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Awareness of Medication-Related Osteonecrosis of the Jaw Among Dentistry Students: A Multicenter Survey Study

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Abstract

Background: This cross-sectional study aimed to evaluate the awareness of fourth- and fifth-year dental students from three Turkish universities (Sakarya, Uşak, and Tokat Gaziosmanpaşa Universities) regarding bisphosphonates (BPs), medication-related osteonecrosis of the jaws (MRONJ), and related issues, as well as to identify potential improvements in their education.

Methods: A survey consisting of 16 multiple-choice and 1 open-ended question was used to assess students' knowledge of BPs, MRONJ, and their educational preferences. Categorical variables were analyzed using chi-square and Fisher's exact tests. Comparisons between educational years were made with *t*-tests or Mann–Whitney *U* tests, and differences among faculties were evaluated with one-way ANOVA or Kruskal–Wallis tests.

Results: A total of 382 students participated: 217 fourth-year and 165 fifth-year students, with a mean age of 22.84 ± 0.94 years. Fifth-year students had significantly more knowledge about BPs ($P = .000$) and listed their university as the primary source of information ($P = .000$). They also had a better understanding of BP active substances ($P = .038$) and MRONJ definitions ($P = .001$) than fourth-year students. Conversely, fourth-year students were less aware of diseases treated by BPs ($P = .038$) and appropriate patient approaches for MRONJ ($P < .001$). Uşak University students outperformed others in recognizing BP indications and active substances ($P < .001$). Overall, 64.3% of participants felt inadequate in evaluating MRONJ risk and treatment, while 88.48% expressed a desire for further education, with 34.91% requesting more clinical training.

Conclusion: The findings indicate that students feel underprepared in managing MRONJ cases, highlighting the need for enhanced clinical and theoretical training.

Keywords: Awareness, bisphosphonate-associated osteonecrosis of the jaw, bisphosphonates, dental students, osteonecrosis

What is already known on this topic?

- *Medication-related osteonecrosis of the jaws (MRONJ) is a severe adverse effect associated with bisphosphonates and other antiresorptive and antiangiogenic agents, significantly impacting dental and surgical treatment outcomes.*
- *Awareness and education about MRONJ among dental professionals, particularly students, are crucial for early diagnosis, prevention, and management.*
- *Previous studies indicate varying levels of MRONJ knowledge among dental students, highlighting the need for improved education and standardized guidelines in dental curricula.*

What this study adds on this topic?

- *This study assesses the awareness and education levels of dentistry students in Türkiye regarding MRONJ and bisphosphonate-related risks, providing insights into their preparedness for managing such cases.*
- *It identifies gaps in knowledge and training, suggesting potential areas for curriculum enhancement to improve students' competence in MRONJ prevention and treatment.*
- *The findings emphasize the need for integrating more comprehensive MRONJ-related education into dental programs to ensure future dentists can effectively handle MRONJ cases.*

INTRODUCTION

Medication-related osteonecrosis of the jaw (MRONJ) is a relatively new disease, with the first case report published in 2003.[1] Although MRONJ was described as a growing epidemic by Marx in 2003,[2] its incidence remains low, ranging from 0.004% to 6.7%, depending on the drugs prescribed, their duration, and routes of administration.[3]

Medication-related osteonecrosis of the jaw cases have been reported in patients receiving drugs that interfere with bone metabolism for conditions such as osteopenia,

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osteoporosis, malignancy-induced hypercalcemia, or bone metastases from solid tumors or multiple myeloma.[4] These drugs include bisphosphonates (BPs), receptor activator of nuclear factor kappa-B ligand inhibitors (Denosumab), antiangiogenic drugs like tyrosine kinase inhibitors, and humanized monoclonal antibodies.[3,4] Bisphosphonates and Denosumab exert antiresorptive effects by suppressing osteoclast activity, while antiangiogenic drugs, either alone or in combination with antiresorptives, inhibit molecules like vascular endothelial growth factor. Monoclonal antibodies inhibit sclerostin function through the Wingless-related integration site (Wnt) pathway.[4,5] These treatments suppress bone resorption and/or increase bone formation, but they also increase the risk of osteonecrosis in the jaws.

Despite the systemic effects of these agents on the skeletal system, osteonecrosis is most commonly observed in the jaw bones, likely due to multifactorial mechanisms. Factors contributing to this include the exposure of dental structures to the oral environment through periodontal tissues, vulnerability to periapical infections, the acidic oral cavity, chronic inflammation, oral surgeries or extractions, chronic diseases such as diabetes, steroid use, and local immune responses.[6] Many of these factors are related to the oral cavity, highlighting the important role of dentists in the diagnosis, treatment, and follow-up of MRONJ. According to the American Association of Oral and Maxillofacial Surgeons (AAOMS) 2022 position paper,[4] management strategies emphasize the role of dentistry and focus on prevention, supporting ongoing oncological or skeletal treatments, and maintaining quality of life.

