Research Paper: Reliability and Reproducibility of the International Caries Detection and Assessment System Index in Evaluation of Dental Decay in People Aged 25-40 Years

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ABSTRACT

Introduction: The most commonly used scale to detect dental caries is the Decay-Missing-Filled (DMF) index. Since the DMF index cannot identify early carious lesions, the new International Caries Diagnosis and Assessment System (ICDAS) was developed. Since the ICDAS index is not included in the dental education courses in Iran, the present study aimed to assess the reliability and reproducibility of the this index after adequate training.

Materials and Methods: In this cross-sectional study, 30 employees in one of the hospitals in Shiraz, Iran, were selected using the convenience sampling method as research subjects, and were examined by two examiners calibrated for DMF index and two examiners calibrated for ICDAS. The agreement between two examiners in each system was investigated using the Kappa coefficient of agreement. One of the DMF examiners and one of the ICDAS examiners examined the sample two weeks later again. The internal agreement of these examiners with their primary examinations was evaluated using the Kappa coefficient.

Results: the ICDAS index, the intra-examiner and the inter-examiner Kappa coefficients were 0.915 and 0.874, and for the DMF index, these indices were 0.903 and 0.833, respectively. These findings indicate almost a complete agreement between the examiners.

Conclusion: Both indices had good reliability and reproducibility. The ICDAS index was useful and applicable for dentists and dental students for diagnosing non-cavitated caries lesions, Therefore, integrating this index in the dental educational courses of Iranian students following further studies seems to be useful in moving toward minimal intervention dentistry.

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1. Introduction

Dental decay is one of the most prevalent chronic diseases, which involves all human societies with different intensities. This disease imposes a financial burden to people and society at the personal and governmental levels. Dental indices can be considered as the main tools for the investigations related to epidemiology in patients to find out the prevalence and intensity of oral diseases. Moreover, prevention programs are based on dental indices for oral health promotion. Dental indices allow dentists to evaluate the advantages of more recent dental treatment methods in comparison with the available old methods [1].

Indices such as Decay-Missing-Filled Teeth (DMFT) and Decay-Missing-Filled Surface (DMFS) have been used for a long time in epidemiologic studies for evaluating dental decay by calculating the number of D: Represents Decayed (D), Missing (M), and Filled (F), Teeth (T) or Surface (S). Lowercase letters (dmft and dmfs) are used to denote evaluating the deciduous teeth, and uppercase letters (DMFT and DMFS) for assessing the permanent teeth. These indices are the most common epidemiologic surveys of dental decay [2]. Based on the evidences presented on the DMT index so far, this criterion has acceptable reliability and reproducibility to be used by dentists and dental students [3].

One main factor contributing to the high prevalence of caries is the lack of recording the stages of dental decay and not finding the decay in the early stages for on-time prevention. Moreover, lack of coordination in the informational system at national and international levels may have destructive impacts on caries prevention programs. These difficulties led to cumulative efforts to design and propose a unified method, called the International Caries Detection and Assessment System (ICDAS) and establishing a unit committee (ICDAS committee) in 2002 to be used all over the world for recording dental decays [4]. In this method, the codes ranging from 0 to 6 are considered for the decay condition of each tooth from the beginning of enamel decalcification to advanced decays. In the ICDAS system, crown decays and those associated with restorations and sealants have different codes. This method has some advantages including identifying intensity, activity or inactivity of dental decays and the possibility of comparing the results of various studies conducted in different countries with higher accuracy [5, 6].

Several studies applied the ICDAS index in their communities to assess its validity and reliability [7]. In 2015, Goswami and Rajwar concluded that the ICDAS index had good potential as the traditional method of World Health Organization (WHO) for examining dental decays [8]. Aidara and Bourgeois declared that the ICDAS index provided 43% information more than the DMF. Therefore, ICDAS index demonstrated more prevention needs in comparison to DMF [9]. The results of other studies such as Ismail et al. and Shoaib et al. showed that these diagnosis criteria had the required validity for application [10, 11].

