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Original article

Awareness, perceptions and attitudes toward medication-related osteonecrosis of the jaw among physicians who treat osteoporosis

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ABSTRACT

Osteoporosis is the most common indication for antiresorptive drugs (ARDs). Medication-related osteonecrosis of the jaw (MRONJ) is a severe complication of ARDs. Multiple risk factors can increase the risk of MRONJ, one of which is the duration of ARD intake, which is usually prolonged for osteoporosis cases. Prevention of MRONJ relies on collaborative care between treating physicians and dental practitioners. Therefore, knowledge about MRONJ and its prevention strategies is crucial for both teams.

Aim: This study aimed to assess the knowledge and attitudes of physicians toward MRONJ in osteoporosis patients. Another aim was to develop recommendations for the prevention of MRONJ.

Materials and methods: Through an online survey, basic information such as the practice location, training, knowledge, perceptions, and attitudes of physicians regarding ARDs and MRONJ in osteoporosis patients was collected. Statistical analysis was performed for all variables, and their correlations were explored.

Results: A total of 221 physicians participated in the survey: 34.8% were rheumatologists, 25.3% were endocrinologists, 8.6% were family medicine physicians, 5.9% were orthopedists, and 5.9% were internal medicine physicians. Of them, 58.0% reported more than 6 years of experience. Only 78.7% were aware of MRONJ and recognized that bisphosphonates (BPs) can contribute to MRONJ. In contrast, 56.0% recognized denosumab as a causative factor for MRONJ. Duration of ARD therapy and pre- and post-ARD dental care were known to influence the risk of MRONJ by 62% and 65.6% of the participants, respectively. Only 41.6% and 31.2% of participants informed patients about MRONJ prior to BP and denosumab therapy, respectively. Only 25.3% and 20.8% referred patients to dentists before BP and denosumab therapy, respectively. Overall, 65.6% of the participants had a negative attitude toward MRONJ, and 34.4% had a positive attitude. A positive attitude was mostly observed among rheumatologists (55.8%) compared to other specialists ($p < 0.001$). More years of experience were associated with a higher level of knowledge and positive attitude.

Conclusion: The findings of this study identified a notable gap in the awareness, knowledge and attitudes of physicians regarding MRONJ in osteoporosis patients. Continuing education programs about ARDs and MRONJ risk are highly recommended.

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1. Introduction

Antiresorptive drugs (ARDs), including bisphosphonates (BPs) and denosumab, are indicated for the treatment of several bone disorders, such as bone metastasis, osteoporosis, Paget's disease

and osteogenesis imperfecta, by decreasing the rate of bone remodeling. BPs act mainly by inhibiting farnesyl pyrophosphate (FPP) synthase and subsequently osteoblast apoptosis (Cremers and Papapoulos, 2011). On the other hand, denosumab acts as an inhibitor of receptor activator of nuclear factor- κ B ligand (RANKL), which normally binds to RANK receptors on osteoclasts to stimulate osteoclast differentiation and activation (Kendler et al, 2010). This can lead to inhibition of osteoclast function and survival and thereby result in suppression of bone resorption.

ARDs are indicated for many bone diseases, particularly osteoporosis and bone metastasis (Fizazi et al, 2009, Lipton et al, 2012, Brown et al, 2014). Despite the remarkable positive impacts of

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ARDs on both cancer and osteoporosis patients, they can cause potentially serious side effects. Medication-related osteonecrosis of the jaw (MRONJ) was first reported in 2003 as a rare but potentially debilitating side effect of intravenous BPs in cancer patients (Marx, 2003). After that, thousands of cases were reported worldwide and were initially named BP-related osteonecrosis of the jaw (BRONJ). Subsequently, the American Association of Oral and Maxillofacial Surgeons (AAOMS) published a position paper about BRONJ to define this entity of bony necrosis (Advisory Task Force on Bisphosphonate-Related Osteonecrosis of the Jaws, 2007). As similar cases have evolved in relation to denosumab as well as antiangiogenic medications, AAOMS proposed to name it MRONJ instead of BRONJ (Ruggiero et al, 2014).