Since no consensus exists on the optimal treatment for MRONJ, prevention is critical, and dentists play a crucial role in this regard. Current literature suggests that the incidence of MRONJ can be reduced by half in patients who undergo dental check-ups and take necessary precautions before starting antiresorptive treatment.[4,7] However, it has been reported that, alongside routine check-ups and preventive measures, the expertise and knowledge of clinicians responsible for implementing these measures are also critical factors.[8] Although studies have been conducted on dentists, dental specialists, medical doctors, and medical specialists, awareness rates regarding MRONJ vary significantly, with reports of 34% among dentists, 49% among oral radiologists, and 84% among oral and maxillofacial surgeons.[9] However, studies involving undergraduate dental students are limited. Our search in the TR Index database (TÜBİTAK ULAKBİM, National Academic Network and Information Center Cahit Arf Information Center, Ankara, Türkiye), revealed few publications on MRONJ awareness, and none focused on undergraduate students in a multicenter setting.

Thus, the aim of this study is to assess the awareness levels of dental students from 3 different regions of Anatolia, considering differences in faculty sizes, student populations, and clinical practice standards. By comparing these findings with current literature, we aim to identify areas for improvement in their education and training.

MATERIAL AND METHODS

This multicenter study was conducted simultaneously during 2 sessions in April 2024, involving undergraduate students in their fourth and fifth years from 3 different dentistry faculties in Türkiye: Uşak University (UU), Sakarya University (SU), and Tokat Gaziosmanpaşa University (TOGU). The current study received ethical approval from the non-interventional clinical research ethical committee of Uşak University (Approval no: 128-128-5, Date: June 8, 2023). The current study was conducted according to the guidelines of the Declaration of Helsinki and the Consensus-Based Checklist for Reporting of Survey Studies (CROSS) guidelines.[10]

Volunteering participants were included in the study if they could fluently read and write in Turkish, had successfully completed courses related to MRONJ prior to taking the questionnaire, and had been undergraduate students at the same faculty for at least 3 years. No exclusion criteria were applied other than these, and participants who did not meet the inclusion criteria were excluded from the study. The participants were asked to anonymously complete a printed questionnaire consisting of 17 questions, of which 16 were multiple-choice questions and 1 was open-ended. The questionnaire comprised 3 sections. The first section included demographic data (gender, age, academic year, and faculty name); the second section included multiple-choice questions regarding knowledge of BPs, including drugs, the definition of MRONJ, factors that cause and increase the risk of MRONJ, and drugs other than BPs that may cause MRONJ; the third section contained 2 multiple-choice questions for students to assess their perceived competence in managing MRONJ cases based on the knowledge gained from their courses and clinical studies. The final open-ended question allowed participants to provide recommendations regarding MRONJ education. The questionnaire was adapted from the studies of Escobedo et al[11] and Patil et al.[12] The obtained data were analyzed by comparing groups based on education year and faculty.

Statistical Analysis

The obtained data were assessed for normal distribution using the Kolmogorov–Smirnov test. Data grouped by education year were analyzed using either the *t*-test or Mann–Whitney *U* test. Homogeneously distributed data grouped by faculty were analyzed using analysis of variance (ANOVA), followed by the Tamhane post-hoc test to detect inter-group differences. Heterogeneously distributed data were analyzed using the Kruskal–Wallis test, followed by the Dunn post-hoc test to identify inter-group differences. Variables such as gender and responses to the open-ended question

were analyzed using chi-square or Fisher's exact tests. Statistical analyses were performed using the Statistical Package for Social Sciences version 24.0 software (IBM Corp.; Armonk, NY, USA). *P*-values greater than .05 were considered insignificant.

The required sample size was calculated based on outcomes from a previous study.[13] Using G*Power 3.1,[14] with an α value of 0.05 and a statistical power of 0.95, a minimum of 220 participants was determined.

RESULTS

The current study was conducted with 382 volunteered participants who met the inclusion criteria. Of the 382 students, 217 (56.8%) were fourth graders and 165 (43.2%) were fifth graders, with a mean age of 22.84 years. None of the demographic variables differed significantly between faculties. The demographic features of the participants are presented in Table 1. Detailed analyses of the survey questions and results according to the participants' classes and faculties are shared in Tables 2 and 3.

In the first question, participants were asked to respond dichotomously regarding whether they had heard about BPs. Analysis of the responses revealed significant differences between the fourth and fifth-grade students ($P < .001$). While 35.86% of the students answered "yes," 36.87% of the participants who answered "no" were fourth graders, and 7.33% were fifth graders. Thus, the lowest rate of negative responses came from fifth-grade students. In comparing the responses from different faculties, the awareness of UU students in recognizing drugs was found to be statistically significantly higher ($P = .000$).

In the second question, when participants were asked where they first heard about BPs, the response "I heard them at university" was statistically significantly different from the other options based on both their classes ($P < .001$) and faculties ($P < .001$).

For the third question, which inquired whether the use of BPs should be questioned in the verbal anamnesis taken from patients, a significant difference was observed in responses based on faculty ($P = .007$), with the highest number of "no" and "I do not know" answers coming from SU (5.12%).

