Original Article

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A Comparison of the Stomatognathic and Neck Functions between Smokers and Non-smokers

Sigara Kullanan ve Kullanmayanların Stomatognatik ve Boyun Fonksiyonlarının Karşılaştırılması

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ABSTRACT

Objective: This study aimed to compare smokers' and non-smokers' stomatognathic and neck functions.

Methods: The study included 100 smokers and 96 non-smokers who did not have any chronic diseases. Temporomandibular and swallowing functions were evaluated as stomatognathic function components. Temporomandibular function with Fonseca Anamnestic Index (FAI) and swallowing function with Eating Assessment Tool (EAT-10) were assessed. The Neck Disability Index (NDI) was used to evaluate neck functions.

Results: The FAI score of smokers was higher than non-smokers (p=0.005). According to FAI scores, 68 (68%) of smokers had the risk of temporomandibular disorder (TMD), whereas 48 (50%) of non-smokers had the risk of TMD. The risk of TMD was higher in smokers (p=0.013). The EAT-10 scores of smokers and non-smokers were similar (p=0.692). Four participants among smokers (4%) and 4 participants among non-smokers (4.1%) had a risk for the swallowing disorder. The risk for the swallowing disorder of smokers and non-smokers was similar (p>0.999). The NDI scores were similar between smokers and non-smokers (p=0.833). According to NDI, 38 (38%) and 38 (39.6%) participants in both smokers and non-smokers had no functional neck disability.

ÖZ

Amaç: Bu çalışmada sigara kullanan ve kullanmayanların stomatognatik ve boyun fonksiyonlarının karşılaştırılması amaçlandı.

Yöntemler: Çalışmaya herhangi bir kronik hastalığı olmayan 100 sigara içen ve 96 sigara içmeyen kişi dahil edildi. Temporomandibular fonksiyon ve yutma fonksiyonu stomatognatik fonksiyon bileşenleri olarak değerlendirildi. Temporomandibular fonksiyon Fonseca Anamnestik Anketi (FAI) ile, yutma fonksiyonu ise Yutma Fonksiyonu Tarama Testi (EAT-10) ile değerlendirildi. Boyun fonksiyonlarını değerlendirmek için Boyun Engellilik Göstergesi (NDI) kullanıldı.

Bulgular: Sigara kullananların FAI skoru kullanmayanlara göre daha yüksekti (p=0,005). FAI skorlarına göre sigara kullananların 68'inde (%68) temporomandibular bozukluk (TMB) riski bulunurken, sigara kullanmayanların 48'inde (%50) TMB riski vardı. Sigara kullananlarda TMB riski daha yüksekti (p=0,013). Sigara kullanan ve kullanmayanların EAT-10 puanları benzerdi (p=0,692). Sigara kullanan 4 hastada (%4) ve sigara kullanmayan 4 hastada (%4,1) yutma bozukluğu riski vardı. Sigara kullanan ve kullanmayanların yutma bozukluğu riski benzerdi (p>0,999). Sigara kullanan ve kullanmayanların NDI skorları benzerdi

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ABSTRACT

The rate of functional neck disability of the groups was similar (p=0.304).

Conclusion: It was found that the risk of temporomandibular dysfunction was higher in smokers than in non-smokers, but not for swallowing and neck function. Even in the absence of chronic disease, the risk of developing temporomandibular dysfunction in smokers should be kept in mind.

Keywords: Neck, smoking, stomatognathic system, swallowing, temporomandibular disorder

ÖZ

(p=0,833). NDI'ye göre sigara kullananların 38'inde (%38) ve kullanmayanların 38'inde (%39,6) fonksiyonel boyun engelliliği yoktu. Grupların fonksiyonel boyun engelliliği oranı benzerdi (p=0,304).

Sonuç: Sigara kullananlarda temporomandibular disfonksiyon riskinin sigara kullanmayanlara göre daha yüksek olduğu ancak yutma ve boyun fonksiyonları için bu durumun söz konusu olmadığı bulundu. Kronik hastalık olmasa bile sigara kullananlarda temporomandibular disfonksiyon gelişme riski akılda tutulmalıdır.