As shown in the vast literature, intravenous BPs, mainly zoledronate and pamidronate, as well as denosumab, XGEVA®, which are indicated mainly for cancer patients, are associated with the highest risk for MRONJ (Khan et al, 2015). In contrast, the risk of MRONJ is lower among osteoporosis patients who take smaller doses of ARDs. The Kaiser Permanente PROBE study reported an MRONJ prevalence of 0.1% and 0.21% among 8572 osteoporotic patients undergoing chronic oral BP therapy (Lo et al, 2010). It is well known that the incidence of MRONJ increases with the longer duration of ARD use, which could be many years for osteoporotic patients.

Implementing multidisciplinary preventive strategies for MRONJ is effective in minimizing its risk (Otto et al, 2018, Ruggiero et al, 2022). As reported by a prospective study, preventive dental care before treatment was found to decrease the incidence of MRONJ by 50% (Vandone et al, 2012). This requires coordination between medical and dental practitioners starting before ARD therapy and continuing throughout treatment. The first step in MRONJ prevention is educating patients about MRONJ, including its risk factors, signs and symptoms, management and prevention. After that, referral to dentists prior to treatment should be performed to optimize oral hygiene and eliminate oral infections.

Given the growing number of osteoporosis patients taking ARDs, MRONJ incidence is expected to escalate. Therefore, the enforcement of interdisciplinary prevention strategies for MRONJ among osteoporosis patients is more important than ever before. Therefore, this study focused on evaluating the knowledge, perceptions and attitudes of physicians in charge of treating osteoporosis regarding MRONJ.

2. Materials and methods

2.1. Study design

This was a cross-sectional observational study. In this study, online questionnaires were distributed from July to September 2021 to physicians. This study included physicians who treated osteoporosis patients (mainly in the fields of endocrinology, rheumatology, internal medicine, family medicine and orthopedics). Online invitations were sent to physicians working in Saudi Arabia via email and/or Twitter.

This study was approved by the Ethics Committee of King Abdulaziz University under number 42120720.

The questionnaire included three sections:

Section I included questions about the city of their medical practice, their specialty, title, and experience, and whether they had prescribed ARDs for osteoporosis patients before.

Section II included questions on knowledge about ARDs and MRONJ, including risk factors, dose-to-risk ratio, signs and symptoms, and prevention measures. This section included the following questions:

- Are you aware of MRONJ?
- To your knowledge, is using BPs a causative factor for MRONJ?
- To your knowledge, is using denosumab a causative factor for MRONJ?
- The incidence of MRONJ among osteoporotic patients taking BPs is
 - a) 0%
 - b) 0.1%
 - c) 0.001%
 - d) 5%
 - e) I do not know
- The incidence of MRONJ among osteoporotic patients taking denosumab is
 - a) 0%
 - b) 0.04% to 0.2%
 - c) 0.0001%
 - f) I do not know
- Is the risk of MRONJ higher for patients taking IV BPs?
 - a) Yes
 - b) No
 - g) I do not know
- Is the risk of MRONJ higher for patients taking ARDs for a longer duration?
 - a) Yes
 - b) No
 - h) I do not know
- Does dental care before and during treatment with ARDs aid in decreasing the risk of MRONJ?
 - a) Yes
 - b) No
 - i) I do not know
- To your knowledge, is the presence of persistent jaw pain essential for MRONJ diagnosis?
 - a) Yes
 - b) No
 - j) I do not know
- To your knowledge, is the presence of exposed jawbone (or fistula that is probed to the bone) essential for MRONJ diagnosis?
 - a) Yes
 - b) No
 - k) I do not know

Section III assessed the professionals' attitudes and practices regarding MRONJ and ARDs. This section included the following questions:

- Do you inform your patients about MRONJ as a side effect before prescribing BPs?
 - a) Yes
 - b) No
- Do you refer the patients to a dental practitioner before initiating BPs?
 - a) Yes
 - b) No
- Do you ask patients taking BPs about their oral health during follow-up visits?
 - a) Yes
 - b) No
- Do you ask patients taking denosumab about their oral health during follow-up visits?
 - a) Yes
 - b) No
- Do you refer patients taking BPs and denosumab to a dental practitioner when they present symptoms related to the jaws?
 - a) Yes
 - b) No

The correct answers regarding the knowledge were determined based on the available evidence regarding MRONJ (Dodson, 2015, Aljohani et al, 2017, Ruggiero et al, 2022).