In the fourth question, which asked participants to mark the diseases that indicate the use of BPs, 6 of the 9 listed diseases were related to these indications. A statistically significant difference was observed when comparing fourth-grade (3.4 ± 1.56) and fifth-grade (3.09 ± 1.30) students ($P = .038$). Furthermore, a significant difference was noted among faculties ($P < .001$). Inter-group comparisons revealed that UU students (3.87 ± 1.51) differed significantly from SU (2.98 ± 1.36, $P < .001$) and TOGU (2.94 ± 1.31, $P < .001$).

In the fifth question, participants were asked to identify drugs from the BP group, whose active ingredients and market names were provided. A significant difference was found between the means of the answers given by fourth graders (1.35 ± 1.76) and fifth graders (2.45 ± 1.87) ($P = .038$). Additionally, when comparing the average number of correct answers among faculties, a significant difference was observed ($P = .002$), with answers from UU participants (2.69 ± 1.71) differing significantly from those of the other faculties (SU: 1.15 ± 1.68; TOGU: 1.54 ± 1.90; $P < .001$).

In the comparison of responses to the sixth question regarding the relationship between BPs and MRONJ, significant differences were found among faculties ($P = .002$), with TOGU having the highest rate of negative responses to this question (2.9%).

The seventh question, which asked for the correct MRONJ definition according to the AAOMS 2022 guide, indicated that fifth-year participants provided a significantly higher number of correct answers ($P = .001$). When comparing answers by faculty, a significant difference was found ($P < .001$), with the highest rate of incorrect answers obtained from TOGU participants (50.64%).

A significant difference was noted between the answers given by fourth and fifth graders in the tenth question regarding the appropriateness of invasive dental procedures in patients receiving BP treatment ($P = .001$). A total of 21.4% of fourth graders provided incorrect answers or indicated they did not know. Again, significant differences were observed among faculties ($P < .001$), with UU participants giving the fewest incorrect or "I don't know" answers (28.13%).

Uşak University participants also provided significantly more correct answers to the 11th question, which assessed the

Table 1. Demographic Variables of the Participants and the Included Faculties

Faculty Demographic Variables	Sakarya University	Uşak University	Tokat Gaziosmanpaşa University	*P*
Fourth grade (n)	60	74	83	.366*
Fifth grade (n)	37	54	74	
Gender (F/M)	64 F/33 M	78 F/50 M	97 F/60 M	.724†
Age (years)	22.62 ± 0.98	22.75 ± 1.14	23.04 ± 1.33	.814*
Total (n, %)	97 (25.4)	128 (33.5)	157 (41.1)	

*The calculated *P* values were obtained from categorical variables by chi-square test.
†The calculated *P* values were obtained from numerical variables by ANOVA test.

Table 2. Survey Questions and Comparison of Participants' Responses According to Their Grades

Question	Fourth Grader (n=217)			Fifth Grader (n=165)			*P*
Q1: Do you know drugs containing BPs? n (%)	Yes		No	Yes		No	<.001*
	137 (35.86)		80 (20.94)	137 (35.86)		28 (7.33)	
Q2: From where did you first hear about BPs? n (%)	1=		13 (5.9)	1=		36 (21.81)	<.001*
	2=		199 (91.7)	2=		125 (75.75)	
	3=		1 (0.46)	3=		0 (0)	
	4=		1 (0.46)	4=		3 (1.81)	
	5=		1 (0.46)	5=		0 (0)	
	6=		2 (0.92)	6=		1 (0.60)	
Q3: Is it important to question BP use in the anamnesis? n (%)	Yes	No	Not known	Yes	No	Not known	.163
	212 (55.5)	2 (0.5)	3 (0.8)	161 (42.1)	4 (1)	0 (0)	
Q4: What are the diseases that are indicated for BPs? (mean ± SD)		3.40 ± 1.56			3.09 ± 1.30		.038†
Q5: Please mark the commercial and active ingredient names of the BP-containing drugs you know. (mean ± SD)		1.35 ± 1.76			2.45 ± 1.87		.038†
Q6: Do you know that BPs may cause MRONJ? n (%)	Yes		No	Yes		No	.408
	208 (54.5)		9 (2.4)	161 (42.1)		4 (1)	
Q7: According to the AAOMS guidelines, which option correctly defines MRONJ? n (%)	False	True	Not known	False	True	Not known	.001*
	110 (28.9)	96 (25.2)	11 (2.9)	53 (13.9)	104 (27.3)	7 (1.8)	
Q8: Mark the risk factors that are associated with MRONJ. (mean ± SD)		4.71 ± 1.56			4.84 ± 1.56		.653
Q9: Should IV BP administered patients be priorly evaluated by dentists? n (%)	False	True	Not known	False	True	Not known	.771
	3 (0.8)	207 (54.2)	7 (1.8)	2 (0.5)	160 (41.9)	3 (0.8)	
Q10: Can invasive dental treatments be performed on patients receiving IV BP therapy? n (%)	False	True	Not known	False	True	Not known	.001*
	54 (14.1)	135 (35.3)	28 (7.3)	23 (6)	131 (34.3)	11 (2.9)	
Q11: Can invasive dental treatments be performed on patients who do not have risk factors and have been taking oral BPs for less than 4 years? n (%)	False	True	Not known	False	True	Not known	.346
	73 (19.1)	103 (27)	41 (10.7)	61 (16.9)	82 (21.5)	22 (5.8)	
Q12: Can invasive dental treatments be performed on patients with risk factors who have been taking oral BPs for less than 4 years? n (%)	False	True	Not known	False	True	Not known	<.001*
	40 (10.5)	128 (33.5%)	49 (12.8)	19 (5)	128 (33.5)	18 (4.7)	
Q13: Can invasive dental treatments be performed on patients who have been taking oral BPs for more than 4 years? n (%)	False	True	Not known	False	True	Not known	<.001*
	52 (13.6)	121 (31.7)	44 (11.5)	20 (5.2)	124 (32.5)	21 (5.5)	
Q14: Mark the drugs other than BPs that you know may cause MRONJ. (mean ± SD)		0.44 ± 0.66			1.06 ± 1.35		<.001†
Q15: Do you find the information you have gained throughout your progress on MRONJ sufficient to determine your risk factors or evaluate the treatment of your patients? n (%)	Yes	No	Not known	Yes	No	Not known	.228
	48 (12.6)	140 (36.6)	29 (7.6)	45 (11.8)	106 (27.7)	14 (3.7)	
Q16: Do you want to learn more about MRONJ? n (%)	Yes	No	Not known	Yes	No	Not known	.157
	189 (49.48)	24 (6.28%)	4 (1.04)	149 (39)	13 (3.40)	3 (0.79)	