Anahtar Kelimeler: Boyun, sigara içme, stomatognatik sistem, yutma, temporomandibular bozukluk

Introduction

Smoking is a harmful addiction that causes global drivers of premature disability and death. It is associated with many pathological factors that cause mortality and pave the way for the formation and progression of many diseases, especially neurological, cardiovascular, and lung diseases. Smoking is largely responsible for all deaths caused by lung cancer and chronic obstructive pulmonary disease (COPD) (1-3). However, not much focus has been given to the impact of smoking on smokers without any chronic disease, who may have smoking-related health issues even if they don't have any chronic diseases. Although smokers may seem healthy due to the absence of common smoking-induced chronic diseases like COPD, smoking harmfully exposes them to risks from the early stages of smoking (4). Smoking is not only a risk factor for many well-known chronic diseases, but also it may cause physical impairment and pain aggravation (5,6) due to its numerous hazardous ingredients causing impaired tissue healing, alteration in pain processing, and inflammation (4,7). Previous clinical researches have demonstrated this (5,8).

The stomatognathic system consists of muscles around the head and neck, chewing muscles, bone structures (lower and upper jaw), temporomandibular joint (TMJ), and soft tissues (salivary glands, vascular and nerve structures) (9,10). Chewing and swallowing, which are physiologically interconnected, are the most prominent functional parts of the stomatognathic system. TMJ is critical in the functionality of this connection (11,12). TMJ, connected to the cervical region by muscles and ligaments, is also included in the structure of the functional complex called the "cranio-cervical-mandibular system" (10,13). Additionally, the convergence of trigeminal and upper cervical nerve inputs in the trigeminocervical nucleus creates neurophysiological connections between TMJ and the cervical spine (14). With its biomechanical, neurophysiological, and functional relationship, TMJ is critical for stomatognathic and neck functions (10-14).

It is hypothesized that smoking may have an impact on gustatory and olfactory perception, as well as masticatory behavior. Consequently, the oral phase of swallowing can be affected, leading to stomatognathic dysfunction (11). Studies investigating the effect of smoking on stomatognathic function generally focused on TMJ (8,15-17). Studies indicated that smoking might increase symptoms and aggravate the pain of patients with TMJ disorders (8,15). However, the findings of the studies comparing the presence of TMJ disorders in smokers and non-smokers are contradictory (16,18). To the authors' knowledge, no study has compared swallowing and neck functions in smokers and non-smokers. Therefore, we aimed to compare stomatognathic (temporomandibular and swallowing) and neck functions in smokers and non-smokers.

Methods

Study Design

This case-controlled research was conducted web-based using an online form. The data collection was performed in February and March 2024. The ethical protocol of the study was approved by the Ankara Yıldırım Beyazıt University Health Science Ethics Committee (protocol number: 01-560, date: 16.01.2024) and this study was performed strictly under the declaration of Helsinki. Participants were informed about the study and their consent was obtained.

Participants

The 18-65 aged healthy participants were invited to the study. The participants were called for the study from the community via an announcement and they were recruited randomly through the snowball sampling method due to eligible criteria. The participants were divided into two groups based on their smoking status: current smokers and non-smokers. All patients were asked a series of questions, including "Do you currently smoke?", "Have you ever smoked?", and if they had smoked before, "For how many years have you smoked in total?" and "What is the average number of cigarettes you smoke per day?". Patients were also asked about their smoking cessation history, including "Have you ever quit smoking?" and "If yes, how long ago did you quit smoking?". Patients who currently smoked and had smoked at least 100 cigarettes in the past year were classified as smokers. Non-smokers verified that they had never smoked. Furthermore, participants who were not current smokers were not classified as non-smokers if they confirmed that they were ex-smokers (19).