2.2. Statistical analysis

Data were coded and analyzed using RStudio Desktop and R software. The Microsoft Excel 2016 Windows version was used for plotting the knowledge level and the percentages of ARDs prescriptions in the population. Categorical data were summarized as frequencies and percentages, while continuous data (knowledge scores) were summarized as the medians and interquartile ranges (IQRs). The chi-square test and Fisher's exact test were used to compare categorical data. Knowledge levels were classified into three levels: poor (<50%), fair (50% to 70%), and good (greater than 70%). Attitude was classified as a positive attitude (≥50%) or negative attitude (<50%). A *p* value < 0.05 was considered significant.

3. Results

3.1. Demographic characteristics

This study included 221 participants. Approximately 34.8% of the participants were rheumatologists, 25.3% were endocrinologists, 8.6% were family medicine physicians, 5.9% were orthopedists, and 5.9% were internal medicine physicians. Consultants and specialists were the most numerous participants (42.1% and 39.8%, respectively). The years of experience of participants were variable; 36.7% had worked for more than 15 years, 21.3% had worked between 6 and 10 years, 14.9% had worked between 3 and 5 years, 13.6% had worked between 11 and 15 years, and 13.6% had worked for <3 years (Table 1).

3.2. Awareness and perceptions

The majority of participants (81.4%) had prescribed ARDs (BPs and/or denosumab) before for their patients. ARDs had been prescribed more than 20 times during the last 3 years by 46.6% of the participants, while 16.7% had prescribed ARDs 5 times or less, 10.0% had prescribed ARDs 10–20 times, and 8.1% had prescribed ARDs 6–10 times. Approximately 78.7% were aware of MRONJ, 76.0% knew that using BPs was a causative factor for MRONJ, and 55.7% knew that using denosumab was a causative factor for MRONJ. Only 25.8% of the participants knew that the incidence of MRONJ among osteoporotic patients taking BPs was 0.1%, and only

Table 1
Demographic Characteristics.

Variable	N	%	
Specialty	Rheumatology	77	34.8
	Endocrinology	56	25.3
	Others	38	17.1
	Family Medicine	19	8.6
	Orthopedics	13	5.9
	Internal Medicine	13	5.9
	General Medicine	5	2.3
Job title	Consultant	93	42.1
	Specialist	88	39.8
	Resident	36	16.3
	General Practitioner	4	1.8
Experience	More than 15 years	81	36.7
	6–10 years	47	21.3
	3–5 years	33	14.9
	<3 years	30	13.6
	11–15 years	30	13.6

23.1% knew that the incidence of MRONJ among osteoporotic patients taking denosumab was 0.04% to 0.2%. Approximately 61.1% of the participants knew that the risk of MRONJ was higher for patients taking IV BPs, and 62.0% knew that the risk of MRONJ was higher for patients taking ARDs for a longer duration. In addition, 65.6% of the participants thought that dental care before and during treatment with ARDs could aid in decreasing the risk of MRONJ. Moreover, 38.0% of them thought that the presence of persistent jaw pain was essential for an MRONJ diagnosis, and 47.5% thought that the presence of exposed jaw bone (or fistula that is probed to the bone) was essential for MRONJ diagnosis (Table 2).