To our best knowledge, most of previous studies have reported the use of ICDAS on extracted teeth [12-15], but few studies have assessed the ICDAS on patients [11, 16]. Moreover, the ICDAS index is not taught and used in dental schools of Iran and dental examination is still carried out using the DMF index. Therefore, assessing the ICDAS index in Iran seems essential to integrate it into our national oral health promotion programs. In this regard, the aim of this study was to investigate the reliability and reproducibility of the ICDAS index.

2. Materials and Methods

In this cross-sectional study, 30 employees aged 25-40 years working in the Nader Kazemi Hospital, Shiraz, Iran were selected as study subjects, using the convenience sampling method. Those who were edentulous, had limitations in opening their mouth or had orthodontics brackets, were excluded from the study and replaced by other subjects. Research objective and method were completely explained to the subjects. The all participated in the study voluntarily and with full informed consent. Permission was obtained from the Dental School of Shiraz University of Medical Sciences.

Two dental students that were chosen as examiners were calibrated by a dentist in Kerman University who was the only person calibrated for this index by the ICDAS committee in Iran. First, description of this index including the introduction, the way of using and its codes were instructed to them. Then, diagnosis pictures were presented to them and finally, the they were tested based on the ICDAS rules. After passing the exam, their ICDAS knowledge was examined on extracted teeth and approved by the specialist. The two other dental students were calibrated for DMF index in their educational setting.

Two examiners recorded the DMF index and the two other examiners recorded the ICDAS index on different

Table 1. The ICDAS codes for determining the condition of each tooth

Code	Code Definition
0	Unfilled and unsealed teeth
1	Relative sealant
2	Full sealant
3	Tooth-colored restoration
4	Amalgam restoration
5	Stainless steel crown
6	Crown or porcelain veneer, gold, porcelain fused metal or other restoration materials
7	Lost or fractured restoration
8	Temporary restoration
9	It is used for the following conditions:
96	9-6 Tooth surface cannot be examined; the surface is excluded
97	9-7 Tooth missing because of decay (tooth surface gets code 97)
98	9-8 Tooth missing for a reason other than decay (all tooth surfaces get code 98)
99	9-9 Unerupted (tooth surface gets code 99)

days to have no idea about the results of each other. Two weeks later, all examinations were repeated by one of the former examiners for DMF and ICDAS indices. Examinations were performed on dental units using a dental mirror and a WHO periodontal probe. Before the examination, subjects cleaned their teeth using a toothbrush. The number of Decayed teeth (D), Missed teeth (M), and Filled teeth (F) were recorded in the DMF form.

In the ICDAS form, based on the instruction published by ICDAS Committee, the condition of teeth at occlusal and plane levels were examined and recorded at both moist and dry states (air-dried for 5 s), according to the codes presented in Tables 1 and 2. In the ICDAS system the condition of each tooth is specified by a tow-digit code, the left digit was recorded by determining the condition of each tooth as follows: 0= Sound; 1= First visual change in enamel seen after drying; 2= Distinct visual change in enamel; 3= Localized enamel breakdown; 4= Underlying dark shadow from dentine; 5= Distinct cavity with visible dentine; and 6= Extensive distinct cavity with visible dentine. The right digit was recorded accord-

Table 2. ICDAS codes associated with decay

Code	Description
0	Intact
1	The first observable change in tooth enamel (it can be seen just after prolonged drying by air, or it is confined to the pit or fissure area
2	A observable and distinct change in enamel
3	Local breakdown of enamel (without visible clinical symptoms of crown involvement)
4	Dark shadow of dentine which is localized below
5	Evident cavity with a visible dentine
6	An extensive evident cavity with visible dentine

Talatof Z, et al. Reliability and Reproducibility of the ICDASI in Evaluation of Dental Decay. J Dentomaxillofacial Radiol Pathol Surg. 2018; 7(3):129-136.

131

ing to Table 2 where the tooth condition is scored from 0 to 9; 0 indicates an intact tooth and other codes [1-9] show teeth with various restorations or tooth losing.