Participants were excluded if they (a) had any diagnosed chronic diseases such as cardiovascular disease [hypertension (HT), history of myocardial infarcts, and any cardiovascular surgery, etc.], pulmonary disease (COPD, asthıma, etc.), endocrine disease [diabetes mellitus (DM), hypo/hyperthyroid, etc.], allergic (allergic rhinitis, etc.), rheumatic, oncologic, neurologic diseases, (b) had a history of any surgery or trauma related to the stomatognathic system (chin, jaw, throat, etc.), or cervical spine (c), had congenital spine deformity, (d) had a major psychiatric disorder, (e) had missing data in the assessment form, and (f) were not volunteer.

Measurements

The demographic, physical, and medical characteristics of the participants [sex, age, height, weight, body mass index, education level, medical history (chronic disease, surgery history), smoking features number of cigarettes smoked per day, years of smoking, history of quitting smoking, and smoking index] were questioned. The smoking index was recorded using the Brinkman formula, which multiplies the number of cigarettes smoked daily by the total number of smoking years. This index was divided into three categories: light smoking (≤200), moderate smoking (200-599), and heavy smoking (≥600) (20). Temporomandibular, swallowing, and neck functions were evaluated with patient-based questionnaires.

Temporomandibular Function

The Fonseca Anamnestic Index (FAI) is used to evaluate the temporomandibular function. It includes 10 items with three response options: "yes" (10 points), "sometimes" (5 points), and "no" (0 points). The score is calculated by adding up the points from all items, and it can classify the results into four categories: no signs or symptoms of temporomandibular disorder (TMD) (0-15 points), mild TMD (20-45 points), moderate TMD (50-65 points), and severe TMD (70-100 points). A total of more than 15 points means a risk for TMD. A higher score indicates higher temporomandibular dysfunction (21).

Swallowing Function

The swallowing function was evaluated with the Eating Assessment Tool (EAT-10) commonly known as EAT-10. It was designed to evaluate the swallowing disorders under 10 questions. Each question is given a score from 0 to 4 based on the severity of the problem (0= no problem, 4= severe problem). The total score is obtained by adding up the points given to each item. A total of 3 points and above means a risk for swallowing disorder. As the total score increases, the severity of swallowing dysfunction increases (22).

Neck Function

Neck function was assessed with the Neck Disability Index (NDI) developed to evaluate neck problems' effects on daily living activities. It consists of 10 items with 6 possible answers for each item ranged 0 to 5 points (0= no pain and no functional disability; 5= worst pain and maximum disability). The sum of the scores corresponding to the response to each item gives the NDI score. If NDI scores are between 0-4, 5-14, 15-24, 25-34, and over 35 points, they are classified as having no, mild, moderate, severe, or complete disability, respectively. Higher scores indicate greater functional neck disability (23).

Statistical Analysis

The sample size needed for the study was determined using a statistical power analysis program (G*Power Version 3.0.10, Franz Faul, Universität Kiel, Germany) (24). A pilot study was conducted with five randomly selected participants from each group, and their FAI scores were utilized to estimate it. A sample size of one hundred ninety participants (ninety-five per group) with a 10% drop rate was required to achieve 80% power with d=0.432 effect size, α=0.05 type I error, and β =0.20 type II error.

Statistical analysis software (IBM Corp. Released in 2012, IBM SPSS Statistics for Windows, Version 22.0) was used for data analysis and calculations. The Kolmogorov-Smirnov test, histogram, detrended normal quantile-quantile graph, skewness and kurtosis coefficients, and coefficient of variation were utilized to examine the distribution of data. Continuous values that followed a normal distribution were represented as mean ± standard deviation (X ± SD), while those that did not follow a normal distribution were represented as median (interquartile range). Categorical variables were represented as frequency (n) and percentage (%). The chi-square or Fischer's exact tests were used to compare categorical variables. For continuous variables, the independent sample t-test was employed to compare the variables of different groups, provided that the assumption of normal distribution was met. If the assumption of normal distribution was not met, the Mann-Whitney U test was used. A result was considered statistically significant if the overall p-value was less than 0.05.

