

# Dental and Temporomandibular Joint Problems among SCUBA Divers in Jeddah, KSA

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**Abstract** The recent increase in the popularity of scuba diving has emphasized the role of the dentist in the prevention and treatment of oralbarotrauma. Barotrauma is a physical injury that results from ambient pressure changes during flying, diving or hyperbaric oxygen therapy [1]. Pressure changes can induce otitis-media, sinusitis, headache or can be manifested as pain to the oral region [2]. Dental barotrauma can happen while ascending; upon surfacing after completing the dive, the diver may report that a tooth broke or has shattered [4]. Divers may also suffer from signs of tempromandibular disorder such as pain in tempromandibular joint (TMJ) and ears, TMJ clicking or crepitus, trismus and impaired TMJ mobility, headache and facial pain [5]. Hence, this article aims to Assessment of dental and TMJ problems in a sample of SCUBA divers in Jeddah Saudi Arabia, Assessment of dental complaints of divers, Assessment of TMJ problems associated with SCUBA diving and relate the previous problems to diving related characteristics such as the duration of practice, the number of dives and the frequency of diving per month. Material and methods: Divers at four dive centers at the Northern coast of Jeddah (Obhur) asked to complete a questionnaire that requested information regarding diving experience and facial pain and dental symptoms experienced during diving. Cross sectional study assessing the prevalence of dental and TMJ problems among divers. The total number was 60 SCUBA divers. Results: most of divers did not complain of sinusitis (75%). More than half of the sample complained of headache (65%). While facial pain was reported by (46.7%) of the sample. More than half did not experience dental pain (65%) while (35%) had dental pain during diving. More than half of the sample did not experience TMJ pain 70% while (30%) reported having TMJ pain during diving. Conclusions: Scuba diving is one of the fastest growing sports in the world. Since Jeddah is the main port of Saudi Arabia, diving has become an occupation as well a popular sport for many people. This attracted our attention to the importance of evaluating the oral problems related to this activity. It is inevitable that the general dental practitioner will have patients who participate in this sport and they should be aware of a number of problems that a diver can experience that are associated with the teeth and related structures. The dental team must educate the diver patient of the infectious potential of the mouthpiece and recommend using only a private one, and encourage maintenance by hygiene procedures after each use, similar to other removable oral devices. The diver should not dive in times of illness. Diving related TMD symptoms should be differentiated from barotitis symptoms.

**Keywords:** Dental, Temporomandibular joint, Jeddah, KSA, divers, scuba diving, oralbarotrauma, oral problems, TMJ problems, Diving recommendations, dental pain, facial pain

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## 1. Introduction

The recent increase in the popularity of scuba diving has emphasized the role of the dentist in the prevention and treatment of oralbarotrauma. Barotrauma is a physical injury that results from ambient pressure changes during flying, diving or hyperbaric oxygen therapy [1].

After flight was developed at early of 20th century. Physiologic and pathologic phenomena of in-flight started to be reported. The introduction of the self-contained underwater breathing apparatus (SCUBA) in the middle of

that century has been associated with manifestations due to atmospheric pressure changes, and were associated with diving as well [2]. Pressure changes can induce otitis-media, sinusitis, headache or can be manifested as pain to the oral region [2]. While barodontalgia (pain in dental apparatus) is a condition intimately related to pre-existing dental pathology. It was speculated that the inability of gases within the tooth to expand to adjust internal pressure when exposed to external pressures by diving or flying makes teeth susceptible to barodontalgia [3]. Other symptoms that divers may complain of includes tooth fracture, restoration fracture (both will be referred as dental fracture), and reduced retention of dental restoration.

Other than need for dental treatment, potential consequences include aspiration or swallowing of the dislodged restoration or dental fragment and pain, which may lead to incapacitation while diving and premature discontinuation of the planned dive. Furthermore barodontocrexis (barometric-induced 'tooth explosion', Greek) describes the phenomenon of dental fracture. Dental fractures reports caused by pressure change considered in-flight conditions were reported several years ago. Dental barotrauma can happen while ascending; upon surfacing after completing the dive, the diver may report that a tooth broke or has shattered [4]. Dental barotrauma can appear with or without pain similar to dental fracture occurring at ground level [2]. Divers may also suffer from signs of temporomandibular disorder such as pain in temporomandibular joint (TMJ) and ears, TMJ clicking or crepitus, trismus and impaired TMJ mobility, headache and facial pain [5]. The prevalence of barodontalgia in Saudi Arabia and Kuwait while diving was reported to be 17.3% ( $P < 0.0001$ ) [3], which attracted the attention to this arising problem and highlighted the need for its evaluation in Jeddah.