3.3. Knowledge scores

The median overall knowledge score was 60.0% with an IQR of 40.0% to 70.0%. Approximately 29.9% of the participants showed poor knowledge, 49.3% showed fair knowledge, and 20.8% showed good knowledge (Figure 1). Our findings showed a significant difference between the knowledge levels of included participants in

Table 2
Awareness and Perception of physicians.

Variable		N	%
How many times did you prescribe ARDs during the last 3 years?	More than 20 times	103	46.6
	None	41	18.6
	5 times or less	37	16.7
	10–20 times	22	10.0
	6–10 times	18	8.1
Are you aware of medication-related osteonecrosis of the jaw (MRONJ)?	Yes	174	78.7
	No	47	21.3
To your knowledge, is using bisphosphonates causative factor for MRONJ?	I do not know	40	18.1
	No	13	5.9
	Yes	168	76.0
To your knowledge, is using denosumab causative factor for MRONJ?	I do not know	63	28.5
	No	35	15.8
	Yes	123	55.7
The incidence of MRONJ in osteoporotic patients under bisphosphonates is	0	1	0.4
	0.001%	46	20.8
	0.0001%	30	13.6
	0.10%	57	25.8
	I do not know	87	39.4
The incidence of MRONJ in osteoporotic patients under denosumab is	0	12	5.4
	0.0001%	45	20.4
	0.04% to 0.2%	51	23.1
	I do not know	113	51.1
Is the risk of MRONJ more for patients taking IV bisphosphonates?	I do not know	62	28.0
	No	24	10.9
	Yes	135	61.1
Is the risk of MRONJ more for patients taking ARDs for longer duration?	I do not know	59	26.7
	No	25	11.3
	Yes	137	62.0
Does dental care before and during treatment with ARDs can aid in decreasing the risk of MRONJ?	I do not know	49	22.2
	No	27	12.2
	Yes	145	65.6
To your knowledge, is presence of persisting jaw pain essential for MRONJ diagnosis?	I do not know	57	25.8
	No	80	36.2
	Yes	84	38.0
To your knowledge, is presence of exposed jaw bone (or fistula that is probed to the bone) essential for MRONJ diagnosis?	I do not know	63	28.5
	No	53	24.0
	Yes	105	47.5