AAOMS, American Association of Oral and Maxillofacial Surgeons; BPs, bisphosphonates; IV, intravenous; MRONJ, medication-related osteonecrosis of jaws; Q, question; SD, standard deviation; 1=never heard; 2=university; 3=visual and written media; 4=scientific article; 5=scientific meeting; 6=others.
*Indicates significant *P* values obtained with chi-square or Fisher exact tests. †Indicates significant *P* values obtained with Mann–Whitney *U* or *t*-tests.

Table 3. Comparison of Participants' Responses According to Their Faculties

Questions Faculties	Sakarya University (SU, n=97)			Uşak University (UU, n=128)			Tokat Gaziosmanpaşa University (TOGU, n=157)			*P*
Q1 (n%)	Yes	No		Yes	No		Yes	No		<.001*
	56 (57.7)	41 (42.3)		119 (93)	9 (7)		98 (63.1)	58 (36.9)		
Q2 (n%)	1=	46 (47.4)		1=	0 (0%)		1=	3 (1.9)		<.001*
	2=	48 (49.4)		2=	126 (98.4)		2=	150 (96.2)		
	3=	0 (0)		3=	1 (0.8)		3=	0 (0)		
	4=	2 (2.1)		4=	0 (0)		4=	2 (1.3)		
	5=	0 (0)		5=	0 (0)		5=	1 (0.3)		
	6=	1 (1.1)		6=	1 (0.8)		6=	1 (0.3)		
Q3 (n%)	Yes	No	Not known	Yes	No	Not known	Yes	No	Not known	.007*
	91 (23.8)	5 (1.3)	1 (0.3)	128 (33.5)	0 (0)	0 (0)	154 (40.3)	1 (0.3)	2 (0.5)	
Q4 (mean ± SD)		2.98 ± 1.41			3.88 ± 1.54			2.94 ± 1.30		<.001†
Q5 (mean ± SD)		1.15 ± 1.73			2.69 ± 1.71			1.54 ± 1.92		<.001†
Q6 (n%)	Yes	No		Yes	No		Yes	No		.002*
	95 (24.9)	2 (0.5)		128 (33.5)	0 (0)		146 (38.2)	11 (2.9)		
Q7 (n%)	False	True	Not known	False	True	Not known	False	True	Not known	<.001*
	41 (10.8)	38 (10)	18 (4.7)	43 (11.3)	85 (22.3)	0 (0)	79 (20.7)	77 (20.2)	0 (0)	
Q8 (mean ± SD)		4.53 ± 1.70			4.91 ± 1.50			4.76 ± 1.53		.484
Q9 (n%)	False	True	Not known	False	True	Not known	False	True	Not known	.126
	1 (0.3)	92 (24.1)	4 (1)	2 (0.5)	126 (33)	0 (0)	2 (0.5)	149 (39)	6 (1.6)	
Q10 (n%)	False	True	Not known	False	True	Not known	False	True	Not known	<.001*
	17 (4.5)	66 (17.3)	14 (3.7)	36 (9.4)	92 (24.1)	0 (0)	24 (6.3)	108 (28.3)	25 (6.5)	
Q11 (n%)	False	True	Not known	False	True	Not known	False	True	Not known	<.001*
	34 (8.9)	40 (10.5)	23 (6)	46 (12)	82 (21.5)	0 (0)	54 (14.1)	63 (16.5)	40 (10.5)	
Q12 (n%)	False	True	Not known	False	True	Not known	False	True	Not known	<.001*
	6 (1.6)	65 (17)	26 (6.8)	40 (10.5)	88 (23)	0 (0)	13 (3.4)	103 (27)	41 (10.7)	
Q13 (n%)	False	True	Not known	False	True	Not known	False	True	Not known	<.001*
	15 (3.9)	63 (16.5)	19 (5)	41 (10.7)	87 (22.8)	0 (0)	16 (4.2)	95 (24.9)	46 (12)	
Q14 (mean ± SD)		0.14 ± 0.54			0.97 ± 0.82			0.85 ± 1.32		<.001†
Q15 (n%)	Yes	No	Not known	Yes	No	Not known	Yes	No	Not known	<.001*
	7 (1.8)	70 (18.3)	20 (5.2)	56 (14.7)	71 (18.6)	1 (0.3)	30 (7.9)	105 (27.5)	22 (5.8)	
Q16 (n%)	Yes	No	Not known	Yes	No	Not known	Yes	No	Not known	.006*
	92 (24.1)	5 (1.3)	0 (0)	116 (30.4)	12 (3.1)	0 (0)	130 (34)	20 (5.2)	7 (1.8)	