## 2. Literature Review

Goethe et al (1989) conducted a ten years longitudinal study which was conducted in Nautical Medical Institute of the German Navy, Kiel, West Germany. The results reported that from 2,580 submariners, divers, and frogmen, 13,618 individual findings were evaluated from a total of about 50,000 dental findings. After their first dental examination within period of 9 years, teeth of navy divers and frogmen had deteriorated very much more than those of submariners. The cause of these dental problems among navy divers was suggested to be due to the additional barometric stress they were subjected to in the past 10 years [4].

On line with this study, Jagger et al (2009 year) assessed the prevalence of orofacial complications associated with self-contained underwater breathing apparatus (SCUBA) diving. Two hundred divers at four dive centers on the north-east coast of Australia were asked using a questionnaire that inquired about diving experience, facial pain and dental symptoms experienced during diving. They found that prevalence of reported orofacial pain was 44%. Twenty-one per cent reported toothache, 27% sinus pain, 16% jaw pain, and 12% other pain. The prevalence of odontocrexis (teeth explosion during diving) was less than 1%. To further clarify this latter point Calder and Ramsey (year) reported findings of an in vitro decompression study on extracted teeth. A number of 86 extracted teeth were examined by using a pressure drop of 1035 kPa (approximating a common diving pressure) to ground atmospheric pressure within two minutes. Five of the teeth studied were damaged. These teeth had poor-quality amalgam restorations and the amalgam or secondary caries under the restoration. The 81 non-damaged teeth included unrestored teeth with carious lesions. Indicating that the presence of leaking amalgam a poor quality restoration is a predisposing factor for tooth fracture [6].

A case report of a 40 years old man was performed by Pecker et al (2009). The case complained of fracture in

three teeth and dislodgement of fillings while he was scuba diving at a depth of 35 meters. These teeth contained carious dentin. The caries was removed, and the affected teeth have been subjected went endodontic, restorative and prosthetic treatment. It was concluded that the inadequate restorations and selection of dental materials in some cases predisposed patients to barotraumas [7].

The effect of Scuba diving on temporomandibular joint was studied in older surveys, many authors attributed these problems to occlusion imbalance or problems in muscle resulting in pain, among them. Hobson in the Department of Dental Health, Dundee Dental Hospital assessed temporomandibular joint dysfunction syndrome and disorders of the (TMJ) associated with the use of a diving mouthpiece. And by using a questionnaire that collected information from 74 divers (62 male, 12 female). They were asked to evaluate the mouthpiece for comfort and overall efficiency and also recorded the level of muscle and joint discomfort experienced during diving and non-diving activities [5].

Hobson (1991) reported that 68% of dental pain was initially due to TMJ dysfunction and many result become severe enough to abandon the dive. A combination of all the variables of TMJ pain during diving given accuracy of 63.5% for pain prediction model. The use of discriminate analysis allowed the construction of a formula for the prediction of diving pain, which the diver may use in order to assess the most suitable mouthpiece. The results documented that the diver should be advised to try a number of mouthpieces to find the design that best suits his mouth, and not just accept the mouthpiece supplied [5].

Aldridge & Fenlon (2004) evaluated the Prevalence of temporomandibular dysfunction in a group of scuba divers, Data were collected retrospectively from a sample of divers who were asked to complete a questionnaire anonymously, consisting of 34 questions. The sample of divers came from those attending King's College London and divers diving with Cook Island Divers and Aitutaki Scuba. Data were collected and the results obtained were tabulated to investigate associations between different variables. The prevalence of TMD symptoms was also calculated. The diving associated prevalence of one TMD symptom for the population was 47.6%. Surprisingly the non-diving associated TMD prevalence was 55.6%, however, it was stated that TMD should really be defined by the presence of more than one symptom. And this would result in a prevalence of 22.2% and 27% respectively. If three symptoms were required, the prevalence would become 9.5% and 7.9% respectively. Limitation of mouth opening as well as nausea were associated with female gender [9].

Al-Hajri and Al-Madi (2006) measured the prevalence of barodontalgia among pilots flying non-commercial war planes and divers practicing in air bases, naval bases and diving schools in Saudi Arabia and Kuwait. The divers targeted in this study were those practicing in King Abdulaziz Naval Base (KANB) in Jubail and the Al-Sharq Diving School in Al-Khobar, Saudi Arabia and the Kuwait Diving School in Kuwait. A questionnaire was developed in English and Arabic and distributed among all pilots and divers present during the research period between November 2004 to April 2005. Two hundred and sixty-two subjects responded from both Saudi Arabia and

Kuwait. The response rate was 72.8% (182) in Saudi Arabia and 80% (80) in Kuwait. The mean age of divers was 33 years. Regarding years of experience a higher frequency of about (39.3%) had 7-12 years of experience, Divers had a higher incidence of pain while diving (13.4%) than when resurfacing sea level (3.9%). Most divers felt pain diving at a depth that ranged from 60 - 80 ft (18 – 24 m). They were subjected to finish treatment and then evaluate pain recurrence, Divers complained of recurrence of tooth pain during practice [2].

