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The prevalence of smartphone, nicotine, and alcohol addiction among university students with temporomandibular disorders

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Abstract

Background: This cross-sectional study aimed to assess the prevalence of smartphone, nicotine, and alcohol addiction among university students with temporomandibular dysfunctions (TMDs) and compare these findings with a control group.

Methods: A total of 909 university students participated. The presence of TMDs was determined according to the Diagnostic Criteria for TMDs and participants categorized as TMDs and control groups. TMD severity was assessed via the Fonseca Anamnestic Index (FAI). Nicotine addiction was evaluated using the Fagerström Test for Nicotine Dependence (FTND), alcohol dependence with the Addiction Profile Index Risk Scanning Scale (APIRSS), smartphone addiction with the Smartphone Addiction Index-Short Form (SPAI-SF), and depression and anxiety levels using the Patient Health Questionnaire-4 (PHQ-4).

Results: Nicotine ($p=0.009$), alcohol ($p=0.004$), and smartphone ($p<0.001$) addictions were more prevalent in students with TMDs. PHQ-4, SPAI-SF, APIRSS, and FTND scores were significantly higher in this group ($p<0.001$; $p=0.003$ for FTND). Among nicotine-addicted participants, those with TMDs had higher FTND scores than controls ($p<0.007$). FAI scores were positively correlated with SPAI-SF ($r=0.283$, $p<0.001$), FTND ($r=0.147$, $p<0.001$), APIRSS ($r=0.123$, $p<0.001$), and PHQ-4 ($r=0.48$,

p<0.001) scores. PHQ-4 scores were correlated with SPAI-SF (r=0.328, p<0.001), APIRSS (r=0.125, p<0.001), and FTND (r=0.120, p<0.001).

Conclusions: The findings emphasize the need for a multidimensional treatment approach in TMDs that consider coexisting addictions.

Keywords: Temporomandibular Joint Disorders; Nicotine Addiction; Smartphone Addiction; Alcoholism; Depression; Smoking.

Background

Temporomandibular disorders (TMDs) constitute a group of conditions involving different regional and systemic symptoms, including pain and limitation at the temporomandibular joint (TMJ), with a high prevalence, ranging from 31% to 75% in the adult population [1, 2]. TMDs have a multifactorial etiology involving numerous factors including sex, age, parafunctional habits, psychological issues, and lifestyle [3]. It has been established that lifestyle is of paramount importance in the management of TMDs. Consequently, there has been a recent proliferation of literature examining the relationship between lifestyle and TMDs severity, with an emphasis on adopting multidisciplinary approaches.

Addictions, which play a significant role in the etiology of most diseases and often complicate treatment, represent a key area of investigation. Among the most prevalent addictions in today's society are nicotine and alcohol [4]. The observed association between the severity of depression and anxiety and the prevalence of TMDs may predispose individuals with

TMDs to the development of these addictions [5, 6]. A systematic review reveals a consensus on this point. Miettinen et al.[7] showed that the regular consumption of alcohol and tobacco products was associated with increased TMDs symptom severity. Similarly, another study reported higher TMDs-related pain in smokers compared with non-smokers [8]. Furthermore, with the advent of technological advancement, smartphone addiction has been added as a global health problem [4, 9]. Although researchers have postulated a correlation between long-term smartphone use and TMDs, there is currently no conclusive evidence in the literature to substantiate this hypothesis. The underlying rationale for this proposition is the alteration in posture that occurs with prolonged smartphone use. Individuals who use smartphones for an extended period exhibit a forward head posture, which places excessive stress on the cervical spine [9]. This prolonged flexion of the cervical spine, coupled with the increased weight of the head, can negatively affect the neck muscles, ligaments, and bony structures [9]. It is therefore hypothesized that the negative effects on the neck may have consequences for the TMJ [9]. Pei et al.[10] reported that individuals with smartphone addiction exhibited more severe and frequent pain and symptoms related to TMDs[10].