Q, question; SD, standard deviation; 1=never heard; 2=university; 3=visual and written media; 4=scientific article; 5=scientific meeting; 6=others.
*Indicates significant *P* values obtained with chi-square or Fisher exact tests. †Indicates significant *P* values obtained with Kruskal–Wallis or analysis of variance (ANOVA) tests.

feasibility of invasive treatment in a clinical case example prepared according to risk factors ($P < .001$).

In the 12th question regarding risk factors, fourth graders provided significantly more incorrect answers (44.24%, $P < .001$). Comparing responses by faculty showed significant differences ($P < .001$), with TOGU participants providing the most correct answers (27%) and UU participants giving the highest number of incorrect answers (10.5%).
When evaluating the answers to the 13th question, which is the last question on risk factors, significant differences were observed between fourth and fifth graders ($P < .001$) and among faculties ($P < .001$). The rate of incorrect and "I don't know" answers among fourth-grade students (44.24%) was significantly higher than that of fifth-grade students (24.85%). Among the faculties, TOGU participants had the highest number of incorrect and "I don't know" answers (39.5%).

In analyzing the answers to the 14th question, which asked about the active substances and their trade names that may cause MRONJ other than BPs, it was found that the mean number of correct answers provided by fifth graders (1.06 ± 1.35) was significantly higher than that of fourth graders (0.44 ± 0.66) ($P < .001$). Examination of the results by faculty also revealed significant differences ($P < .001$), with the mean number of correct answers given by SU (0.14 ± 0.54) being significantly lower than those of the other faculties ($P < .001$).

In the third part of the survey, the 15th question asked whether participants considered themselves sufficient in determining the risk of MRONJ and managing it. When the responses were categorized by faculty, it was revealed that the majority of participants in each faculty considered themselves significantly inadequate ($P < .001$). The 16th question, which inquired about participants' educational expectations, found that 88.5% expressed a desire for more information. Finally, when the 17th question asked about the method through which this education should be provided, the preference for increased clinical training (30.9%) was most prominent (Figures 1 and 2).

DISCUSSION

Given the lack of universally accepted treatment protocols for MRONJ, it is crucial to take the necessary precautions to prevent its occurrence. The current study aimed to assess the awareness of dental students enrolled in dentistry faculties, who receive their professional education through clinical internships, regarding MRONJ. Furthermore, it sought to identify areas in their education that require improvement.

The current results indicate that 73% of the participants were aware of BP-containing drugs, which are significant contributors to MRONJ etiology. This finding, while slightly higher than results reported in previous studies,[15-17] still underscores a gap in achieving ideal awareness levels. Although it is compatible with the current data, it is also obvious that we are still far from the ideal result of 100% awareness. However, when the relationship between BPs and MRONJ formation was questioned, 96.1% of the current participants reported that they were aware of this relationship, which is compatible[15] with or higher[16] than the results of similar studies. Similarly, when asked whether patients' medical records should be questioned about BP use, 97.64% of the participants stated that BP use should be questioned in the medical history.