Results

Three hundred-four participants were evaluated for the study's eligibility criteria. Firstly, 3 participants were excluded due to having missing data (n:1) and not being volunteers (n:2). According to their smoking status, participants were assigned into the smoker (n=145), and non-smoker (n=156) groups. Of 145 active smokers 45 were excluded due to having a chronic disease [cardio-pulmonary diseases (CPD) (n:8), HT (n:10), DM (n:4), hypo/hyper thyroid (n:4)], history of chin, face, or neck surgery or trauma (n:15), having allergenic rhinitis (n:4). Because 60 of non-smokers were not suitable for non-smokers group, 96 non-smokers were involved. Of a group of 60 participants, 27 had chronic conditions [rheumatic disease (n:4), CPD (n:6), DM (n:6), hypo/hyper thyroid (n:7), HT (n:4)], history of chin, face, or neck surgery or trauma (n:13), having allergenic rhinitis (n:5), having history of smoking (n:15). The study ultimately included 100 smokers and 96 never smokers. A flowchart illustrating the process from assessing eligibility criteria to data analysis for the study is provided in Figure 1.

Out of a total of 100 smokers, 42 (42%) were female and 58 (58%) were male. The educational level of the smokers was as follows: 13 (13%) had completed primary school, 20 (20%)

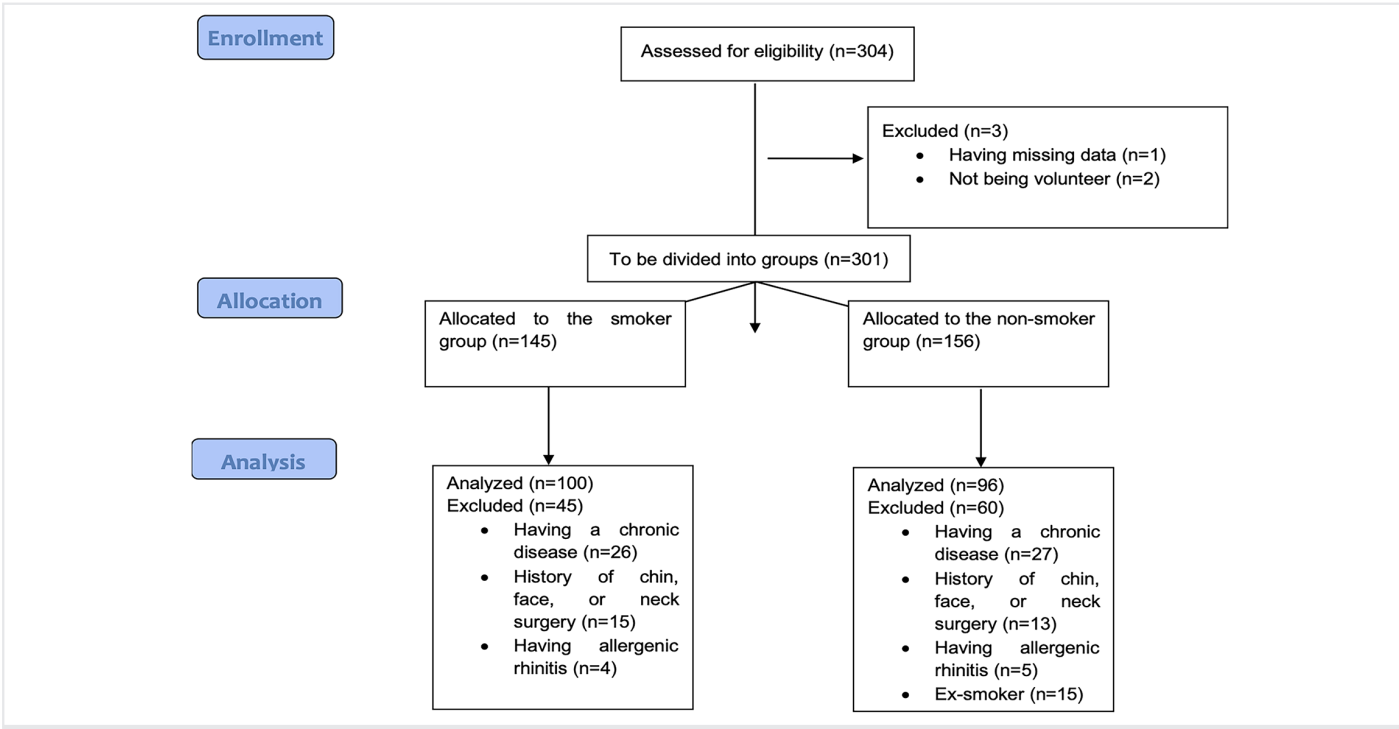

Figure 1. The flowchart of the study

had completed high school, 55 (55%) had obtained a bachelor's degree, and 12 (12%) had obtained a master's degree (Table 1). The mean of cigarettes smoked per day was 17.20±9.32, the smoking year was 16.38±10.32, and the smoking index was 311.30±287.76. Of the smokers, 51 (51%), 34 (34%), and 15 (15%) were light, moderate, and heavy smokers, respectively (Table 2). Out of 96 non-smokers, 68 (70.8%) were females and 28 (29.2%) were males. Six (6.3%) completed primary school, 13 (13.5%) completed high school, 61 (63.5%) had a bachelor's degree, and 16 (16.7%) had a master's degree (Table 1).