Demonstrating the effect of addictions, which are highly prevalent in society, on TMDs will facilitate the development of proactive approaches for the management of TMDs. The relationship between addiction and TMDs has been previously investigated in different countries, including China and Finland [7, 10]. Smartphone, nicotine, and alcohol addiction related to TMDs may be different between Turkish university students and

other populations because addictive behavior is influenced by various factors, including age and cultural characteristics. Therefore, our primary purpose was to investigate the prevalence of smartphone, nicotine, and alcohol addiction among Turkish university students with TMDs. Furthermore, we sought to compare these findings with those from a group of healthy individuals. Additionally, we aimed to identify the relationship of nicotine, smartphone, and alcohol addiction with depression and TMDs severity. The hypothesis of this study was that Turkish university students with TMDs would be more likely to exhibit addictive behaviors regarding nicotine, alcohol, and smartphone use.

Methods

Ethical Statement

This study was approved by the Toros University Non-Interventional Clinical Research Ethics Committee (Protocol Number: 2024/06-09). Prior to their participation in the study, all subjects were provided with comprehensive information regarding the nature and scope of the investigation. Their consent was obtained in an informed manner. Specifically, both written and verbal consent were required, with written consent documented through signed forms and verbal consent recorded in the presence of a witness. Throughout the course of the study, the research team adhered to the ethical standards set forth in the Declaration of Helsinki. Additionally, the study was conducted in accordance with the STROBE (Strengthening the Reporting of Observational Studies in

Epidemiology) statement for case-control studies and the STROBE Checklist for observational studies.

Sample Size

A power analysis was conducted to determine the optimal sample size using the Calculator.net software. A total of 3.744 students were registered, and a prevalence of TMDs of 31% was used as a reference point. It was determined that a minimum of 303 individuals per group were required to achieve a power of 0.95 and a type I error rate of 0.05 [2].

Participants

The present study was conducted with a sample of 18-25 years old university students from a variety of academic departments at Toros University. The evaluation form was administered to a sample of 909 students between June 24, 2024, and July 22 of 2024. Participant recruitment, initial screening, and administration of sociodemographic and questionnaire assessments were conducted by two physiotherapists with 5 years of experience (ÜY, EE). The presence of TMDs was evaluated by a maxillofacial surgeon with 26 years of expertise (BAK) in accordance with the Diagnostic Criteria for TMDs (DC/TMD) and the standards of the International Association for Dental, Oral and Craniofacial Research (IADR). Participants were then classified into TMD and control groups [11, 12]. Participants who had undergone radiotherapy to the head, neck, or shoulder; had a history of surgery or orthodontic treatment related to the maxillofacial and neck area; had used analgesic and anti-inflammatory drugs or received any treatment related to TMDs in the previous year; or

had experienced generalized joint damage affecting the head, neck, or shoulder region or major trauma were excluded from the study. Additionally, the study excluded individuals with a history of acute or chronic inflammatory diseases, as well as those diagnosed with radiculopathy, myelopathy, systemic, metabolic, neurological, or immune diseases, post-traumatic stress disorder, or congenital conditions (Figure-1).

Assessment of the Temporomandibular Joint Symptom Severity

The severity of TMDs was evaluated using the Turkish version of the Fonseca Anamnestic Index (FAI). The FAI was reported to be sufficiently valid and reliable in the Turkish population (ICC: 0.739-0.897) by Kaynak et al. [13]. The FAI, which assesses the severity of TMDs according to signs and symptoms, is a simple questionnaire consisting of 10 specific questions. In this questionnaire, each question includes 3 answer options (Yes-Sometimes-No). In the questionnaire scoring, ‘Yes’ option is scored as 10 points, ‘Sometimes’ option is scored as 5 points, and ‘No’ option is scored as 0 points. According to the total score of the questionnaire; 0-15 points: No TMDs, 20-40 points: Mild TMDs, 45-65 points: Moderate TMDs, 70-100 points: Refers to severe TMDs [13].