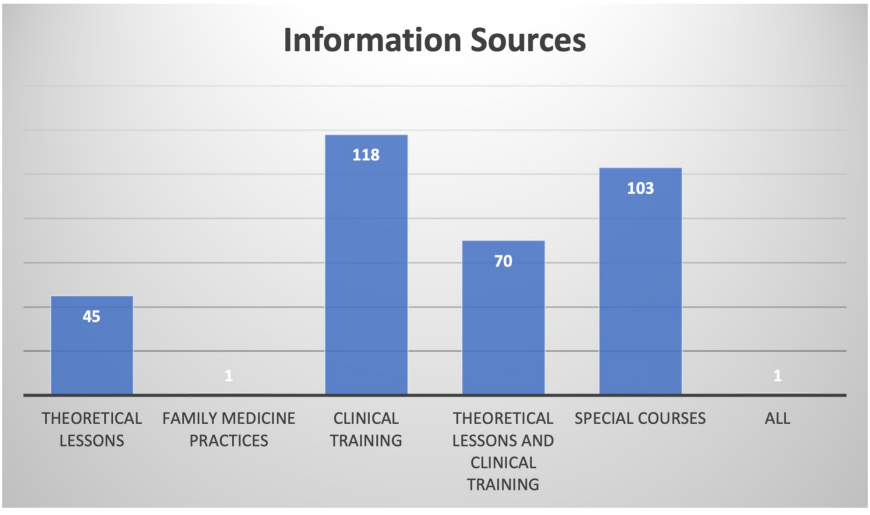

Figure 1. Graphical distribution of responses of the participants to Q17 who answered Yes to Q16. (Q17: Please indicate your preferred learning method).

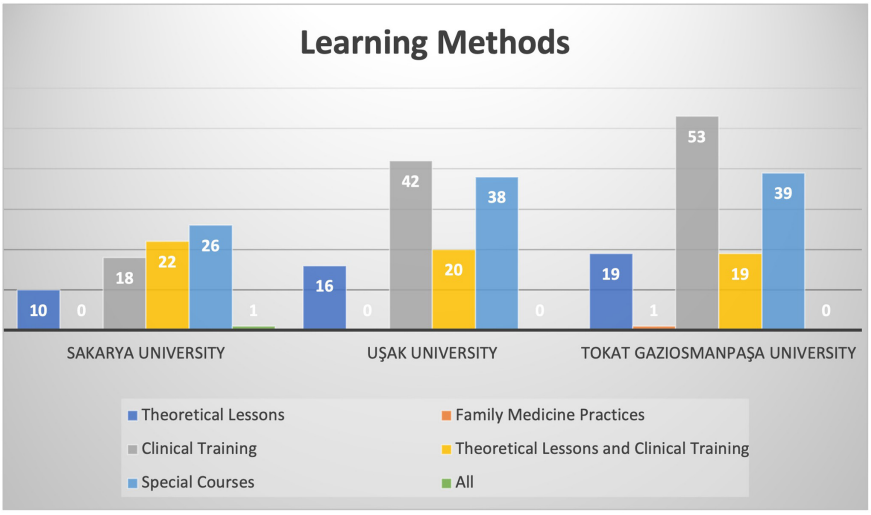

Figure 2. Graphical distribution of responses of the participants to Q17 who answered Yes to Q16. (Q17: Please indicate your preferred learning method).

Following the publication of case reports on ONJ linked to BPs used for treating malignancy-related hypercalcemia in 2003, the manufacturer of pamidronic and zoledronic acid issued warnings about the risk of MRONJ. This alert was broadened in 2005 to include all oral BPs and was further incorporated into the British National Formulary in 2008. In 2015, the European Medicines Agency warned physicians to remind their patients to whom they were administering BPs about the risk of MRONJ.[3] Despite these efforts, awareness regarding BP risks remains insufficient, as evidenced by the fact that initial awareness occurs primarily at the university education level (84.82%). Previous studies corroborate these findings, demonstrating that the contributions of other information sources—such as mass media, scientific articles, and conferences—remain limited.[16]

Similar to most literature,[11,15-17] the current study found that awareness of BPs increases with years of education. When asked to identify active substances within the BP group (Alendronate, Risedronate, Ibandronate, Neridronate, Pamidronate, Zoledronate, Tiludronate), fifth-year students demonstrated significantly greater knowledge, with an average of 2.45 substances recognized. The highest awareness levels were observed for the most commonly prescribed active ingredients,[18] Alendronate (61.43%, 67.2%, fourth and fifth grades, respectively) and Zoledronic acid (56.72%, 58.3%, fourth and fifth grades, respectively), consistent with previous studies.[11,15,16,19] It was observed that the fourth graders had significantly more knowledge of the diseases in question 4, which included 6 correct answers (Paget's disease of bone, osteogenesis imperfecta, osteopenia and osteoporosis, hypercalcemia of malignancy, bone metastases, and multiple myeloma) and that indicated the use of BPs. Although there was a significant difference in the comparison made according to the grades of the participants, the average of the correct answers given was around three diseases. Despite recognizing the BP-MRONJ relationship and emphasizing the importance of questioning BP use in patient medical histories, participants exhibited limited knowledge about critical topics, including active ingredients and indicated diseases.

When asked for the correct definition of MRONJ disease, which includes useful information about its clinical features, the percentage of correct answers (52.36%) differed negatively from similar studies in the literature.[15,17] However, it is consistent with the fact that fifth graders gave a significantly higher percentage of correct answers.