In the group of smokers, 32 participants (32%) reported no symptoms of TMD, 48 (48%) reported mild symptoms, 16 (16%) reported moderate symptoms, and only 4 (4%) reported severe TMD. On the other hand, no cases of severe TMD were reported in the non-smoker group. Out of the non-smokers, 36 participants (37.5%) had mild TMD symptoms, 12 (12.5%) had moderate symptoms, and 48 (50%) showed no symptoms of TMD. Sixty eight (68%) of smokers had the risk of TMD, whereas 48 (50%) of non-smokers had the risk of TMD. The presence of TMD (p=0.013) and TMD severity (p=0.024) was different between smokers and non-smokers. FAI score evaluating temporomandibular dysfunction was higher in smokers than non-smokers (p=0.005) (Table 3).

According to the EAT-10 score, 4 participants among smokers (4%) and 4 participants among non-smokers 4.1% had a risk for the swallowing disorder. The risk for the swallowing disorder of smokers and non-smokers was similar (p>0.999). The EAT-10 score evaluating swallowing function was similar between smokers and non-smokers (p=0.692) (Table 3).

Out of the smokers, 38 participants (38%) had no, 44 (44%) had mild, and 18 (18%) had moderate functional neck disability. Whereas, non-smokers reported no 38 (39.6%), mild 48 (50%), and moderate 10 (10.4%) functional neck disability. In both groups, no severe functional disability was found. The rate of functional neck disability of the groups was similar (p=0.304). The NDI scores evaluating neck function were similar between smokers and non-smokers (p=0.833) (Table 3).

Discussion

The purpose of this study was to compare stomatognathic (temporomandibular and swallowing) and neck functions in smokers and non-smokers who did not have any chronic diseases. We found that the percentage of TMD was higher in smokers compared to non-smokers. Additionally, the severity of TMD in smokers, according to the FAI score, was also higher. However, no significant difference was observed between smokers and non-smokers in the swallowing and neck functions. Therefore, we reported that smoking could cause temporomandibular dysfunction, but it didn't affect swallowing and neck function.

