Evaluation of International Caries Detection and Assessment System (ICDAS)-related Caries Severity among Caries Risk Groups in Pendul District: An Observational Study

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Aim: The aim of this study was to evaluate the difference in severity of caries code 5 or 6 according to the International Caries Detection and Assessment System (ICDAS) among caries risk groups in Pendul district. Materials and Methods: This was an observational study with a cross-sectional design. A total of 730 people who were residing in Pendul district belonged to population of this study. One of the inclusion criteria of this study was the people who were ≥5 years old according to World Health Organization. On the basis of our preliminary survey, we confirmed 660 people who fulfilled the inclusion criteria. The subjects were selected using the accidental simple random sampling. Slovin's formula was used with margin of error 8% to obtain the 138 subjected people. Of the 138 subjects studied, there were only 87 people who could be included in the further inclusion criteria by having dental caries code 5 or 6 according to ICDAS. The Kruskal–Wallis statistical test was used to analyze the differences as the data belong to nonparametric and there were three variable groups. Next, the Mann–Whitney U was used to test the differences between these variables. Results: The results of this study showed that there was a significant difference in the severity of caries among caries risk groups (P < 0.05). Conclusion: The higher the caries risk the higher the caries severity that was observed. This result supported the potential use of caries risk assessment as a predictive and supportive tool to prevent the increasing caries severity in the community.

Keywords: Caries risk, caries risk assessment, caries severity, ICDAS

INTRODUCTION

Dental caries is a complex and biologically dynamic process of tooth decay.[1] The term “caries” is taken from the Latin word that means “damage or decay.” This damage can affect the enamel, dentine, and cementum.[2] Dental caries involves progressive damage to enamel, dentine, and cementum that is initiated by bacterial activity on the surface of vulnerable teeth.[3]

Dental caries is one of the most common human diseases and affects most individuals.[4] Epidemiological studies of dental caries are very useful in determining the needs and effectiveness of dental care. The most common epidemiology tool of dental caries is the Decay–Missing–Filled Teeth (DMF-T) index.[1] Based on the results of the basic health research called Riskesdas in 2018, DMF-T score in Indonesia stood at 7.1, whereas the DMF-T score in 2013 Riskesdas stood at 4.6, that is, it increased by 2.5. The Special Region

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of Yogyakarta itself has a DMF-T score of 5.9, above the average Indonesian DMF-T score. The Pendul district region is one of the selected districts having partnership collaboration with our community and preventive dental health center. According to our previous unpublished dental problem-related data taken from people of Pendul district, approximately 80% of the population complained about toothache within a year.

The International Caries Detection Assessment System (ICDAS) is another tool used to detect the presence of dental caries lesions. This system can record the severity and incidence of dental caries lesions. The ICDAS uses codes that range from the initial changes seen in enamel to large cavities. Code 0 is a healthy tooth in which there are no signs of caries lesions, codes 1 and 2 show early signs of caries lesions in tooth enamel, codes 3 and 4 describe caries lesions that are beginning to spread in tooth enamel, whereas codes 5 and 6 describe the most severe caries lesions, extending into the dentine.

The basis for the development and application of caries prevention programs is a good understanding of caries as a multifactorial disease that is caused by interactions between the composition of microorganisms in the plaque, substrate, and host factors. According to Purkait, during caries formation, bacteria ferment carbohydrates to produce acids that damage the tooth structure. The bacteria synthesize sucrose from carbohydrates, which then helps the bacteria and plaque to attach and grow on hard and smooth tooth surfaces within a certain period.

The treatment procedures for dental caries have been previously conducted according to the assessment of demineralization status or cavitation on the tooth surface, followed by caries tissue removal and appropriate restorative placement. However, it is now known that caries management protocols that do not address the responsible risk factors for the disease will lead to new caries lesions and the failure of each given treatment. Assessing patient caries risk status is an important component in modern dental caries management, the emphasis being on nonoperative or preventive approaches. One method of commonly used caries risk assessment (CRA) involves conducting surveys using CRA questionnaire, which was formulated by the American Dental Association (ADA).

The purpose of this study was to evaluate whether there are differences or not in the severity level of caries lesion as coded 5 or 6 according to the ICDAS among caries risk groups in Pendul district, Argorejo, Sedayu, Bantul, the Special Region of Yogyakarta.