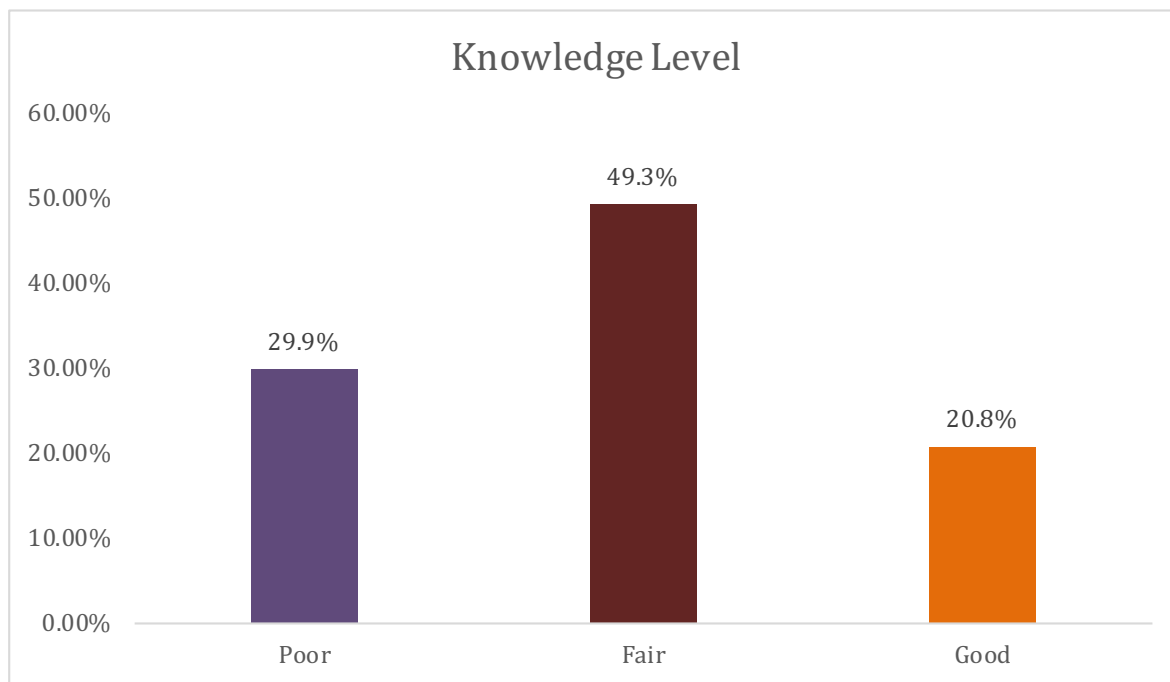


Fig. 1. The knowledge level of included participants.

terms of their specialty ($p<0.001$), job title ($p=0.033$), experience ($p=0.006$), history of ARD prescriptions ($p<0.001$), and frequency of ARD prescriptions ($p<0.001$). The highest percentage of good knowledge was observed among rheumatologists (29.9%), followed by endocrinologists (26.8%), others (13.2%), orthopedists (7.7%), internal medicine physicians (7.7%), and family medicine physicians (5.3%). In addition, consultants and specialists had a higher percentage of good knowledge than residents and general practitioners (24.7%, 22.7%, 8.3%, and 0%, respectively). We observed that the greater the years of experience, the higher the level of knowledge. Participants who had more than 15 years of experience demonstrated good knowledge, 32.1%, compared to 19.1% of those with 6–10 years of experience and 18.2% of those with 3–5 years of experience. Likewise, participants who prescribed ARDs had a higher percentage of knowledge (24.4%) than those who did not prescribe ARDs (4.9%) (Table 3).

3.4. Attitudes toward MRONJ

When the participants were asked if they informed their patients about MRONJ as a side effect before prescribing BPs, 41.6% answered yes. Only 25.3% of the participants were willing to refer the patients to dental practitioners before BP initiation. In addition, only 31.2% were willing to inform the patients about MRONJ before prescribing denosumab. Moreover, 20.8% of the participants were willing to refer the patients to a dental practitioner before denosumab initiation. On the other hand, 73.8% said that they referred patients taking BPs and denosumab to dental practitioners when they presented symptoms related to the jaws (Table 4).

Based on these findings, 65.6% of the participants had a negative attitude toward MRONJ, and 34.4% had a positive attitude. A positive attitude was more frequently observed among rheumatologists (55.8%) compared to other specialists ($p < 0.001$). Participants who had 11–15 years or more than 15 years of experience demonstrated positive attitudes (50.0% and 43.2%, respectively). Similarly, participants who prescribed ARDs had a higher

percentage of positive attitudes (38.3%) than those who did not prescribe ARDs (17.1%). Interestingly, participants who had good knowledge of MRONJ had a significantly higher ($p<0.001$) percentage of positive attitudes (60.9%) than those with fair (36.7%) and poor knowledge (12.1%) (Table 5).

4. Discussion

The prevalence of osteoporosis in the Saudi population is reported to be 28.2% and 37.8% among females and males older than 50 years, respectively (Ardawi et al, 2005). ARDs have been shown to minimize the risk of both vertebral and nonvertebral fractures and therefore were approved for the management of osteoporosis (LeBoff et al, 2022). MRONJ is a serious debilitating adverse drug event in patients receiving long-term ARDs that mainly affects the jaw bones. Although the prevalence of MRONJ among osteoporosis patients is lower than that among oncology patients, it actually increases with a longer duration of administration. The prevalence of MRONJ among osteoporosis patients taking oral BPs increased from zero at the time of induction to 0.2% 4 years later. Likewise, for denosumab, the incidence increased from 0.09 in the first year to 0.2 after six years (Dodson, 2015). Adequate knowledge about MRONJ is a prerequisite to improve treatment outcomes and reduce the complications associated with these medications. As the ultimate goal of management of osteoporosis is to improve patients' quality of life and decrease morbidity, the treating physician should aim to aid in MRONJ prevention and management. Prevention of MRONJ is based on multidisciplinary strategies performed by medical and dental teams. Any lack in perceptions, knowledge, or attitudes in either of these teams can jeopardize the health of osteoporosis patients. Physicians are the first to have contact with osteoporosis patients, and they have to explain the risk of MRONJ to their patients and refer them afterward to dentists. Any ignorance concerning this obligation can expose patients to a serious complication that is difficult to manage. To our knowledge, this study is the first to explore the knowledge, awareness and attitudes regarding MRONJ among physicians

