aged 11-12 years who were able to understand basic instructions and who furnished written consent from their parents. Those below or above the age range, with any acquired physical disabilities, such as loss or deformity of limbs, were excluded. Of about 200 private and government schools in Bhakkar, seven with the highest student enrolment were conveniently selected. The list of children from classes 5, 6 and 7 was obtained from the register of each school.

A single examiner underwent training and calibration process for both the WHO and modified ICDAS indices at the University of Malaya. The calibration for the WHO assessment method was performed on a separate sample of 20 children in the similar age range over two days. The children were selected from a school not included in the main study. Intraoral examinations were performed on the school premises. Based on the WHO method, teeth were recorded as having decayed / frank cavitation (D), missing (M), filled with dental restoration (F), or sound (0).[16] The intra-examiner reliability of 0.88 indicates a substantial agreement for the WHO method.

For the ICDAS index, calibration process was carried out over two days with a time interval of one week on 62 extracted teeth, which have been ICDAS-coded by the Malaysian ICDAS taskforce group. Teeth were recorded as follows: 0: sound; 1: first visual change in enamel seen after drying; 2: distinct visual change in enamel; 3: localised enamel breakdown; 4: underlying dark shadow from dentine; 5: a distinct cavity with visible dentine; 6: extensive distinct cavity with visible dentin.[17] However, in this study, modified ICDAS codes 1 and 2 were merged and named code A as it was not possible to dry tooth surfaces with compressed air in the research area.[18] The inter-examiner kappa value achieved by the trainee was 0.69 and 0.82, indicating substantial agreement.

The intraoral examination was performed on school premises using mouth mirror, dental loupes (2.5 magnification), Light-emitting diode (LED) headlight illumination, cotton/gauze and WHO periodontal probe. Children were seated on a portable dental chair and the procedures were performed twice on the same participants using a different index following a 30-minute interval. In the case of modified ICDAS for the assessment of initial enamel lesion, tooth surface was dried with cotton and plaque removal was performed using a ball-ended periodontal probe, as recommended by the ICDAS guidelines.[19]

Statistical analysis was performed using SPSS 17 and Med Calc statistical software. To establish the correlation between WHO criteria and modified ICDAS, three cut-off points were created as follows: cut-off I (0 as sound A-6 were classifi ed as carious), cut-off 2 (0-A as sound, 3-6 as decayed) and cut-off 3 (0-3 as sound, 4-6 as decayed) respectively. The weighted kappa scores were calculated to measure the agreement between the two methods. Wilcoxon test was employed to compare the decayed teeth detected by the WHO criteria and modified ICDAS at all cut-offs. McNemar test was applied to compare caries prevalence calculated by the two methods at all cut-offs. $p<0.05$ was taken as significant.

Results

Of the 400 children initially listed, 322(80.5%) met the inclusion criteria. Of them, 226(70%) obtained parental consent. However, only 183(81%) subjects were present on the assessment day. There were 101(55.2%) boys, and 121(66%) subjects were from private schools. Those aged 12 years were 112(61.2%) while 71(38.8%) were aged 11 years.

With WHO criteria, 81(44%) children were classified as sound and 102(56%) with decay. All of the caries-free children had non-cavitated caries lesions at a modified ICDAS score <3. All children diagnosed as caries-positive by WHO criteria had modified ICDAS score of at least 3 (Table 1).

A total of 23,296 surfaces were examined of which 22968(99%) were identified as caries-free by both criteria. Besides, 18(0.07%) surfaces identified as decayed by WHO criteria were categorised as sound by modified ICDAS (Table 2). Statistically, there was no significant difference in the value of Decayed Missing and Filled Surface (DMFS) / Decayed Missing and Filled Teeth (DMFT) index and prevalence of dental caries by the WHO method compared to ICDAS at cut-off 2 ($p>0.05$). The mean value for modified ICDAS cut-off 1 was 4.92±2.6 and 4.30±2.2 which were significantly higher than the DMFS and DMFT values. Conversely, the mean values of modified ICDAS at cut-off 3 were 2.0±1.7 and 1.85±1.3 were significantly lower than the DMFS and DMFT values ($p<0.05$). For modified ICDAS cut-off 1 and 3, the prevalence of caries were significantly higher

Table-1: Relationship between the scores for caries-free and caries-positive children obtained using modified ICDAS and WHO criteria.

WHO	Number of children with the highest modified ICDAS score						
	0	A	3	4	5	6	Total
Caries Free	37	44	0	0	0	0	81(44.3%)
Caries Positive	0	0	34	27	28	13	102(55.7%)
Total	37(20.2%)	44(24.0%)	34(18.6%)	27(14.8%)	28(15.3%)	13(7.1%)	183(100%)

WHO: World Health Organisation; ICDAS: International Caries Detection and Assessment Systems

Table-2: Relationship between the scores for the sound and decayed component obtained using modified ICDAS and WHO criteria at the tooth surface level.

WHO	Number of surfaces with modified ICDAS score						
	0	A	3	4	5	6	Total
Caries Free	22569	399	0	0	0	0	22968(99%)
Caries Positive	18	0	174	55	57	24	328(1%)
Total	22587(97%)	399(1.7%)	174(0.7%)	55 (.2%)	57 (.2%)	24 (.1%)	23296(100%)

WHO: World Health Organisation; ICDAS: International Caries Detection and Assessment Systems

Table-3: Comparison between DMFS, DMFT (Mean±S.D) and prevalence of caries obtained with modified ICDAS using cut off scores 1, 2 and 3 with the same parameters obtained using WHO criteria.