Assessment of the Depression and Anxiety Symptoms

Depression and anxiety symptoms were evaluated with the four-item short version of the Patient Health Questionnaire (PHQ-4). Demirci and Ekşi [14] conducted the study for Turkish adaptation of this scale and the Cronbach's alpha value was reported as 0.85. The four-item scale is described as the

shortest composite measurement tool to assess depression and anxiety disorders [15]. The questionnaire is a 4-point Likert-type scale with each item scored as (0) never, (1) few days, (2) more than half of the days, (3) almost every day [14]. The total score of the questionnaire ranges from 0 to 12, higher scores present increased the prevalence of symptoms associated with depression and anxiety.

Assessment of Nicotine Addiction

Participants' cigarette/nicotine addiction levels were evaluated using the Turkish version of the Fagerström Test for Nicotine Dependence (FTND) [16]. The FTND comprises six items, each of which is assigned a distinct score. The scoring system ranges from 0 to 2 points for very low nicotine addiction, 3-4 points for low nicotine addiction, 5 points for moderate nicotine addiction, 6 to 7 points for high nicotine addiction, and 8 to 10 points for very high nicotine addiction [16].

Assessment of Alcohol Addiction

Alcohol consumption and dependence were evaluated with the Addiction Profile Index Risk Scanning Scale (APIRSS). The Cronbach's Alpha coefficient of the questionnaire, whose validity and reliability study was conducted by Ögel et al. [17] was determined as 0.70. Each question of the APIRSS, which comprises six items, is scored between 0 and 2. The scale score ranges between 0 and 12, and scores 3 and above indicate an increased level of alcohol addiction [17].

Assessment of Smartphone Addiction

The level of smartphone addiction was evaluated using the Turkish version of the Smartphone Addiction Scale-Short Form. The validity and reliability study of the Turkish version of SPAI-SF in university students was conducted by Noyan et al. [18] and the Cronbach's alpha coefficient of the scale was reported as 0.867. The SPAI-SF, developed for evaluating the risk of smartphone addiction in adolescents and young adults, is a 6-point Likert-type scale with 10 items [18]. Participants were asked to choose one of 6 alternative answers to each question: strongly disagree', disagree', 'somewhat disagree', 'somewhat agree', 'agree', and 'strongly agree'. Each item is assigned a rating on a scale of 1 to 6, with a total score ranging from 10 to 60 [18]. It is reported that the risk of addiction rises as the score increases [18].

Statistical Analysis

The data of the study were analyzed with a statistical software program (SPSS software version 26, IBM Corporation, Armonk, NY, USA). The conformity of the variables to normal distribution was analyzed using visual (histogram and probability graphs) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk tests). Since the variables were not normally distributed, the findings are presented as median (interquartile range). The differences of the parameters between the two groups were analyzed using the Chi-Square and the Mann-Whitney U tests. The correlation of the severity of TMDs with depression and smartphone, nicotine, and alcohol addiction participants with TMDs was evaluated using Spearman's correlation analysis. The results of the correlation analysis were classified

as follows: <0.20: "Poor", 0.21-0.40: "Fair", 0.41-0.60: "Moderate", 0.61-0.80: "Good", and >0.80: "Very Good" agreement. For the relevant statistical analysis methods, any p value less than 0.05 was accepted as statistically significant. Multiple logistic regression analysis was conducted to identify significant predictors of TMDs presence, dependency levels, TMDs severity, and psychological parameters. Predictors were selected using a backward stepwise method, with removal set at $p > 0.10$ and reentry at $p < 0.05$. Model fit was evaluated using the Hosmer–Lemeshow goodness-of-fit test, where $p < 0.05$ indicated a significant difference between observed and predicted values [19]. Odds ratios (ORs) for TMDs presence were calculated by simultaneously considering all parameters. Nagelkerke's R^2 was used to estimate the proportion of variance in TMDs presence explained by the model, with values >0.75 considered very good, 0.50–0.75 good, 0.25–0.50 moderate, and ≤0.25 poor predictive power[20]. The model's classification accuracy, including sensitivity and specificity for correctly identifying participants with and without TMDs, was determined using a 2×2 classification table.

