



# The effect of Turkish dental practitioners' perceptions and experience of ICDAS II on caries treatment decisions

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## Abstract

**Background:** The International Caries Detection and Assessment System (ICDAS) was developed to integrate several criteria systems into one standard system for caries detection and assessment. The aim of this study was to identify Turkish dental practitioners' perceptions and experience about ICDAS II and assess how they could affect clinical decision-making.

**Methods:** A web-based data collection form, including demographic characteristics, experience of caries detection systems, and two different clinical images with caries and treatment options, was given to Turkish dental practitioners. Data were analyzed with the chi-square test and logistic regression using SPSS 22.0 software (IBM, Chicago, IL) at a significance level of  $P < 0.05$ .

**Results:** Data collection forms were completed by 382 general dental practitioners. For the first clinical scenario 70.7% of the practitioners decided that no treatment was required. For the second clinical scenario 89.5% of the practitioners decided to perform tooth restoration. Considering the clinical scenario 2 treatment options, while practitioners working in the public hospital marked amalgam restoration at a higher rate, practitioners working in private clinics marked composite resin restoration and root canal treatment at a higher rate ( $P < 0.05$ ). With regard to effects on treatment choices for clinical scenarios, binary logistic regression analysis found no significant effects of gender, age, or institution ( $P > 0.05$ ).

**Conclusion:** The visual caries detection system, ICDAS II, was a useful tool in standardizing caries diagnostic skills for practitioners and improving decision-making abilities on caries treatment.

**Keywords:** Assessment, Clinical decision-making, Dental caries, Detection, Dental practice management

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## Introduction

The difficulty of identifying and categorizing dental caries has been acknowledged since the late 19th century.<sup>1</sup> Several clinical caries determination criteria have been developed that describe the various stages of dental caries. However, most of these criteria were insufficient to detect the earliest symptoms of the disease.<sup>2</sup> Therefore, the practitioner should use an accurate classification to estimate lesion depth when clinically diagnosing a carious lesion. The best available treatments for various kinds of carious lesions should be included in the classification system.<sup>3</sup> The clinical caries detection criteria, which are usually based on visual examination and subjective evaluations such as color, translucency, and hardness have high specificity and low sensitivity.<sup>2,4</sup> In order to reduce subjectivity and increase sensitivity,<sup>2,5</sup> a classification system has been proposed to support clinicians' appropriate treatment decisions using the currently available non-invasive and invasive approaches for different forms of caries lesion processing.<sup>6-8</sup>

After undergoing various adjustments, the

2002-developed International Caries Detection and Assessment System (ICDAS) was introduced as ICDAS II in 2005.<sup>9</sup> ICDAS II is a basic, reasonable, and evidence-based system for identifying and categorizing dental caries.<sup>10</sup> The ICDAS II criteria, based on visual inspection of clean, plaque-free teeth, describes six stages of caries severity, varying from initial changes visible in the enamel to extensive cavitation in dentin.<sup>2</sup>

The important advantage of the ICDAS II codes was making the identification of the caries process and its treatment uniform in dental practice.<sup>11</sup> It has been reported that dentists show considerable variation in the management of treatment decisions. Uncertain factors, such as socioeconomic considerations, may influence the dentist's decision-making process when selecting the best therapeutic approach. This process could be divided into three stages. The detection phase is the initial stage, during which a disease is found. A diagnosis-based decision about intervention is made in the second stage. The third step is selecting a treatment from the available ones.<sup>12</sup>



Many schools<sup>2,13-15</sup> have tried e-learning programs to teach the ICDAS II for caries diagnosis to dental students. Trends in dentistry show that preventive and restorative approaches in all cases must be evidence-based. However, it is easy to use ICDAS II, and it has been used more extensively in the last decade, especially in epidemiologic studies. Whether or not ICDAS II is widely used among dental practitioners in daily clinical routines remains unknown.

Therefore, the current study's objective was to determine how Turkish dental practitioners perceived and used ICDAS II, which could have an impact on clinical decision-making perspectives as evidenced by two particular cases of varying degrees of severity.