Statistical analysis was performed in SPSS V. 18 software. The Kappa coefficient was used to investigate inter- and intra-examiner reproducibility. According to Cohen, Kappa values ≤0 shows no agreement; 0.01-0.20, none to slight; 0.21-0.40, fair; 0.41-0.60, moderate; 0.61-0.80 substantial; and 0.81-1.00, almost perfect agreement [17].

3. Results

Thirty subjects (20 women and 10 men) participated in this study with the mean age of 28 years. The total number of lost teeth was 119 of which 59 lost due to reasons other than caries, 47 because of caries, and 13 teeth had no eruption. According to DMF index, the total number of filled teeth among subjects was 129 of which 26 had composite filling and 104 had amalgam filling. The total number of decayed teeth based on this index was 37. According to ICDAS index, 346 teeth were considered as decayed teeth. The frequency of subjects based on ICDAS codes is shown in Figure 1, and the distribution of recurrent caries in filled teeth based on ICDAS and DMF indices is shown in Table 3. Based on ICDAS index, 70 recurrent caries were detected of which 63 were non-cavitated, while only 7 cavitated caries lesions were detected by DMF index. The intra-examiner and the inter-examiner Kappa coefficients for the ICDAS and DMF indices are shown in Table 4 (P<0.001). Therefore, according to Cohen [17], there is an almost perfect agreement between intra- and inter-examiners.

4. Discussion

In present study, teeth were examined by both DMF and ICDAS indices. Based on the DMF index, 37 teeth were considered as carious teeth. However, the ICDAS index showed 346 teeth as carious teeth. Considering cavitated lesions, the ICDAS index (codes 5 and 6) revealed similar results to those of the DMF index. As expected, the ICDAS index could demonstrate the stages, depth, and type of carious lesions in examined teeth. The number of recurrent caries using DMF and ICDAS criteria was 7 and 70, respectively.

The Kappa coefficients for inter- and intra-examiner agreement for DMF index were 0.83 and 0.90 and the values for ICDAS index were 0.87 and 0.91, respectively. According to Cohen [17], these values are in almost perfect ranges. Therefore, following proper training of dental students, the ICDAS index seems to be a reliable and reproducible index. Several studies have been performed worldwide to assess the reliability and repro-

Table 3. Number of the recurrent caries in filled teeth according to ICDAS and DMF indices

Recurrent Caries	ICDAS Index	DMF Index
Cavitated lesion in composite fillings	2	2
Cavitated lesion in amalgam fillings	5	5
Early stage lesion in composite fillings	11	-*
Early stage lesion in amalgam fillings	15	
Stabilized lesions in composite fillings	8	-*
Stabilized lesions in amalgam fillings	29	

* Not detected lesions by DMF index

Table 4. Kappa coefficients for inter-examiner and intra-examiner agreement

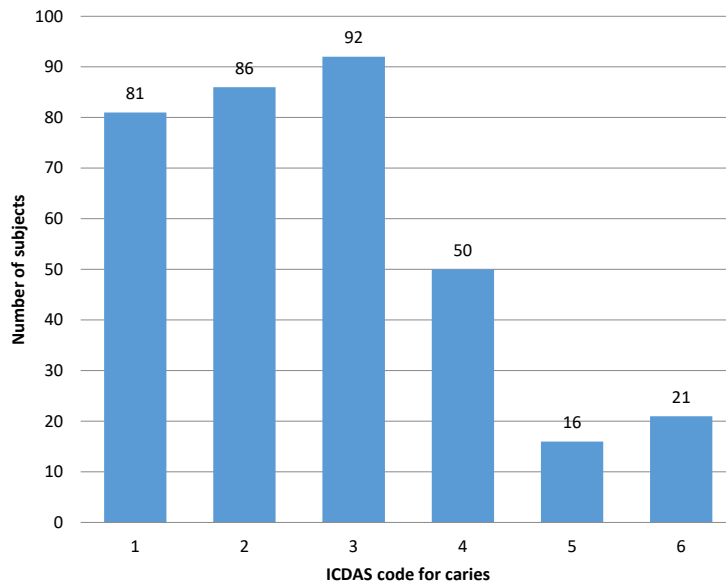| Examiners	Examiner 1	Examiner 2 in Second Examination
Examiner 1 (DMF)	0.90	0.83
Examiner 1 (ICDAS)	0.91	0.87