Studies suggest that smokers experience more severe pain in the presence of TMD than non-smokers, indicating that smoking is a risk factor for exacerbating temporomandibular symptoms (8,25). Although smoking was accepted as a risk factor for aggravating pain and dysfunction in patients with TMD, they focused on the effects of smoking on the severity of temporomandibular dysfunction. The findings of studies comparing temporomandibular function between smokers and non-smokers were contradictory (16,18). Sachdeva et al. (16) reported that smokers (56.9%) had higher TMD incidence than

Table 1. The comparison of the demographic and medical characteristics of groups

	Smokers (n=100)	Non-smokers (n=96)	p-value
Age (year), median (IQR)	37.00 (13.00)	30.00 (15.00)	**<0.001**[a*]
Body mass index (kg/m^2), median (IQR)	24.87 (4.64)	24.45 (5.68)	0.412[a]
Sex, N (Percentage)			
Female	42 (42)	68 (70.8)	**<0.001**[b]
Male	58 (58)	28 (29.2)	
Education level, N (percentage)			
Primary school	13 (13)	6 (6.3)	
High school	20 (20)	13 (13.5)	0.182[c]
Bachelor	55 (55)	61 (63.5)	
Master	12 (12)	16 (16.7)	

* p<0.05, [a]: Mann-Whitney U test, [b]: Fischer exact test, [c]: Chi-square test, N: Frequency, IQR: Inter-quartile range

Table 2. The smoking characteristics of smokers

	Smokers (n=100)
Mean of cigarettes smoked per day, X ± SD	17.20±9.32
Smoking years, X ± SD	16.38±10.32
Smoking index, median (IQR)	240 (405)
Smoking index category, N (percentage)	
Light	51 (51)
Moderate	34 (34)
Heavy	15 (15)

N: Frequency, X: Mean, SD: Standard deviation, IQR: Inter-quartile range

non-smokers (43.1%). Göğremiş and Sönmez(18) determined that 91.7% of smokers and 85.4% of non-smokers had TMD and they concluded that there was no significant difference in the incidence of TMD between smokers and non-smokers. Our findings were consistent with the study of Sachdeva et al. (16). We discovered that the risk rate of TMD was 68% in smokers, whereas it was 50% in non-smokers. Furthermore, our study also revealed that the severity of TMD was higher in smokers as compared to non-smokers. Smoking has been associated with aggravating chronic pain by acting on pain via hypersensitivity and inflammatory pathways. It also impairs the healing process, and this leads to aggravating chronic pain and dysfunction (7,26). Smoking can cause changes in the pattern of mastication behavior, a major function of the TMJ. Smokers exhibit atypical patterns in both functions compared to non-smokers (11). Our findings suggest that the higher incidence and severity of TMD in smokers than non-smokers can be attributed to the physiological (7,26) and biomechanical (11) effects of smoking on the TMJ.

We investigated the swallowing function in smokers and non-smokers. We found that the swallowing functions of smokers and non-smokers were similar. Moreover, we found that only a small percentage of both smokers (4%) and non-smokers (4.1%) were at risk of developing a swallowing disorder. Although as yet, no study has compared the swallowing function in smokers and non-smokers participants without COPD, studies reported that patients with COPD which is a smoking-induced disease had impaired swallowing function (27,28). In COPD patients, laryngopharyngeal mechanosensitivity may be reduced and swallowing function may be impaired, characterized mainly by pharyngeal stasis (29). So we may comment that smokers without COPD had similar swallowing functions as those of non-smokers. No differences in swallowing function between smokers and non-smokers can be attributed to our method for assessing swallowing function using the EAT-10. Smoking may impair taste and smell perception during the oral phase of swallowing (30). However, since swallowing is a submaximal function, this impairment might not lead to any functional problems. Alternatively, smoking may have impacted the spatial and temporal parameters of swallowing, which are not detectable by the EAT-10 (22).