## Methods

Ethical approval (2020.11.09-10) was granted for this cross-sectional study from the Ankara Yıldırım Beyazıt University Ethics Committee. Then, permission was obtained from the Turkish Dental Association for the application of the data collection form (issue No.: 011.1446). According to data published by the Turkish Dental Association, the total number of general dental practitioners in Turkey was 34045 in 2019. The sample size was calculated using the formula  $n = \frac{Nt^2 pq}{d^2} (N - 1) + t^2 pq$ .

The required minimum sample size was calculated as 380 at 95% confidence level.

This cross-sectional study was performed on volunteer participants graduated from the Faculty of Dentistry who could read in Turkish and had no visual impairment between December 1, 2020 and February 1, 2021. The data collection form was prepared on a platform called Survey Monkey and sent to the participants online. This data collection form was sent to dentists who are members of the Turkish Dental Association via email. Online survey questions invited general dental practitioners who were interested in participating to select between preventive and restorative solutions for various clinical circumstances within a 10-minute time limit.

The web-based data collection form used consists of four parts. In the first part, approval was obtained from the participants. The second part includes questions about the socio-demographic characteristics of the participants, including their age, gender, city of residence, and years' experience as a practitioner. In the third part, participants marked the caries classification methods they already knew, and brief information was given about ICDAS II criteria (Figure 1A). In the last part, there were questions about two different clinical scenarios and the treatment options of these clinical scenarios [(In 9<sup>th</sup> and 11<sup>th</sup> questions the ICDAS codes were asked (Q9: ICDAS code 2, Q11: ICDAS code 6)]. Question 9 was related to clinical scenario 1. Clinical scenario 1 (Q9) was about a 21-year-old female patient with a low risk of caries, who

visited the dentist regularly; the lesion that needed to be identified was a clear and visible change in enamel, and the answer was ICDAS 2. Question 11 was related to clinical scenario 2. Clinical scenario 2 (Q11) was about a 36-year-old male patient with a high risk of caries; the lesion that needed to be identified was a large cavitation with visible dentine, and the answer was ICDAS 6 (Figure 1B). In the 10<sup>th</sup> and 12<sup>th</sup> questions, treatment options were listed: no treatment needed, 6-month clinical-radiological follow-up, fluoride gel/varnish application, pit and fissure sealant application, resin infiltration application, preventive resin application, glass-ionomer restoration, composite resin restoration, amalgam restoration, root-canal treatment, crown application, and tooth extraction.

## Statistical analysis

The data extracted from the completed data collection forms were exported into an Excel file. Chi-square tests were performed using SPSS 22.0 software (IBM, Chicago, IL) at  $P < 0.05$  significance level. Logistic regression modelling calculated at 95% confidence level was used to assess associations between dependent variables (invasive and non-invasive treatments) and the independent variables (gender, age, and institution).

## Results

A total of 485 dentists participated in this study and 382 (258 female and 124 male) of them finished the whole data collection form. The mean age of the participants was  $33.6 \pm 9.8$ . Table 1 provides a description of the participants' sociodemographic characteristics. Table 2 demonstrates the distribution of the caries classification system reported by the participants.






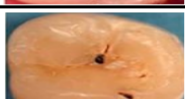

Differences were found between male and female ( $P = 0.0001$ ) participants in classifications according to ICDAS II. Participants in the 20–29 age group had received more training about ICDAS II than other age groups ( $P = 0.0001$ ).

For the first clinical scenario, 53.1% of the participants gave an ICDAS 2 response, and most of the participants (70.7%) believed that no treatment was required (Figure 2). For the second clinical scenario, 93.5% of the participants gave an ICDAS 6 response, and most of the participants (89.5%) chose composite resin restoration (Figure 2).

There were statistically significant differences between genders among those who chose 6-month clinical-radiological follow-up and fluoride gel/varnish application for the treatment of clinical scenario 1 ( $P < 0.05$ ). A large number of participants who chose 6-month clinical-radiological follow-up for clinical scenario 1 were in the 20–29 age group ( $P = 0.015$ ; Table 3).