Table 3
Association between knowledge level and participants demographics.

Variable		Poor	Fair	Good	p-value
Specialty	Endocrinology	6 (10.7%)	35 (62.5%)	15 (26.8%)	P<0.001
	Family Medicine	9 (47.4%)	9 (47.4%)	1 (5.3%)	
	General Medicine	4 (80.0%)	1 (20.0%)	0 (0%)	
	Internal Medicine	3 (23.1%)	9 (69.2%)	1 (7.7%)	
	Orthopedics	6 (46.2%)	6 (46.2%)	1 (7.7%)	
	Rheumatology	14 (18.2%)	40 (51.9%)	23 (29.9%)	
	Others	24 (63.1%)	9 (23.7%)	5 (13.2%)	
Job title	Consultant	25 (26.9%)	45 (48.4%)	23 (24.7%)	P=0.033
	General Practitioner	1 (25.0%)	3 (75.0%)	0 (0%)	
	Specialist	21 (23.9%)	47 (53.4%)	20 (22.7%)	
	Resident	19 (52.8%)	14 (38.9%)	3 (8.3%)	
Experience	<3 years	15 (50.0%)	13 (43.3%)	2 (6.7%)	P=0.006
	3–5 years	10 (30.3%)	17 (51.5%)	6 (18.2%)	
	6–10 years	18 (38.3%)	20 (42.6%)	9 (19.1%)	
	11–15 years	10 (33.3%)	17 (56.7%)	3 (10.0%)	
	More than 15 years	13 (16.0%)	42 (51.9%)	26 (32.1%)	
Have you prescribed antiresorptive drugs (ARDs) (bisphosphonates and/or denosumab) before?	Yes	37 (20.6%)	99 (55.0%)	44 (24.4%)	P<0.001
	No	29 (70.7%)	10 (24.4%)	2 (4.9%)	
How many times did you prescribe ARDs during the last 3 years?	None	27 (65.9%)	13 (31.7%)	1 (2.4%)	P<0.001
	5 times or less	19 (51.4%)	17 (45.9%)	1 (2.7%)	
	6–10 times	6 (33.3%)	7 (38.9%)	5 (27.8%)	
	10–20 times	4 (18.2%)	14 (63.6%)	4 (18.2%)	
	More than 20 times	10 (9.7%)	58 (56.3%)	35 (34.0%)	

Table 4
Attitude of participants towards MRONJ.

Variable		N	%
Do you inform your patients about MRONJ as a side effect before prescribing bisphosphonates?	No	70	31.7
	Sometimes	59	26.7
	Yes	92	41.6
Do you refer the patients to dental practitioner before bisphosphonates intake?	No	111	50.2
	Sometimes	54	24.5
Do you inform the patients about MRONJ before prescribing denosumab?	Yes	56	25.3
	No	106	48.0
	Sometimes	46	20.8
Do you refer the patients to dental practitioner before denosumab intake?	Yes	69	31.2
	No	126	57.0
	Sometimes	49	22.2
Do you ask the patients under bisphosphonates about their oral health in the follow-up visits?	Yes	46	20.8
	No	79	35.7
	Sometimes	38	17.2
Do you ask the patients under denosumab about their oral health in the follow-up visits?	Yes	104	47.1
	No	90	40.7
	Sometimes	40	18.1
Do you refer patients on bisphosphonates and denosumab for dental practitioner when they present symptoms related to the jaws?	Yes	91	41.2
	No	36	16.3
	Sometimes	22	9.9
	Yes	163	73.8

who are in charge of managing osteoporosis patients in Saudi Arabia. The results of this study could aid in implementing strategies to decrease the risk of MRONJ in Saudi Arabia and to continue ARDs without interruption.