**MATERIALS AND METHODS**

**SETTING AND DESIGN**

This was an observational study with a cross-sectional design. The study took place from December 2018 to January 2019 in Pendul district. The population of this study covered the local people who were residing in Pendul district, Argorejo, Sedayu, Bantul, the Special Region of Yogyakarta, which comprises four subdistricts Rukun Tetangga (RT) (family based-cluster system): 49, 50, 51, and dan 52 with total 730 of the population. This study was approved by the National Ethics Committee Board, branch of the Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta under the certification number 172/EP-FKIK-UMY/V/2019.

**SAMPLING CRITERIA**

The inclusion criteria of the study were those who were residing in Pendul district, those who were 5 years old or above, and those who were with caries code 5 or 6 according to the ICDAS. The exclusion criteria of the study were those who were less than 5 years old, those who were without caries code 5 or 6 according to ICDAS, and those who were not willing to participate in the study. On the basis of the preliminary survey, the subjects of this study were the 660 people who were residing in Pendul district aged ≥5 years. The subjects were selected using the accidental simple random sampling with the criteria of age ≥5 years. This study used Slovin’s formula with margin of error 8% to obtain the amount of people to be the subjects:

\[
n = \frac{N}{1 + N(\alpha)},
\]

\[
n = \frac{660}{1 + 660(0.08)},
\]

\[
n = \frac{660}{1 + 4.224},
\]

\[
n = 138,
\]

where \( n \) indicates the sample number, \( N \) indicates total population, and \( \alpha \) indicates the margin of error.

Of the 138 subjects studied, only 87 people who had dental caries code 5 or 6 according to ICDAS were included in the inclusion criteria; hence, the power size sample was approximately 75.15%. None of the subjects dropped out from the study.

**METHOD AND OBSERVATIONAL PARAMETERS**

Eighty-seven eligible subjects were then selected using the accidental sampling method. Caries severity was
assessed using the ICDAS code 5 or 6 form. The clinical appearances of caries below are used as the diagnosis criteria in conducting the study\cite{12}:

Although the caries risk status was assessed using the CRA questionnaire according to the ADA platform, CRA tools could address oral health disparities and enhance the efficiency of the oral health care system. CRA tools were designed by ADA for children 0 through 6 years old and people 7 years and older. A patient is considered at low risk in the absence of moderate- and high-risk factors and at the high risk when at least 1 high-risk factor is identified.

Reliability test of caries risk assessment from ADA validation in Pendul district

| Cronbach α | Number of researchers |
|------------|-----------------------|
| 0.710      | 5                     |

Interclass correlation coefficient test of caries risk assessment from ADA in Pendul district

| Interclass correlation | 95% confidence interval | F Test with true value 0 |
|------------------------|-------------------------|--------------------------|
|                        | Lower Bound             | Upper Bound              | Value | df1 | df2 | Sig.     |
| Single measures        | 0.328                   | 0.138                    | 0.573 | 3.443 | 19  | 76  | 0.0006  |
| Average measures       | 0.710                   | 0.444                    | 0.870 | 3.443 | 19  | 76  | 0.0006  |

The result of interclass correlation coefficient test shows that the average of the scores of the five researchers are reliable (interval of 0.61–0.80 with 95% confidence), suggesting that despite the apparent differences in scoring, the process was successful in training the researchers to separate different levels of performance.

Even after several calibrations, still there was a possibility for having bias during the observation. Such information may affect in differences in the way information is collected, measured, or interpreted by each researcher of the study groups. The way of minimizing observer bias is to develop a protocol for the information collection, measurement, and interpretation, use of standardized questionnaires, and train the researchers.