Among participants who chose 6-month clinical-radiological follow-up and root-canal treatment for the treatment of clinical scenario 2, differences were found

A: ICDAS II criteria

ICDAS II CRITERIA		DEFINITION
ICDAS 0		Sound enamel surface (After drying the enamel surface for 5 seconds, there is no evidence of caries.)
ICDAS 1		The first visual changes in the enamel (There is no sign in the enamel when the tooth surface is moist. There are opacity or color changes that can be observed after the surface has been dried with air for 5 seconds.)
ICDAS 2		Significant visual changes in enamel (Opacity or color changes are observed when the tooth is both moist and dry.)
ICDAS 3		Regional enamel destruction (When the tooth is dried, tissue loss is observed, but it does not contain dentin tissue.)
ICDAS 4		Dark shade reflected from dentine (The structural integrity of the enamel tissue may or may not be deteriorated.)
ICDAS 5		Visible cavitation formation including dentine
ICDAS 6		Large carious cavity with dentine

B: Clinical Scenarios

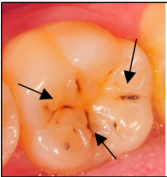
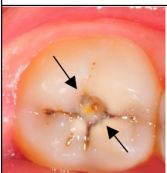
	Scenario 1: In a 21-year-old female patient with a low risk of caries, who came to the dentist regularly, a clear and visible change in enamel was detected. According to this; what criterion does such a case get in the ICDAS II classification?
	Scenario 2: In a 36-year-old male patient with high caries risk, large cavitation with visible dentine was detected. According to this; what criterion does such a case take in the ICDAS II classification?

Figure 1. ICDAS criteria<sup>10</sup> and clinical scenarios

between age groups ( $P < 0.05$ ). A higher number of participants who marked root-canal treatment for clinical scenario 2 were in the 20–29 age group ( $P = 0.044$ ). A high number of participants working in private practices chose root canal treatment and composite resin restoration for clinical scenario 2 treatment; a high number of participants working in public hospitals chose amalgam restoration ( $P < 0.05$ ; Table 4).

The results of binary logistic regression analysis regarding the influence of gender, age, and institution on treatment decisions (invasive and non-invasive) for the clinical scenarios were not significant ( $P > 0.05$ ).

### Discussion

The present study found differences in Turkish dental

practitioners' perceptions and experience about ICDAS II that could affect clinical decision-making. Dental caries scoring and classification systems help practitioners standardize the complicated nature of the caries assessment process.<sup>12</sup> ICDAS II, a new set of visual criteria, is used to detect and evaluate caries ranging from initial changes in enamel to extensive cavitation on tooth surfaces. It is also used for clinical follow-up, scientific research, and epidemiological studies.<sup>16</sup>

The major goal of the current research was to determine how dental practitioners' views and experiences with the ICDAS II criteria might influence the determination of clinical case severity and possible treatments. The data collection form was given to the dental practitioners working in Turkey, currently and actively engaged in the

clinical practice of dental caries diagnosis and treatment. On a global level, the cariology curricula could range significantly, and there were significant variations in the organizational structure and didactic style.<sup>10</sup> Dental students have long been taught how to examine caries using World Health Organization (WHO) criteria, as well as its morphological structure, localization, development, and rate of progression; however, in the last ten years, the inclusion of ICDAS II criteria in the dentistry curriculum has gained widespread acceptance. In the present study,

it was found that the number of those who received training on ICDAS II was higher in practitioners aged 20–29. This could be related to developments in the curricula, providing these dentists with more training on this caries detection system at universities, compared with more experienced practitioners.

Another important purpose of the present study was to identify dentists' monitoring and decision making processes in relation to treatment strategies using two clinical scenarios (Figure 2). Clinical scenario 1 (ICDAS code 2) illustrated a patient with a clear and visible change in enamel surface and clinical scenario 2 (ICDAS code 6) illustrated a large visible cavitation. In the present study,<sup>12</sup> most practitioners considered preventive (non-invasive) interventions to be the best option for clinical scenario 1 (ICDAS code 2). Additionally, more practitioners in the 20–29 age group marked the 6-month clinical-radiological follow-up (76.6%). Very few chose operative treatment (preventive resin application (13.1%), glass ionomer restoration (1.8%), and composite resin restoration (5.8%)), none of which could be considered appropriate. Overtreatment or potentially unnecessary restoration eliminate the chance of remineralization and put patients in a restorative cycle.<sup>17</sup> Because any repair necessitates the loss of a sizable quantity of intact tissue, is permanent, and will probably require replacement with additional tissue removed in the future, the timing of intervention is crucial to avoid the 'death spiral of restoration,' a circle of care.<sup>18</sup> Hence, it was ethically wrong and biologically illogical to disregard non-operative treatment.<sup>19</sup> Dentists have adopted a restorative strategy for a long time, choosing to treat caries rather than prevent it. Recent trends have made an effort to distinguish between early lesions that require preventative measures and lesions for which surgical care is advised. Biologically based approaches have improved our understanding of the caries treatment process, but clinical implementation of comprehensive caries care has failed in many nations.<sup>20</sup>