### 3. Study Objectives

#### 3.1. Main Objective

Assessment of dental and TMJ problems in a sample of SCUBA divers in Jeddah Saudi Arabia.

#### 3.2. Secondary Objectives

- Assessment of dental complaints of divers.
- Assessment of TMJ problems associated with SCUBA diving.
- Relate the previous problems to diving related characteristics such as the duration of practice, the number of dives and the frequency of diving per month.

### 4. Material and Method

#### 4.1. Study Setting

Divers at four dive centers at the Northern coast of Jeddah (Obhur) asked to complete a questionnaire that requested information regarding diving experience and facial pain and dental symptoms experienced during diving.

#### 4.2. Study Type

Cross sectional study assessing the prevalence of dental and TMJ problems among divers.

#### 4.3. Study Sample

In three weeks of field work the total available number of was 60 collected for questioner administration.

#### 4.4. Ethical Approval

The Research Ethics Committee at College of Dentistry, Qassim University, KSA approved this study (Code #:EA/6019/2018). The waiver of the informed consent process was approved on the basis of the questionnaires being anonymous and self-administered and containing no identifiers

### 5. Results

Table 1 shows that divers aged (25-29) years constituted the most frequent age group (51.7%) while the majority of the sample were trainees (73%).

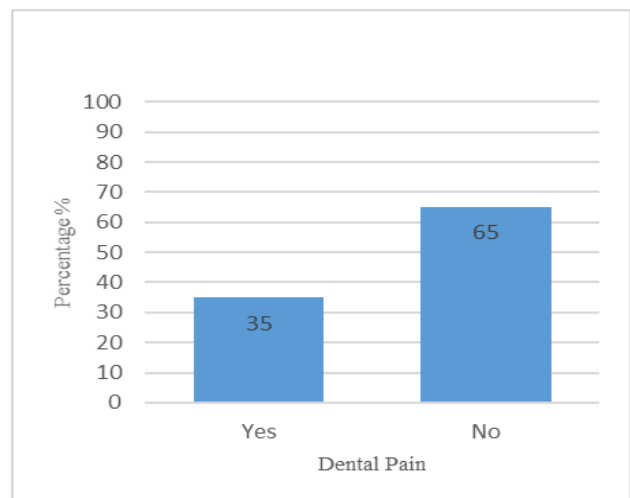
**Table 1. Demographic Characteristics of the Study Population**

Age groups	Frequency	Percent	Valid Percent	Cumulative Percent
15-19 years	2	3.3	3.3	3.3
20-24 years	11	18.3	18.3	21.7
25-29 years	31	51.7	51.7	73.3
30-34 years	9	15	15	88.3
35-39 years	5	8.3	8.3	96.7
40-44 years	1	1.7	1.7	98.3
45-50 years	1	1.7	1.7	100
Total	60	100	100	
Trainer or trainee	Frequency	Percent	Valid Percent	Cumulative Percent
trainee	44	73.3	73.3	73.3
trainer	16	26.7	26.7	100
Total	60	100	100	

**Table 2. Non Dental Complaints of the Study Population**

Sinusitis		Frequency	Percent
	yes	15	25
	no	45	75
	Total	60	100
Facial pain		Frequency	Percent
	yes	28	46.7
	no	32	53.3
	Total	60	100
headache		Frequency	Percent
	yes	39	65
	no	21	35
	Total	60	100

Table 2 shows that most of divers did not complain of sinusitis (75%). More than half of the sample complained of headache (65%). While facial pain was reported by (46.7%) of the sample.



**Figure 1. Dental pain among the study population**

Figure 2 shows the percentage of participants who experienced dental pain. More than half did not experience dental pain (65%) while (35%) had dental pain during diving.

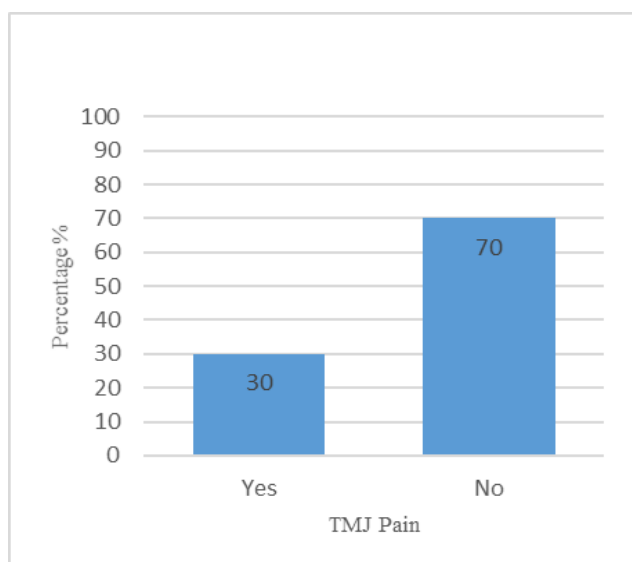


Figure 2. TMJ pain among the study population

Figure 2 shows the number & percentage of participants who experienced TMJ pain. More than half of the sample did not experience TMJ pain 70% while (30%) reported having TMJ pain during diving.