**Statistical analysis**

Data were analyzed by using the Statistical Package for the Social Sciences (SPSS) software program, version 16.0 (IBM, Chicago, Illinois), followed by the Kruskal–Wallis test and the Mann–Whitney U test. The Kruskal–Wallis statistical test was used to analyze the differences as the data belong to nonparametric and there were three variable groups, with a \( P \) value of less than 0.05 and confidence interval of 95%. Next, the Mann–Whitney \( U \) was used to test the differences between variables with a \( P \) value of 0.05 and confidence interval of 95%. Our study design approved and considered the ethical guidance from the Declaration of Helsinki prior participant recruitment and data collection.

| Table 1: Characteristics of participants by age |
|-----------------------------------------------|
| Age                                           |
| Frequency | Mean number of teeth with caries code 5 or 6 ICDAS | The number of participants in each caries risk group (CRA) |
|----------|---------------------------------|---------------------------------|
| 5–11 years old | 20 | 2.1 teeth | 1 | 7 | 12 |
| 12–25 years old | 9 | 1.78 teeth | 1 | 4 | 4 |
| 26–45 years old | 19 | 2.47 teeth | 1 | 6 | 12 |
| 46–65 years old | 33 | 3.03 teeth | 0 | 13 | 20 |
| >65 years old | 6 | 2.83 teeth | 0 | 3 | 3 |

ICDAS = International Caries Detection and Assessment System
RESULTS

A total of 138 research subjects were invited for interview and intraoral clinical examinations. Only 87 met the inclusion criteria to be the participant in this study.

Table 1 shows the sample population characteristics. Most participants (33 people) were 46–65 years old. The highest average number of teeth with caries code 5 or 6 in this study (3 teeth) was observed from this group.

Table 2 shows that among the 138 subjects, 87 were having dental caries code 5 or 6 according to ICDAS, which was 63.04% within the population. Further categorization of these 87 participants is described in Figure 1 which indicated the number of severe caries teeth in each participant which showed that most of the individual person in the population had at least one to three severe caries lesions.

On the basis of the caries risk identification by the CRA approach, all the participants of this study in Pendul district could be categorized into three groups as shown in Table 3. Among 87 subjects who had teeth with caries code 5 or 6 according to the ICDAS predominantly belonged to the high risk of caries group.

Table 4 shows the results of the Shapiro–Wilk normality test. The $P$ values for the moderate and high risk of caries groups were 0.0002 and 0.00007, which showed that the data were not normally distributed ($P < 0.05$). The Kruskal–Wallis test was then performed because the data were nonparametric and there were more than two variable groups. The result from the Kruskal–Wallis test showed the $P$ value of 0.007, meaning that there was a significant difference in caries severity among caries risk groups as indicated in Table 5. The Mann–Whitney $U$ test was then carried out to determine the most severe caries condition among caries risk groups as shown in Table 6. Table 6 shows the most significant differences in caries severity, which was indicated from the comparison between the low and high caries risk groups and showed that the biggest significant severity different could be observed between the high-risk group and the low-risk group.

| Caries risk groups | Frequency (5 or 6 scored by ICDAS) | Percentage (%) |
|--------------------|-----------------------------------|----------------|
| Low                | 3                                 | 3.45           |
| Moderate           | 33                                | 37.93          |
| High               | 51                                | 58.62          |
| Total              | 87                                | 100            |

Table 3: Risk groups based on caries risk assessment

Table 4: Results of the Shapiro–Wilk normality test

| Caries risk groups | Shapiro–Wilk Statistic | df  | Sig.  |
|--------------------|------------------------|-----|-------|
| Moderate           | 0.261                  | 33  | 0.0002 |
| High               | 0.212                  | 51  | 0.00007|

Table 5: Result of Kruskal–Wallis test

| Caries risk groups (CRA) | Mean rank (average number of teeth scored 5 or 6 by ICDAS) | Sig.  |
|--------------------------|----------------------------------------------------------|-------|
| Low                      | 13.00                                                    | 0.007 |
| Moderate                 | 37.73                                                    |       |
| High                     | 49.88                                                    |       |

Table 6: Results of Mann–Whitney $U$ test

| Caries risk groups | Mean rank | Sig.  |
|--------------------|-----------|-------|
| Low                | 7.50      | 0.045 |
| Moderate           | 19.50     |       |
| Low                | 7.50      | 0.020 |
| High               | 28.68     |       |
| Moderate           | 35.23     | 0.023 |
| High               | 47.21     |       |
**Discussion**

This study revealed the difference in caries severity according to the ICDAS among low, moderate, and high caries risk groups according to the ADA in Pendul district. Participants who were 46–65 years old had the highest number of teeth with caries code 5 or 6 (approximately three teeth in average), and most individuals in this group had a high risk of caries. This pattern may be related to factors that affect dental health status in accordance with the Senjaya's study, such as the reduced production of saliva with age, and the habit of teeth and mouth cleaning. The decreasing production of saliva and its various enzymes can cause dry mouth, decrease the ability to taste food, and possibly accelerate the accumulation of plaque and calculus formation, which can lead to caries lesion.