For clinical scenario 2 (ICDAS code 6), while

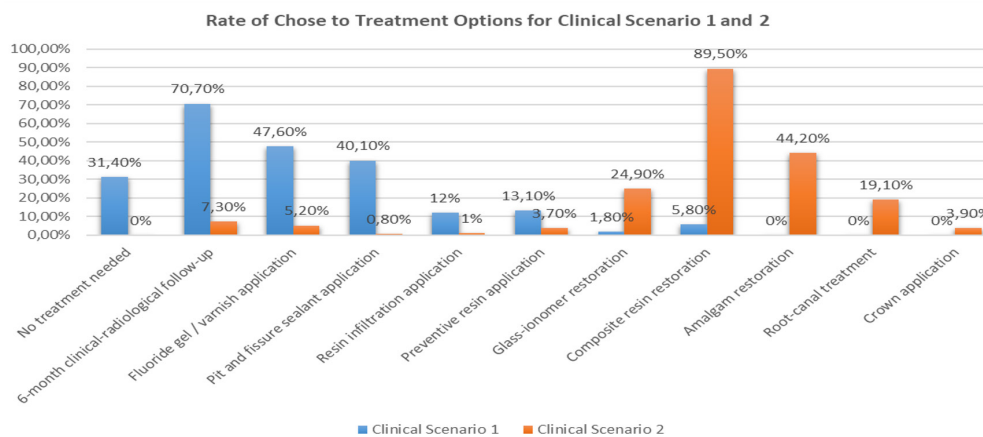
**Table 1.** The socio-demographic characteristics of the participants.

Variable	No. (%)	
Gender	Female	258 (67.5)
	Male	124 (32.5)
Age	20–29	175 (45.8)
	30–39	124 (32.4)
	40+	83 (21.8)
Institution	Public hospital	81 (21.2)
	University clinic	136 (35.6)
	Private practice	159 (41.6)
	Other	6 (1.6)

**Table 2.** Caries classification system chosen by the participants trained in the past

	No. (%)
The morphological structure of caries	366 (95.8)
The localization of caries	364 (95.3)
The development of caries	350 (91.6)
The progression rate of caries	313 (81.9)
The caries classification of WHO	188 (49.2)
The Nyvad system	136 (35.6)
The UniViSS System	51 (13.4)
The ICDAS II	199 (52.1)

Note: UniViSS, universal visual scoring system; ICDAS, International Caries Detection and Assessment System; WHO, World Health Organization.



**Figure 2.** Treatment options and preferences of the participants for clinical scenario 1 and 2

**Table 3.** Distribution of participants according to treatment options for clinical scenario 1 by gender, age, and institution ( $P < 0.05$ )

		No treatment needed	6-month clinical-radiological follow-up	Fluoride gel/ varnish application	Pit and fissure sealant application	Resin infiltration application	Preventive resin application	Glass-ionomer restoration	Composite resin restoration
Gender	Female	78 (30.2%)	192 (74.4%)	140 (54.3%)	108 (41.9%)	36 (14%)	37 (14.3%)	3 (1.2%)	11 (4.3%)
	Male	42 (33.9%)	78 (62.9%)	42 (33.9%)	45 (36.3%)	10 (8.1%)	13 (10.5%)	4 (3.2%)	11 (8.9%)
	<i>P</i>	0.473	<b>0.021</b>	<b>0.0001</b>	0.298	0.137	0.376	0.221	0.115
Age	20–29	52 (29.7%)	134 (76.6%)	89 (50.9%)	63 (36%)	22 (12.6%)	28 (16%)	4 (2.3%)	8 (4.6%)
	30–39	48 (38.7%)	87 (70.2%)	59 (47.6%)	55 (44.4%)	18 (14.5%)	12 (9.7%)	1 (0.8%)	10 (8.1%)
	40+	20 (24.1%)	49 (59%)	34 (41%)	35 (42.2%)	6 (7.2%)	10 (12%)	2 (2.4%)	4 (4.8%)
	<i>P</i>	0.069	<b>0.015</b>	0.331	0.315	0.276	0.266	0.613	0.406
Institution	Public hospital	25 (30.9%)	60 (74.1%)	44 (54.3%)	37 (45.7%)	12 (14.8%)	12 (14.8%)	1 (1.2%)	6 (7.4%)
	University	49 (36%)	96 (70.6%)	70 (51.5%)	52 (38.2%)	17 (12.5%)	16 (11.8%)	1 (0.7%)	3 (2.2%)
	Private practice	44 (28.4%)	108 (69.7%)	64 (41.3%)	61 (39.4%)	17 (11%)	21 (13.5%)	5 (3.2%)	12 (7.7%)
	Other	2 (20%)	6 (60%)	4 (40%)	3 (30%)	0 (0%)	1 (10%)	0 (0%)	1 (10%)
	<i>P</i>	0.454	0.783	0.173	0.635	0.542	0.911	0.456	0.102