Results

A total of 909 volunteers, 641 with TMDs and 268 asymptomatic individuals, participated in the study. Of the participants, 610 (67.1%) were female and 299 (32.9%) were male. The overall prevalence of TMDs-related symptoms was 70.5%. There were no significant differences between groups in terms of age (p=0.446), body weight (p=0.757), height (p=0.287), and body mass index (p=0.579) parameters (Table 1).

The prevalence of nicotine (p=0.009), alcohol (p=0.004), and smartphone (p<0.001) addiction was statistically significantly higher in individuals with TMDs in comparison to the control group (Table 2). The prevalence of nicotine addiction in individuals with TMDs was 32%, while it was 23.9% in the control group. Similarly, the prevalence of alcohol addiction was statistically significantly higher in individuals with TMDs (22.3%) in comparison to the control group (14.6%). Moreover, the prevalence of screen addiction was higher in individuals with TMDs (44.7%) than in asymptomatic individuals (26.1%) (Table 2).

The median (interquartile) values of the scales assessing TMDs symptoms, depression, and addiction severity are provided in Table 3. The PHQ-4 (p<0.001), SPAI-SF (p<0.001), APIRSS (p<0.001), and FTND (p=0.003) scores were significantly higher in individuals with TMDs compared to controls (Table 3).

In Table 4 only individuals with smoking, alcohol and smartphone addiction were analysed with reference to FTND, APIRS, SPAI-SF cut-off values. According to the results of these analyses the FTND total scores of the individuals with TMDs were found to be higher than those of the asymptomatic individuals (p=0.007). However, APIRSS (p=0.757) and SPAI-SF (p=0.119), showed no statistically significant difference between the individuals with TMDs and the control group regarding the level of addiction (Table 4).

Results of the correlation analysis between TMDs severity and depression and addiction in participants with TMDs are given in Table 5. A moderate

positive correlation was found between the FAI and PHQ-4 scores ($r=0.489$, $p<0.001$). The FAI scores had poor to fair correlation with the SPAI-SF ($r=0.283$, $p<0.001$), FTND ($r=0.147$, $p<0.001$), and APIRSS ($r=0.123$, $p<0.001$) scores. The PHQ-4 exhibited poor to fair correlation with the SPAI-SF ($r=0.328$, $p<0.001$), APIRSS ($r=0.125$, $p<0.001$), and FTND ($r=0.120$, $p<0.001$) scores. A significant positive and fair correlation was observed between the APIRSS and the FTND ($r=0.377$, $p<0.001$) (Table 5).

The variables included in the multiple logistic regression analysis were TMDs severity, symptoms of depression and anxiety, and levels of smartphone, alcohol, and nicotine dependence (Table 6). The results indicated that symptoms of depression and anxiety, as well as smartphone addiction, were significantly associated with the presence of TMDs diagnosed according to the DC/TMD criteria. The odds ratio for TMDs presence was 1.29 for depression and anxiety symptoms and 1.11 for smartphone addiction. Nicotine dependence ($p = 0.515$) and alcohol dependence ($p = 0.854$) were not statistically significant predictors.

The Hosmer–Lemeshow goodness-of-fit test was not statistically significant, indicating consistency between the observed data and the fitted model. The potential predictors explained 95.8% of the total log likelihood for TMDs presence, reflecting excellent predictive capacity (Nagelkerke's $R^2 = 0.958$). The model demonstrated 99.6% sensitivity, 98.8% specificity, and 99.4% overall accuracy in predicting TMDs presence.