In the present study, 29.9% of the physicians showed poor knowledge about MRONJ, 49.3% showed fair knowledge, and only 20.8% showed good knowledge. MRONJ was first reported approximately two decades ago; however, only 78.7% of the participants were aware of MRONJ, 76.0% knew that MRONJ is associated with BPs, and only slightly more than half of them knew that MRONJ is associated with denosumab. In addition, only 61.1% knew the risks associated with the intravenous route of administration, and 62.0% knew the risks associated with long duration of administration. A recent study in Japan investigated the knowledge of 268 physicians who prescribed ARDs for osteoporosis and found that 94% of the respondents were aware of MRONJ (Yamori et al, 2021). Therefore, the findings of the present study are particularly alarming, as all

the participants agreed that management of osteoporotic patients is one of their professional duties, and 81.4% had already prescribed ARDs more than 20 times during the last 3 years. A cross-sectional study conducted approximately 10 years ago to assess the awareness and knowledge of Saudi physicians regarding MRONJ demonstrated that only 31.5% of the participants were aware of osteonecrosis of the jaw, while more than half of them were treating patients with BPs (Al-Mohaya et al, 2011). They concluded that physicians had low awareness and deficient knowledge regarding MRONJ. Therefore, interventions to raise awareness and knowledge among healthcare providers are recommended. Among Lebanese physicians, El Osta and his team (El Osta et al, 2015) investigated the knowledge regarding MRONJ. Their findings showed that while 63.2% of the physicians were treating patients with BPs, 37.5% were unaware of MRONJ. However, these studies were conducted approximately 10 years ago, and MRONJ is expected to be well known now, particularly among physicians who prescribe ARDs, which is not the case among the participants of the present study.

Regarding the factors associated with knowledge level, the highest knowledge scores were found among rheumatologists, consultants, participants with more years of experience, and participants who had previously prescribed ARDs. Likewise, several studies have found that experience, specialty, and training are associated with the level of knowledge (Al-Mohaya et al, 2011, El Osta et al, 2015, Miranda-Silva et al, 2020, Acharya et al, 2022). This finding highlights the importance of continuing education to enforce knowledge about MRONJ.

Furthermore, 65.6% of the participants had a negative attitude toward MRONJ, and only 34.4% had a positive attitude. Only 41.6% and 31.2% of the participants informed patients about MRONJ as a possible side effect before starting treatment with BPs and denosumab, respectively. Moreover, only approximately one-quarter of the participants were willing to refer the patients to dental practitioners before BP and denosumab initiation. Surprisingly, a quarter of the participants would not refer patients to a dentist even if they presented symptoms related to the jaws. Patient education on such a side effect with a high impact on quality of life prior to initiating medications such as ARDs is mandatory for ethical and medico-legal considerations. In addition, referral to dentists prior to ARD therapy, if the patient's medical status allows,

Table 5
Association between Attitude level and participants demographics.