**Table 4.** Distribution of participants according to treatment options for clinical scenario 2 by gender, age, and institution ( $P < 0.05$ )

		6-month clinical-radiological follow-up	Fluoride gel / varnish application	Pit and fissure sealant application	Resin infiltration application	Preventive resin application	Glass-ionomer restoration	Composite resin restoration	Amalgam restoration	Root-canal treatment	Crown application
Gender	Female	22 (8.5%)	15 (5.8%)	2 (0.8%)	0 (0%)	12 (4.7%)	62 (24%)	232 (89.9%)	118 (45.7%)	44 (17.1%)	11 (4.3%)
	Male	6 (4.8%)	5 (4%)	1 (0.8%)	4 (3.2%)	2 (1.6%)	33 (26.6%)	110 (88.7%)	51 (41.1%)	29 (23.4%)	4 (3.2%)
	<i>P</i>	0.278	0.626	–	<b>0.011</b>	0.243	0.585	0.854	0.396	0.182	0.782
Age	20–29	22 (12.6%)	10 (5.7%)	2 (1.1%)	2 (1.1%)	10 (5.7%)	42 (24%)	156 (89.1%)	78 (44.6%)	39 (22.3%)	10 (5.7%)
	30–39	5 (4%)	5 (4%)	1 (0.8%)	2 (1.6%)	4 (3.2%)	32 (25.8%)	110 (88.7%)	63 (50.8%)	26 (21%)	3 (2.4%)
	40+	1 (1.2%)	5 (6%)	0 (0%)	0 (1.6%)	0 (0%)	21 (25.3%)	76 (91.6%)	28 (33.7%)	8 (9.6%)	2 (2.4%)
	<i>P</i>	<b>0.001</b>	0.761	1	0.822	0.055	0.934	0.785	0.053	<b>0.044</b>	0.333
Institution	Public hospital	3 (3.7%)	4 (4.9%)	2 (2.5%)	2 (2.5%)	6 (7.4%)	14 (17.3%)	69 (85.2%)	51 (63%)	15 (18.5%)	7 (8.6%)
	University	11 (8.1%)	8 (5.9%)	1 (0.7%)	2 (1.5%)	2 (1.5%)	45 (33.1%)	122 (89.7%)	62 (45.6%)	18 (13.2%)	2 (1.5%)
	Private practice	13 (8.4%)	8 (5.2%)	0 (0%)	0 (0%)	6 (3.9%)	34 (21.9%)	143 (92.3%)	53 (34.2%)	40 (25.8%)	6 (3.9%)
	Other	1 (10%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (20%)	8 (80%)	3 (30%)	0 (0%)	0 (0%)
	<i>P</i>	0.563	0.976	0.185	0.213	0.161	<b>0.041</b>	<b>0.28</b>	<b>0.0001</b>	<b>0.019</b>	0.082

practitioners working in public hospitals chose amalgam restoration at a higher rate, practitioners working in private clinics chose composite resin restoration and root canal treatment at a higher rate. Practitioners working in public hospitals avoid composite resin because the application process is complex, it is affected by many factors such as saliva and blood, and it has a long application time. Unfortunately, there are too many patients in public hospitals and short treatment periods make this result inevitable. Tellez et al also explained that health care practitioners' decisions could change if the amount of payments for preventive treatment options are increased.<sup>21</sup>