Table 3 shows dental pain reported by the divers. It shows that the total percentage who complained from dental pain were (35%). The highest frequency of divers who reported having dental pain had less than 5 years of experience of diving (39.9%), dived less than four times a month (40.5%), and dived less than 50 times (48.4%). Dental pain did not differ significantly according to any of these diving characteristics.

Table 4 shows that 18 divers (23.34%) reported having TMJ pain, the highest frequency of them are divers for 5-10 years (55.6%), Most of Divers who have TMJ pain, dived less than four times a month. And less than 50 times (42.9%). There was a statistically significant difference between the groups only relative to the years of experience ( $p=0.02$ ) but not to the other characteristics (number & frequency of dives).

Table 3. Dental pain relative to diving characteristics:

dental pain		yes%	No%	Asymp. Sig.
Years of diving	less than 5 years	39.30%	60.70%	.431
	from 5 to 10 years	38.10%	61.90%	.400
	more than 10	18.20%	81.80%	.278
dental pain		yes%	no%	Asymp. Sig.
number of dives	less than 50	48.40%	51.60%	.080
	50-100	20.00%	80.00%	.075
	more than 100	21.40%	78.60%	.047
dental pain		yes	no	Asymp. Sig.
Frequency of diving	less than four times a months	17	25	.151
	equal to or more than four times a months	4	14	.076

Table 4. TMJ pain relative to diving characteristics:

TMJ pain		yes	no	Asymp. Sig.
Frequency of diving	less than four times a months	14	28	.452
	equal to or more than four times a months	4	14	.681
	total	18	42	.60
TMJ pain		yes%	no%	Asymp. Sig.
Times of diving	less than 50	72.20%	42.90%	.107
	50-100	16.70%	28.60%	.098
	more than 100	11.10%	28.60%	.044
TMJ pain		yes%	no%	Asymp. Sig.
Years of diving	less than 5 years	44.40%	47.60%	.020
	from 5 to 10 years	55.60%	26.20%	.005
	more than 10	0.00%	26.20%	.283

Table 5. Dental and TMJ pain relative to the diving status:

Dental pain		yes%	No%	Asymp. Sig.
Trainer or trainee	Trainee (73.30%)	38.7%	61.3%	.327
	Trainer (26.70%)	25.0%	75.0%	
TMJ pain		yes%	No%	Asymp. Sig.
Trainer or trainee	Trainee (73.30%)	36.4%	63.6%	.074
	Trainer (26.70%)	12.5%	87.5%	

Table 5 shows an obvious variation between the percentage of trainees and trainers complaining of dental (38.7%, 25.0%) and TMJ (36.4%, 12.5%) pain, however the difference was not statistically significant at the 5% level ( $p=.32$  and  $.074$ ) respectively.

## 6. Discussion

Since Jeddah is the main port of Saudi Arabia, diving has become an occupation as well a popular sport for many people. This attracted our attention to the importance of evaluating the oral problems related to this activity. Barodontalgia is an oral pain elicited by a pressure change in an otherwise asymptomatic tissue. These problems can be of both odontogenic and nonodontogenic origin.

Although diver's mouth syndrome (DMS) has long been recognized by scuba divers, little attention has been paid to the influence of wearing a scuba diving mouthpiece on the stomatognathic system. In this review, DMS-related stomatognathic events (DMS-SE) while wearing a mouthpiece, the relationship between components of the mouthpiece and those events, and design considerations to reduce the risk of those events are discussed based on evidence from 32 articles concerning scuba diving mouthpieces [10].

## 7. Conclusions

Scuba diving is one of the fastest growing sports in the world. It is inevitable that the general dental practitioner will have patients who participate in this sport and they should be aware of a number of problems that a diver can experience that are associated with the teeth and related structures. The dental team must educate the diver patient of the infectious potential of the mouthpiece and recommend using only a private one, and encourage maintenance by hygiene procedures after each use, similar to other removable oral devices. The diver should not dive in times of illness, for the concern of his or her mate.

Diving related TMD symptoms should be differentiated from barotitis symptoms. Despite the potential limitations

in the construction process because of the number of stages involved, the greater expense and the possible reluctance of experienced divers to change from the standard commercial mouthpiece, Hobson and Newton recommended the fabrication of a custom mouthpiece for divers, with a bite platform at least 4mm in thickness, especially for divers who experience diving associated TMD symptoms.

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