In examining systemic diseases and risk factors associated with MRONJ, both fourth- and fifth-year students performed similarly, identifying an average of 4.71 and 4.84 risks, respectively. Although no significant difference was found based on the duration of education, higher results were observed compared to sample studies in the literature.[15,16] When questioned about the dental management of at-risk patients, participants provided a higher rate of correct answers than those reported in the existing literature.[15,16,19] However, as the most crucial approach to MRONJ treatment is prevention, the knowledge level in this area needs improvement.

The lowest rate of correct answers was observed for a question involving various combinations of oral BP use for less or more than 4 years, IV BP use, and risk factors. Specifically, the question concerning the management of patients with no risk factors who had used oral BPs for less than 4 years garnered the lowest score (48.42%). Similar confusion regarding this issue is also reported at a high level in the literature.[16]

Despite the minimal risk associated with oral BPs used in treating conditions like osteoporosis and osteopenia,[20] the fact that more than 52% of participants gave incorrect or "I don't know" responses to this scenario suggests that students lack confidence in treating such patients, potentially leading to unnecessary delays in treatment. When asked about drug groups other than BPs associated with MRONJ, 60.5% of participants reported not knowing any active substances beyond BPs. Among the substances mentioned, Denosumab was the most recognized, at 19.6%. Fifth-year students were found to know significantly more active substances than fourth-year students. While this finding is consistent with the results of Alghofaili et al[19] and Aljohani et al,[3] it is considerably higher than the outcomes reported by Rosella et al[15] and Almousa et al.[16] This inconsistency, also reflected in the literature, indicates a need to introduce other drug groups related to MRONJ, alongside BPs.

When comparing the results of the current study across universities, statistically significant differences were observed. In particular, participants from TOGU provided the highest rate of incorrect and "I do not know" responses when asked to define MRONJ. Sakarya University participants demonstrated the most significant disagreement and abstention from the statement that BP use should be investigated during the anamnesis. As there are no existing multicenter studies in the literature that compare different universities, the current results were interpreted using the study's internal parameters.

These discrepancies can be attributed to variations in the educational approaches of the faculties involved in this study. At TOGU, MRONJ is incorporated into the curriculum; however, updates are needed to align the content with current guidelines. In contrast, SU delivers MRONJ education in a seminar-style format rather than as a dedicated course topic, which may result in less comprehensive exposure. Uşak University includes MRONJ as part of its course content but does not report specific curriculum updates or adaptations.

While some dentistry faculties include MRONJ as a course topic, differences in the depth of coverage and the degree of integration into practical training appear to contribute to the variations in awareness. Furthermore, the lack of a standardized national curriculum for MRONJ education in Turkish dentistry faculties exacerbates these inconsistencies. To address these gaps, MRONJ should be incorporated as a distinct and standardized topic across all faculties. Such courses should include detailed content on drug mechanisms, risk factors, clinical features, and patient management strategies. Establishing a national guideline for MRONJ education and ensuring regular updates to course content would also help bridge disparities and promote consistent knowledge dissemination.

Although significant differences were found between faculties, a substantial 64.3% of participants rated themselves as inadequate in identifying patients with risk factors and managing MRONJ cases. While the majority expressed a preference for clinical (practical) education, the results of this study suggest that to address the deficiencies observed in theoretical knowledge, there should be an increase in both theoretical courses covering all aspects of MRONJ, integrated into the routine curriculum, and practical training that emphasizes demonstrations and treatment options.

Despite the findings, the current study has several limitations. According to 2023-2024 data, there are 109 dentistry faculties in Türkiye with a total of 50283 undergraduate students.[21] Considering these figures, the sample size and the number of faculties involved should be expanded in future research. The survey used in this study was adapted from similar studies in the literature,[11,15] as no current, valid, and reliable survey exists in Turkish. For future studies, it is recommended to develop a validated and reliable survey with standardized questions designed to assess awareness and knowledge of MRONJ and BPs, tailored to different assessment objectives. Moreover, this study did not investigate the pathophysiology of MRONJ or the mechanisms of action of the drugs responsible for the disease in detail. Future research could include questions that explore different clinical scenarios to better assess theoretical educational needs and provide practical training recommendations.

Based on the current findings, the level of awareness among dentistry students regarding BPs and MRONJ was found to be consistent with existing literature. However, it was also revealed that while participants felt inadequate in terms of clinical education, there were notable theoretical gaps as well. Therefore, both theoretical and practical training should be expanded during university education to ensure the accurate identification of cases at risk of developing MRONJ and to improve the proper dental management of such cases in the future.

Data Availability Statement: The data relevant to this study are available upon reasonable request from the corresponding author.

Ethics Committee Approval: The current study received ethical approval from the non-interventional clinical research ethical committee of Uşak University (Approval no: 128-128-5, Date: June 8, 2023).