Dental practitioners' natural attitudes and learned concepts (caries diagnosis and treatment) seem to have a greater impact on treatment decisions than their

biological understanding of the disease itself. Clinicians may receive detailed training in caries scenarios during their professional life and this can change their decisions throughout their practice.<sup>12</sup>

Dental students must receive systematic training in cariology, according to Schulte et al,<sup>22</sup> in order to be able to use this comprehensive knowledge when making decisions about the prevention and treatment of caries in both specific patients and the general population. However, there was still a sizable gap between the cariology curricula taught in dental colleges and what was actually carried out in practice. Based on the evidence that is currently accessible, suggestions for reducing variation in diagnosis and treatment should be made. Additionally, questions have been raised regarding how quickly dentists can implement new techniques. The outcomes

and costs for patients are affected when dentists disagree about the diagnosis and therapy of the same or similar patients.<sup>12</sup> Although evidence-based recommendations and guidelines have been created, it may be challenging to spread this knowledge.<sup>20</sup> The conduct of clinicians may be changed by intervention strategies including participatory workshops, audit and feedback, and educational access, claim Bader and Shugars.<sup>12</sup> In terms of patient safety and health outcomes, clinical decision-making is a crucial component of clinical success. In order to keep patient safety, it appears essential to think critically to analyze, reason, make decisions, and diagnose more effectively.<sup>23</sup>

It is important to keep in mind the possible limitations of this study. Unfortunately, it was not possible to collect any information about non-responders due to the anonymous design of the data collection form. Also, the form may not provide accurate data as the answers are affected by the recall ability of the participants. Response bias leading to “politically” correct answers subject to social desire bias, was another limitation of this study. Practitioners may find it challenging to interpret the carious lesion in this research from a direct visual description. Another drawback was the low use of nonoperative therapy in this particular group, which can be attributed to a number of factors including patient demand, dentist experience, and health system incentives.<sup>24</sup> Also, most of the practitioners who participated in the survey were working in private clinics, where the patient has to pay per procedure and the cost of preventive treatment, except for sealants, is not economically justified.

## Conclusion

Within the limitations of the present study;

- When new graduates are compared with experienced practitioners, they are more educated in ICDAS II criteria. The early inclusion of ICDAS in the dentistry program can be a helpful aid for developing caries diagnosis abilities.
- While practitioners working in the public hospitals marked amalgam restoration at a higher rate, practitioners working in private clinics marked composite resin restoration and root canal treatment at a higher rate.
- There are many reasons to standardize dental practitioners’ management concepts, such as a less invasive management system for carious lesions in early stages, for practitioners and the healthcare system.

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## Authors’ Contributions

**Conceptualization:** Hasibe Sevilay BAHADIR, Çiğdem Çelik.

**Data curation:** Hasibe Sevilay BAHADIR, Çiğdem Çelik.

**Formal analysis:** Hasibe Sevilay BAHADIR, Çiğdem Çelik.

**Funding acquisition:** Hasibe Sevilay BAHADIR, Çiğdem Çelik.

**Investigation:** Hasibe Sevilay BAHADIR, Çiğdem Çelik.

**Methodology:** Hasibe Sevilay BAHADIR, Çiğdem Çelik.

**Project administration:** Hasibe Sevilay BAHADIR, Çiğdem Çelik.

**Resources:** Hasibe Sevilay BAHADIR, Çiğdem Çelik.

**Software:** Hasibe Sevilay BAHADIR, Çiğdem Çelik.

**Supervision:** Hasibe Sevilay BAHADIR, Çiğdem Çelik.

**Validation:** Hasibe Sevilay BAHADIR, Çiğdem Çelik.

**Visualization:** Hasibe Sevilay BAHADIR, Çiğdem Çelik.

**Writing - original draft:** Hasibe Sevilay BAHADIR, Çiğdem Çelik.

**Writing - review & editing:** Hasibe Sevilay BAHADIR, Çiğdem Çelik.

## Competing Interests

The authors report no conflicts of interest.

## Ethical Approval

Ethical approval (2020.11.09- 10) was granted for this cross-sectional study from the Ankara Yıldırım Beyazıt University Ethics Committee.

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