Variable		Negative	Positive	p-value
Specialty	Endocrinology	42 (75.0%)	14 (25.0%)	P<0.001
	Family Medicine	17 (89.5%)	2 (10.5%)	
	General Medicine	5 (100%)	0 (0%)	
	Internal Medicine	7 (53.8%)	6 (46.2%)	
	Orthopedics	9 (69.2%)	4 (30.8%)	
	Rheumatology	34 (44.2%)	43 (55.8%)	
	Others	31 (81.6%)	7 (18.4%)	
Job title	Consultant	59 (63.4%)	34 (36.6%)	P=0.202
	General Practitioner	3 (75.0%)	1 (25.0%)	
	Specialist	54 (61.4%)	34 (38.6%)	
	Resident	29 (80.6%)	7 (19.4%)	
Experience	<3 years	26 (86.7%)	4 (13.3%)	P=0.006
	3–5 years	22 (66.7%)	11 (33.3%)	
	6–10 years	36 (76.6%)	11 (23.4%)	
	11–15 years	15 (50.0%)	15 (50.0%)	
	More than 15 years	46 (56.8%)	35 (43.2%)	
Have you prescribed antiresorptive drugs (ARDs) (bisphosphonates and/or denosumab) before?	Yes	111 (61.7%)	69 (38.3%)	P<0.010
	No	34 (82.9%)	7 (17.1%)	
Knowledge level	Poor	58 (87.9%)	8 (12.1%)	P<0.001
	Fair	69 (63.3%)	40 (36.7%)	
	Good	18 (39.1%)	28 (60.9%)	

is also mandatory to minimize the oral risk factors associated with MRONJ. This indicated that physicians who treated osteoporosis in this study had deficient attitudes, and continuing education programs need to be urgently implemented. Miranda-Silva and his colleagues investigated the knowledge and attitudes of 239 physicians, and a higher percentage of physicians (84.6%) agreed that referral to dentists before starting ARDs was essential (Miranda-Silva et al., 2020). In Japan, 59% of physicians explain MRONJ to their patients, and 30% request oral care prior to administration of ARDs (Yamori et al., 2021). Finally, they concluded that the behavior of physicians and dentists was insufficient for the prevention of MRONJ among patients with osteoporosis. The results of the aforementioned studies clearly demonstrated better attitudes toward MRONJ than those in the present study. A positive attitude, however, was more frequently observed among rheumatologists, participants who had 11–15 years or more than 15 years of experience, participants who prescribed ARDs, and participants who had good knowledge of MRONJ. This highlights the importance of knowledge reinforcement to improve deficiencies in clinicians' attitudes toward MRONJ. In contrast, a study conducted in Spain showed that knowledge of the side effects of ARDs decreased with increasing years of professional experience (Escobedo et al., 2018).

There are some limitations to this study. First, an online questionnaire was used, which could increase the risk of response bias. Second, the sample may not be representative of all Saudi physicians. Third, the survey question about the risk of MRONJ in patients taking IV BPs had to be specific either to osteoporosis or cancer patients as the risk is different in the two groups. However, this study is the first to investigate the level of knowledge and attitudes of physicians responsible for the medical management of osteoporosis in Saudi Arabia, and based on these findings, the following recommendations are put forward: 1. The physician should inform the patient about the risk of MRONJ before starting ARDs and briefly explain the risk factors and the importance of dental management in the prevention of MRONJ.

2. Physicians are responsible for referral of patients to dental professionals before ARD therapy, however, ARDs can be initiated in urgent cases (i.e. in patients with considerable risk of fracture) before complete optimization of oral health. The urgency of medical treatment must be decided after individual case assessment as the benefit of fracture prevention can outweighs the risk of MRONJ.

3. Physicians must reinforce patient compliance with dental follow-ups at every appointment. Moreover, they must ask about

any dental complications that might be related to MRONJ and refer the patient to urgent dental care if needed.

5. Conclusion

This study indicated a notable lack of knowledge and poor attitudes among physicians who provide treatment for osteoporosis patients in Saudi Arabia. Physicians with more experience and consultants showed better perceptions and attitudes. Informing patients about MRONJ and referring them to the dental team before the start of ARDs are essential to minimize the risk of MRONJ and decrease patient morbidity. Raising awareness about this uncommon but serious side effect of ARDs through continuing education targeting this group of physicians is highly recommended.

6. Ethics approval and consent to participate

This study was approved by the Ethics Committee of King Abdulaziz University under number 42120720.

7. Availability of data and materials

Data available upon request from authors (Suad Aljohani, sraljohani@kau.edu.sa).

Author contribution

S. Aljohani has solely contributed to this study.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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