Discussion

This study, which was conducted with a large sample of 909 participants, is the first study in Turkey to examine the phenomena of nicotine, alcohol, and smartphone addiction in individuals with TMDs and to compare these addictive behaviors in individuals with TMDs with those observed in asymptomatic controls. Another strength of the study is the use of valid and reliable scales in the evaluation of the parameters. The findings of the study show that individuals with TMDs have higher prevalence and degree of addiction to nicotine, alcohol, and smartphone. The results of the correlation analyses conducted in our study demonstrated a statistically significant positive correlation of TMDs severity with depression and smartphone, alcohol, and nicotine addiction. Furthermore, the results indicated a statistically significant positive fair correlation between depression severity and smartphone addiction, as well as alcohol and nicotine addiction, albeit of a weak magnitude. The prevalence of symptoms related to TMDs was found to be 70.5% in Turkish university students.

Nicotine and alcohol dependence levels of individuals with TMDs were found to be higher than those of asymptomatic controls. It is also observed that depression and anxiety levels of individuals with TMDs are higher than those of the control group. The results of our correlation analysis are similar with those of prior studies examining the depression and addiction components in individuals with TMDs confirming this interaction [7, 10]. It should be noted that the strength of the correlations is generally poor to

fair, except for the relationship between TMDs and depression. Consistently, the regression model identified PHQ-4 and SPAI-SF scores as significant independent predictors of TMDs presence. Each one-point increase in depressive/anxiety symptom scores increased the odds of TMDs by 1.29-fold, and each one-point increase in smartphone addiction scores increased the odds by 1.11-fold. As expected, higher levels of depression were associated with an increase in all addiction types examined in the present study. The enhancing effect of depression on addictive behavior has previously been explained by researchers based on the tendency to compensate for the effects of depression and the observation that individuals experience greater withdrawal when depressed [21]. Research highlights that up to 60% of adults with depression have smoked at some point in their lives and that the presence of higher depressive symptoms has been found to be associated with an elevated likelihood of engaging in smoking behavior [21]. Considering the multifaceted and biopsychosocial etiological origin of TMDs, the primary reason for nicotine and alcohol dependence in individuals with TMDs may be higher levels of depression and anxiety compared to the control group. Furthermore, one of the most commonly reported symptoms of TMDs is pain in more than one area and chronic pain syndrome is found in more than 50% of individuals with TMDs [22]. The prevalence of co-occurrence of chronic pain and depression was recorded as 59.1% [23]. Similarly, 35% of individuals with chronic pain have been shown to have increased levels of anxiety [24]. The frequent co-occurrence of chronic pain and depression symptoms is attributed to neuroplastic changes in the brain [25]. It has been suggested that

increased alcohol and nicotine addiction constitutes risk factors for sleep bruxism, which is related to dopaminergic system dysfunction [26]. Research has shown that psychoactive substances such as alcohol and nicotine have an effect on the central nervous system by altering the functional properties of neurotransmitters and receptors [7]. In light of this information, another reason for the difference in nicotine and alcohol addiction levels between the two groups may be that TMDs trigger chronic pain, increasing depression and anxiety levels, and individuals resort to alcohol and cigarettes as a strategy to cope with chronic pain.

Although the association between psychological symptoms and TMDs is well established in the literature, recent perspectives on this relationship highlight the need to move beyond simple correlations. De la Torre Canales et al. proposed a biopsychosocial model in which emotional and behavioral factors are integral to both the onset and maintenance of TMDs [6]. More recently, Souza et al. emphasized that psychological factors should be regarded not merely as associated variables but as central drivers within multifactorial models [27]. In this context, the findings align with this theoretical framework, demonstrating that psychological symptoms are significant contributors in the multivariate logistic regression model predicting TMDs. Furthermore, Sangalli et al. highlight the importance of integrating brief behavioral interventions and psychological therapies (e.g., cognitive behavioral therapy, stress management) into treatment strategies for patients with TMDs, particularly when psychological comorbidities are present [28]. Therefore, the results support the growing body of evidence indicating that psychological assessment and

management should be regarded as essential components of both etiologic understanding and therapeutic planning for TMDs.