Informed Consent: Written informed consent was obtained from the participants who participated in this study

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REFERENCES

1. Migliorati CA. Bisphosphanates and oral cavity avascular bone necrosis. *J Clin Oncol*. 2003;21(22):4253-4254. [CrossRef]
2. Marx RE. Pamidronate (Aredia) and zoledronate (Zometa) induced avascular necrosis of the jaws: a growing epidemic. *J Oral Maxillofac Surg*. 2003;61(9):1115-1117. [CrossRef]
3. Aljohani MH, Aljohani AS, Aljohani RM, Alsharif WK, Nourwali I, Elsayed SA. Medical and dental professions' varying levels of awareness regarding medication-related osteonecrosis of the jaw in Saudi Arabia? A cross-sectional study. *J Contemp Dent Pract*. 2024;25(1):62-67. [CrossRef]
4. Ruggiero SL, Dodson TB, Aghaloo T, Carlson ER, Ward BB, Kademani D, et al. American Association of Oral and Maxillofacial Surgeons' Position Paper on Medication-Related Osteonecrosis of the Jaws-2022 Update. *J Oral Maxillofac Surg*. 2022;80(5):920-943. [CrossRef]
5. Pimolbutr K, Porter S, Fedele S. Osteonecrosis of the jaw associated with antiangiogenics in antiresorptive-naïve patient: a comprehensive review of the literature. *BioMed Res Int*. 2018;2018:8071579. [CrossRef]
6. Migliorati CA. Oral complications in cancer patients–medication-related osteonecrosis of the jaw (MRONJ). *Front Oral Health*. 2022;3:866871. [CrossRef]
7. Campisi G, Mauceri R, Bertoldo F, et al. Medication-related osteonecrosis of jaws (MRONJ) prevention and diagnosis: Italian consensus update 2020. *Int J Environ Res Public Health*. 2020;17(16):5998. [CrossRef]
8. Bacci C, Cerrato A, Bardhi E, Frigo AC, Djaballah SA, Sivolella S. A retrospective study on the incidence of medication-related osteonecrosis of the jaws (MRONJ) associated with different preventive dental care modalities. *Support Care Cancer*. 2022;30(2):1723-1729. [CrossRef]
9. Al-Samman AA, Al-Ani RS. Across-sectional survey on medication-related osteonecrosis of the jaws' knowledge and awareness in a sample of dental society. *J Craniomaxillofac Surg*. 2019;47(6):926-931. [CrossRef]
10. Sharma A, Minh Duc NT, Luu Lam Thang T, et al. A consensus-based Checklist for Reporting of Survey Studies (CROSS). *J Gen Intern Med*. 2021;36(10):3179-3187. [CrossRef]
11. Escobedo MF, García-Consuegra L, Gay S, et al. Influence of the teaching program on the learning in knowledge and practice of osteonecrosis of the jaws produced by antireasorptives in dental students of the Principality of Asturias (Spain). *J Clin Exp Dent*. 2017;9(12):e1402-e1407. Published online 2017. [CrossRef]
12. Patil V, Acharya S, Vineetha R, Nikhil K. Awareness about medication-related osteonecrosis of the jaw among dental professionals: a multicentre study. *Oral Health Prev Dent*. 2020;18(3):505-509. [CrossRef]
13. Alam M, Khan ZM, Alam L, Faraid V, Khan A. Addressing osteonecrosis: a preventable catastrophe - A multi-center study. *Pak J Med Sci*. 2023;39(1):262-267. [CrossRef]
14. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods*. 2007;39(2):175-191. [CrossRef]
15. Rosella D, Papi P, Pompa G, Capogreco M, De Angelis F, Di Carlo S. Dental students' knowledge of medication-related osteonecrosis of the jaw. *Eur J Dent*. 2017;11(4):461-468. [CrossRef]
16. Almousa MA, Alharbi GK, Alqahtani AS, Chachar Y, Alkadi L, Aboalela A. Dental practitioners' and students' knowledge of medication related osteonecrosis of the jaw (MRONJ). *Saudi Pharm J*. 2021;29(1):96-103. [CrossRef]
17. Sereikaite G, Guzeviciene V, Peceliunaite G, Daugela P, Juodzbalys G. Assessment results of dental students' knowledge about bisphosphonates and bisphosphonate-related osteonecrosis of the jaw. *J Oral Maxillofac Res*. 2023;14(4):e3. [CrossRef]
18. Ganesan K, Goyal A, Roane D. Bisphosphonate. In: *StatPearls*. StatPearls Publishing; 2024. Available at: http://www.ncbi.nlm.nih.gov/books/NBK470248/. .Accessed October 7, 2024.
19. Alghofaili MM, Mohsin SF, Nahari NM, Alkhalifah TS, Almazyad RK, Alsaegh MK. Knowledge of dental students and practitioners about medication-related osteonecrosis of the jaw in the Central Region of Saudi Arabia. *Cureus*. 2024;16(1):e52165. Published online January 12, 2024. [CrossRef]
20. Ruggiero SL, Dodson TB, Fantasia J, et al. American Association of Oral and Maxillofacial Surgeons position paper on medication-related osteonecrosis of the jaw—2014 update. *J Oral Maxillofac Surg*. 2014;72(10):1938-1956. [CrossRef]
21. *Yükseköğretim Bilgi Yönetim Sistemi*. Available at: https://istatistik.yok.gov.tr/.