The Kruskal–Wallis test showed a significant difference in the mean number of teeth having caries code 5 or 6 according to the ICDAS between each caries risk group ($P = 0.007$). The results of this study are consistent with those of Carta et al.’s study, who reported a difference in the incidence of caries severity code 5 or 6 according to the ICDAS in low, medium, and high caries risk groups.

The Mann–Whitney $U$ test also showed significant differences among the low, medium, and high caries risk groups. Again, the results were consistent with Carta et al.’s study, who found that severe caries, namely codes 5 and 6 according to ICDAS, was mostly found in individuals with moderate and high caries risk compared to low caries risk.

The difference in caries severity could be due to the presence of different risk factors that support the occurrence of caries in each caries risk group. On the basis of the results of the CRA of the ADA in Pendul district, the frequent consumption of sweet foods and drinks between meals is a common and also critical risk factor for severe caries progression; indeed, Bebe et al. reported that people who consume high quantities of glucose or sweet foods are 7.1 times more likely to experience dental caries than those who consume little or no sweet foods. Other risk factor possibilities could be also incorporated since there are three of more new cavities, non-cavity caries lesions, new restorations, and teeth lost due to caries in the last 36 months. Experiencing severe dry mouth (xerostomia) is also a high caries risk factor as the reduced flow of saliva in the mouth can reduce the salivary buffer capacity, which can then reduce the pH of saliva so that it becomes one of the factors causing the development of caries.

The risk factors that support a moderate caries risk in this study included the exposure of teeth to fluoride. Cruvinel et al. showed that the habit of teeth brushing with toothpaste containing fluoride could contribute to a lower incidence of dental caries. Having one or two new cavities and/or noncavity caries lesions or restorations in the last 36 months also indicates a moderate caries risk. The presence of plaque is also a risk factor for caries incidence. For example, Utami reported that individuals with a high dental plaque index have 3.3 times greater risk for dental caries than individuals with a low plaque index. The presence of unusual dental morphology that interferes with dental and oral hygiene could also be a risk factor for dental caries. Research conducted by Bebe et al. showed that crowded teeth have a 5.6 times greater risk for dental caries than normal teeth. Individuals with a low caries risk do not have these high and moderate caries risk factors. Since the dental plaque is one of the critical caries risk factor, proper plaque control procedures are essential. Beside the regular plaque control procedures, a unique predatory bacterium such as *Bdellovibrio bacteriovorus* recently become another interesting subject for being used to control dental plaque formation.

The existence of the significant difference in the severity of carious lesion in each participant among caries risk groups and also the higher caries severity which predominantly could be observed from the high caries risk group indicated corresponding prediction between CRA categorization, implying personal habits and further carious lesion progression.

Taken together, this study suggested the more benefits and supports for using CRA from the ADA to educate and promote the preventive evidence-based approach toward the community through improving individual habits and self-awareness in order to avoid the extensive progression of the carious lesion as early as possible. This study has several limitations during on site data acquiring such as participant accessibility problem, time limitation, number of research volunteer. Those limitations could affect to the interpretation bias of this study. Further studies are critical to improve time for collecting the data, number of the research volunteer and the access difficulty to explore the rural area which could affect in subject selection. The further studies are critical to improve and strengthen this hypothesis such as through incorporating the bigger coverage of sample population and involving multiple observers.

**Conclusion**

According to our study, it was assumed that reduce the caries severity occurrence among the community. Enhancing both promotive and preventive actions as early as possible based on CRA from ADA as a
supporting predictive tool will be beneficial to promote the arrested carious lesion, whereas taking an early interceptive treatment may also prevent the tooth for being extracted.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

AUTHOR CONTRIBUTIONS

Not applicable.

ETHICAL POLICY AND INSTITUTIONAL REVIEW BOARD STATEMENT

Not applicable.

PATIENT DECLARATION OF 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.

DATA AVAILABILITY STATEMENT

Not applicable.

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