When individuals with nicotine, alcohol, and smartphone addiction were analyzed according to the FTND, APIRSS, and SPAI-SF cut-off scores, the addiction level of individuals with TMDs who were addicted to nicotine was higher than that of asymptomatic controls. When individuals with alcohol and smartphone addiction were analyzed, results show that the two groups have similar addiction levels. In contrast, neither alcohol addiction (APIRS) nor nicotine dependence (FTND) emerged as significant predictors in the regression model, with odds ratios of 0.96 and 0.91, respectively, indicating no meaningful association with TMDs presence after controlling for other variables. In order to determine the relationship between smoking and TMDs, Sanders et al.[29] dichotomized age as adults over 30 and young adults under 30 and found that smoking was associated with the risk of TMDs in young adults. Miettinen et al.[7] reported that increased frequency in daily smoking and alcohol consumption is associated with TMDs symptoms in young adults. The results of our study are in parallel with those of two previous studies conducted in a similar age range and population. The observed higher nicotine and alcohol dependence among individuals with TMDs may be partly attributable to underlying anxiety, which has been identified as a driver of substance use. Recent research by Saracutu et al. has highlighted the mediating role of bruxism, particularly awake bracing, in the relationship between anxiety and TMDs-related symptoms [30, 31]. The main reason for the high level of addiction among nicotine addicts in the TMDs group, while the level of addiction among

alcohol and smartphone addicts was similar to the control group, may be due to the fact that cigarette consumption is a risk factor for parafunctional oral behavior, poor oral hygiene, and oral diseases [32]. Studies suggesting that non-smokers have better oral and dental health care than smokers, that university students are unaware of good oral hygiene practice procedures, and that inappropriate oral behaviors are associated with painful TMDs support this view [32].

The level of smartphone addiction was higher in individuals with TMDs compared to controls. The prevalence of mobile device usage, particularly among adolescents and young adults, has reached approximately 75% of the global population. This has led to the emergence of a new phenomenon, text neck syndrome, which has been described as “the pain of the 21st century” [33]. In this syndrome, prolonged use of mobile devices such as smartphones, tablets, and personal computers has been identified as a contributing factor to the development of overuse injuries in the cervical vertebrae [33]. The degree of neck flexion increases during the use of mobile devices. Prolonged and repetitive flexion of the neck leads to a forward posture of the head, which results in impaired postural control, imbalances in muscle strength, and compression of spinal structures [34]. Moreover, it has been reported that the prevalence of jaw, neck, and shoulder pain increases with the duration and frequency of mobile device use [35]. The high prevalence of smartphone addiction observed in individuals with TMDs can be attributed to the detrimental effects of prolonged sitting posture and static loading on the cervical joints of the cranio-cervico-mandibular system.

The overall prevalence of symptoms related to TMDs in the 909 university students included in the study was 70.5% which aligns with a systematic review on the epidemiology of TMDs, and it is known that the prevalence of TMDs in the general population varies between 1% and 75% [1]. The results of this study (70.5%) are similar to those reported by Karthik et al. (80.6%)[36] and Kaynak et al. (62%) [37], both of which evaluated the prevalence of TMDs among university students. In our study, which included university students, 71.3% of the individuals with TMDs were female. These results are consistent with the literature, and it is reported that TMDs are significantly more prevalent among individuals within the 20-40 age range [1, 38]. Additionally, many studies have observed that the prevalence of TMDs is 2-4 times higher in females compared to males [1, 36, 37]. Although the elevated prevalence of TMDs in women is believed to be attributable to a complex interplay of biological, psychological, and social factors, including regular hormonal fluctuations and variations in connective tissue and muscle architecture, the observation that TMDs are susceptible to influence by reproductive hormones, with symptom exacerbation occurring during the reproductive years between the ages of 20 and 40, may be the primary determinant of its higher prevalence in the female gender [36, 39].

These findings underscore the interplay between mood, addictive behaviors, and TMD symptomatology, reinforcing the value of a biopsychosocial approach to understanding and managing TMDs. Notably, the results of this study align with the fundamental principles outlined in the International Association for Dental, Oral and Craniofacial Research

(IADR) standard of care for TMDs management [11]. These standards emphasize patient-centered approaches, acknowledge the multifactorial biopsychosocial etiology of TMDs, and prioritize outcomes related to quality of life over mere symptom resolution.