We compared the self-reported neck function of smokers and non-smokers and found no difference. To the best of our knowledge, no studies have been conducted to compare neck function between smokers and non-smokers. Previous research has primarily focused on comparing neck pain rates and intensity (31,32). It was reported that smokers compared to non-smokers have more risk for musculoskeletal pain, especially spine pain (31). A study found that smokers had a 1.39 times higher risk of neck pain than non-smokers (32). Due to the negative effects of smoking on pain development and the aggravation of pain intensity (33,34), we had assumed that smoking could also affect neck function, but we did not find any differences between smokers and non-smokers. One possible explanation for the lack of significant differences in neck function between smokers and non-smokers is that neck function is influenced by multiple determinants, such as individual, clinical, and emotional factors (35). Also, we assessed neck function with a self-reported questionnaire. Therefore, our results should be questioned with objective methods.

Study Limitations

It is important to note that our study had some limitations that must be considered. Firstly, due to the cross-sectional design

Table 3. Comparison of temporomandibular, swallowing, and neck functions of groups

	Smokers (n=100)	Non-smokers (n=96)	p-value
Fonseca Amnestic Index Score, median (IQR)	25.00 (25.00)	17.50 (28.75)	**0.005**[a*]
The presence of temporomandibular disorder, N (percentage)			
Available	68 (68)	48 (50)	**0.013**[b*]
Absent	32 (32)	48 (50)	
Eating Assessment Tool Score, median (IQR)	0.00 (0.00)	0.00 (0.00)	0.692[a]
The presence of swallowing disorder, N (percentage)			
Available	4 (4)	4 (4.1)	>0.999[b]
Absent	96 (96)	92 (95.9)	
Neck Disability Index Score, median (IQR)	6.00 (8.00)	7.00 (7.50)	0.833[a]
The presence of functional neck disability, N (percentage)			
Available	62 (62)	38 (39.6)	0.304[c]
Absent	38 (38)	58 (60.4)	

[*] p<0.05, [a]: Mann-Whitney U test, [b]: Fischer exact test, [c]: Chi-square test, N: Frequency, IQR: Inter-quartile range

of the study, it is challenging to make causal inferences based on the data and analyses. Moreover, two groups in this study exhibited differences in certain demographic characteristics, such as age and gender. Since this is a cross-sectional study with a randomly selected sample from the broader population, these differences are expected. However, it is important to consider this when interpreting the results. Future studies should focus on participants of the same gender or within a narrower age range for more accurate comparisons. Additionally, the study only relied on self-reported measures to examine the stomatognathic and neck functions. The study was limited to patients' perceptions of these factors. As a result, future studies should consider using objective measurement methods. A thorough clinical examination of TMJ dysfunction should be conducted to address this limitation. Lastly, it is important to consider the possibility of selection bias as the patients in the study were limited to those who could fill out an online form via a web-based survey method.

Conclusion

We found that smokers had higher temporomandibular dysfunction than non-smokers. Additionally, we revealed that the severity of TMD was higher in smokers as compared to non-smokers. However, swallowing and neck functions were similar between smokers and non-smokers. We choose a study sample without any diagnosed chronic disease like COPD. So, we may comment that even in the absence of chronic disease smoking may cause a risk of temporomandibular dysfunction. So, the risk of developing temporomandibular dysfunction in smokers even in the absence of chronic disease should be kept in mind. In addition, the recommendations of healthcare professionals to quit smoking habits in their patients with TMD are very valuable.

Ethics

Ethics Commitee Approval: The ethical aproval of the study was obtained from the Ankara Yıldırım Beyazıt University Health Science Ethic Comitte (protocol number: 01-560, date: 16.01.2024).

Informed constent: Participants' informed consent was obtained.

Footnotes

Authorship Contributions

Surgical and Medical Practices: O.M., E.İ.H., S.Ç., S.A., N.Ö.Ü., Concept: O.M., N.Ö.Ü., Design: O.M., E.İ.H.,

N.Ö.Ü., Data Collection or Processing: O.M., E.İ.H., S.Ç., S.A., N.Ö.Ü., Analysis or Interpretation: O.M., S.Ç., N.Ö.Ü., Literature Search: O.M., E.İ.H., S.Ç., S.A., N.Ö.Ü., Writing: O.M., E.İ.H., S.Ç., S.A., N.Ö.Ü.

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