	WHO (Mean±S.D)	Modified ICDAS cut off-scores Cut 1 (0 Sound A-6 decayed)	Cut 2 (0-ASound 3-6 decayed)	Cut 3 (0 Sound 4-6 decayed)
DMFS	(3.28±2.5)	(4.92±2.6)	(3.21±2.3)	(2.0±1.7)
p-value[1]		0.000	0.64	0.002
DMFT	(2.69±1.7)	(4.30±2.2)	(2.67±1.7)	(1.85±1.3)
p-value[1]		0.000	0.70	0.003
Prevalence (95% CI)	55.7 (48.2 - 63.1)	79.8 (73.2 - 85.3)	55.8 (48.2 - 63.1)	37.2 (30.1 - 44.6)
p-value[2]		0.000	1.0	0.000

[1]ICDAS compared with WHO (Wilcoxon test), [2]ICDAS compared with WHO (McNemar test). WHO: World Health Organisation; ICDAS: International Caries Detection and Assessment Systems; SD: Standard deviation; DMFS: Decayed Missing and Filled Surface; DMFT: Decayed Missing and Filled Teeth.

Table-4: Comparison of intra-examiner reliability values (95% CI) obtained by WHO criteria and by ICDAS criteria with cut-off 1, 2 and.

	WHO	Modified ICDAS
DMFS	0.84 (0.74-0.94)	0.66 (0.57-0.74)
ICDAS cut - off score 1	n/a	0.48 (0.32-0.65)
ICDAS cut - off score 2	n/a	0.87 (0.76-0.98)
ICDAS cut - off score 3	n/a	0.90 (0.84-0.97)

Cohen's Kappa statistic, n/a Not applicable. WHO: World Health Organisation; ICDAS: International Caries Detection and Assessment Systems

(79.8%) and lower (37.2%) respectively compared to the WHO criteria (Table 3). The mean time spent on the application of modified ICDAS was 3.5±0.9 minutes compared to WHO method 1.7±0.5 minutes ($p<0.0001$). Intra-examiner reproducibility was higher with WHO methods compared to ICDAS index, but when ICDAS was collapsed into sound and decayed at all cut-offs, higher kappa values were recorded at cut-offs related to the cavitated lesion (Table 4).

Discussion

The conventional WHO method used for caries diagnosis has numerous limitations.[20] One of the major restrictions is that it only records obvious caries lesions and does not provide additional information regarding the state and stages of caries. To overcome the limitation of the existing method, modified ICDAS was developed where early and accurate information regarding the type, location and depth of caries lesions is recorded, which allows appropriate precautionary and curative approach to be taken. As most carious lesions are now found at earlier stages,[21] the use of an index which includes the recording of both cavitated and non-cavitated lesions will improve the sensitivity of caries detection. However, before adopting the modified ICDAS, it is crucial to assess the feasibility and validity of this system compared to the current method, especially when used in a different population.

Our study found that the equivalence between the WHO and modified ICDAS indices for all the three parameters assessed (DMFS, DMFT and overall caries prevalence) were at cut-off point 2, where modified ICDAS codes 0 and A were considered sound and codes 3-6 were classified as caries. This finding can be considered similar to a study conducted on 12-year-old children in Spain,[22] although different cut-off points were used. Iranzo-Cortes et al.[22] reported that for DMFT, the least difference was found when full ICDAS codes 0-1 were considered sound, and for DMFS variable where full ICDAS codes 0-2 were classed as healthy. In our study, we merged modified ICDAS codes 1 and 2 and recorded it as 'A' due to reasons mentioned already. Had the two aforementioned studies used the same codes where codes 1 and 2 had been collapsed into code A, there is a possibility that the discriminant validity of the two indices will be found at the same cut-off point as caries coded as ICDAS 1 and 2 are only distinguished by whether drying method was used or not.

The nevertheless studies conducted on pre-school children have also demonstrated that the cut-off point where modified ICDAS codes 3-6 were considered caries exhibited discriminant validity similar to the WHO criteria.[10-23] A possible explanation for this is that histological evidence has shown that caries lesion classified as code 3 has advanced beyond enamel.[10-24] Therefore, it is concluded that at this stage, caries may have penetrated into dentin and due to this it can be measured and compared according to the WHO criteria.[10-22]

Despite having a significant advantage over the conventional criteria, the common problem encountered with using modified ICDAS is the longer time required for oral examination. In this study, the approximate mean time difference between using the modified ICDAS and WHO methods was almost two minutes. Braga et al.[10] reported that the mean examination time when full ICDAS was used was almost twice as long as the WHO index. This would indirectly increase study expenditure and, hence, may be a limiting factor in using it in caries survey. However, with adequate and proper training and increased familiarity with the index, this time factor can be improved in the future.

In the current study, only one examiner was involved in the assessment of caries using both indices. Hence, there is a chance of examiner bias. However, this was minimised by applying appropriate washout period in between the two assessments. Nevertheless, bias can also occur if more than one examiner was used for each system.[10]

Conclusion

Modified ICDAS was found to be feasible for epidemiological surveys on school-going children. Using score 3 of this system as a cut-off provideed equivalence with the WHO criteria. However, prolonged examination time can limit its use in field surveys. Modified ICDAS can be used in future epidemiological investigations to determine caries prevalence in Pakistan as it records

carious lesion at an earlier stage and provides relevant information to plan appropriate prevention compared to the WHO method.

Disclaimer: The study is part of a PhD project conducted by the Pakistani author, while the two Malaysian co-authors were his supervisors based at the University of Malaya, Kuala Lumpur, and MAHSA University Selangor, Malaysia.

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