Figure 1. Frequency of subjects according to ICDAS codes

ducibility of this index. Some of these studies merely performed in vitro [12-14]. To use the ICDAS index in epidemiological studies, its assessment in human subjects is the next step. Jablonski-Momeni et al. in 2008 assessed the ICDAS index in 100 extracted teeth among four dentists. They found the Kappa values for inter- and intra-examiner reproducibility were 0.62-0.83. Although their results were in the acceptable range, our findings reported higher kappa values. Examining the extracted teeth may be the reason for the different outcomes in comparison to human subjects' examinations.

In another study in 2015 in New Delhi, 31 children aged between 3-14 years were examined using the WHO method and the ICDAS index. It was concluded that the ICDAS index had a potential similar to the WHO method in examining dental decays [8]. Braga et al. [18] reported a Kappa coefficient of 0.91 for the ICDAS index on the primary molars extracted in children. Although they performed the study in children, their results were in line with the current study.

A recent study in 2019 was performed by five dentists using ICDAS index, on 270 extracted permanent premolars and molars [15]. The kappa coefficient for inter-examiner reproducibility ranged 0.50-0.68 indicating a moderate agreement. Higher values reported in our study may be due to fewer numbers of examiners (two).

We assessed the human samples in this study, while in vitro samples were examined in the most of previous studies. So the results could be more applicable than in

vitro studies. Most of the teeth with carious lesions detected by the ICDAS criteria in the current study, were classified as code 3. This implies the importance of early caries detection for developing minimal intervention dentistry. These lesions were not detected by the DMF index. Hence, applying the ICDAS criteria seems to be an advantage for this system over traditional systems. Moreover, preventive programs can be performed for these teeth in the early stages.

The number of non-cavitated recurrent caries lesions detected in the present study by ICDAS were 63, while by DMF index, only sevencavitated recurrent caries lesion were identified. Therefore, early detection of non-cavitated recurrent lesions is another advantage for the ICDAS index which can prevent further aggressive treatments. The examiners were evaluated using extracted teeth prior to the study. So, the calibration was performed well in this study. Moreover, the examiners were unaware of the records of each other.

Further studies should be performed with a larger sample size. In Iran, the ICDAS index is not commonly taught in dental schools; therefore, we had difficulties in educating and calibration of examiners. In this regard, the examiners inevitably traveled to Kerman city to calibrate for this index.

Less studies have been performed in Iran on applying the ICDAS index; hence, further studies should be designed with a larger sample size and more calibrated examiners across the country. Dentists should be trained

Talatof Z, et al. Reliability and Reproducibility of the ICDASI in Evaluation of Dental Decay. J Dentomaxillofacial Radiol Pathol Surg. 2018; 7(3):129-136.

133

for applying the ICDAS index in diagnosing dental caries. If this system performed well, preventive dental care can lead to minimal intervention dentistry. Most of the carious teeth classified as code 1 to 4 in ICDAS can be arrested and rematerialized as sound teeth by applying on-time preventive programs. Therefore, integration of this system criteria in the dental curriculum can be beneficial to promote oral health. Moreover, ICDAS system can be applied in future epidemiological studies.

5. Conclusion

The ICDAS index was feasible for dental students following proper training. The reliability and reproducibility of ICDAS and DMF indices were great. Hence, it can provide appropriate information to arrest the early carious lesions by preventive programs.

Ethical Considerations

Compliance with ethical guidelines

The all participated in the study voluntarily and with full informed consent. Permission was obtained from the Dental School of Shiraz University of Medical Sciences (Number Grant. 8894136).

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Authors contribution's

Conceptualization: All authors; Methodology: Zahra Talattof, Aida Arazi; Investigation: All authors; Writing -original draft: All authors; Writing-review & editing: Arghavan Behbahanirad, Azita Azad; Supervision: Azita Azad, Arghavan Behbahanirad.

Conflict of interest

There are no conflicts of interest to declare.

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135

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