There are some limitations to our study. Firstly, addiction rates may be different in different types of TMDs, such as myogenic, arthrogenic, and mixed type, which should be confirmed by clinical examination. Participants in our study were 18-25 years old university students, which may have the potential to affect the generalizability of the study results to different age groups. Furthermore, the individuals with TMDs in the present study were recruited from a university population rather than a treatment-seeking clinical population, thereby providing community-based data. This population may also have exhibited abnormal clinical or psychological outcomes due to academic pressure, as previously reported by Sangalli et al. [40]. Consequently, the prevalence rates reported in this study may differ from those observed in clinical, treatment-seeking populations. In this study, TMDs was defined as a clinical diagnosis based on DC/TMD criteria; however, emerging literature advocates for a re-conceptualization that acknowledges the heterogeneity of TMDs presentations, including the role of bruxism—particularly awake bracing—which has been described as the “medical gateway for dentistry” and proposed as a mediator between psychological factors, substance use, and TMD symptomatology. Notably, bruxism was not directly assessed in the present study [11, 41]. Given this, the absence of bruxism-related measures may have limited the ability to fully elucidate the mechanisms linking

anxiety, addictive behaviors, and TMDs in this sample. Future research should address these limitations by enrolling treatment-seeking clinical populations, directly assessing bruxism and other parafunctional activities, and incorporating potentially relevant sociodemographic variables such as income level to provide a more comprehensive understanding of the relationship between psychological factors, addictive behaviors, and TMDs.

Conclusion

In conclusion, the prevalence of nicotine, alcohol, and smartphone addiction are higher in individuals with TMDs in comparison to asymptomatic participants. Increased TMDs severity is associated with higher depression and higher levels of addiction to nicotine, alcohol, and smartphone. Depression levels have an influence on addiction behavior; however, this effect is limited. Clinicians should be aware of this relationship between TMDs severity and addiction when managing the treatment of individuals with TMDs.

Declarations

Data availability: The datasets produced or scrutinized in the present study can be obtained upon reasonable request from the corresponding author.

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Conflicts of interest: No declaration of conflicts of interest.

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Ethics statement: All the authors complied with the ethical policies outlined on the journal's author guidelines page.

Ethics approval and consent to participate: This study was approved by the Toros University Non-Interventional Clinical Research Ethics Committee with the decision number (2024/06-09). This study has been approved and meets all criteria for ethical standards defined in the 1964 Declaration of Helsinki and all amendments made after. All participants provided written informed consent prior to participation.

Consent to publish declaration: Not applicable.

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Figure Legend

Figure 1. Flowchart of the study

Tables

Table 1. Demographic characteristics of the participants.

Parameters		TMD group (n=641)	Control group (n=268)	*p*
Age (years)		21(20-22)	21(20-22)	0.446
Weight (kg)		64 (55-76)	64.50(55-80)	0.757
Height (m)		1.68 (1.62-175)	1.70 (1.63-1.78)	0.287
BMI (kg/m^2)		22.59 (20.30-25.32)	22.39 (20.06-25.24)	0.579
Sex	Female	457 (%71.3)	153 (%57.1)	**<0.001**[a]**
	Male	184 (%28.8)	115 (%42.9)	

Data was given as Median (Interquartile range) and percentiles. kg, kilogram; m, meter; BMI, body mass index. a; ** p<0.001, Chi-Square Test.

Table 2. Comparison of addiction rates in TMD and control groups.

Parameters		TMD group (n=641)	Control group (n=268)	p
Tobacco Addiction	Yes	205 (32.0%)	64 (23.9 %)	**0.009***
	No	436 (68.0%)	204 (76.1%)	
Alcohol Addiction	Yes	143 (22.3%)	39 (14.6%)	**0.004***
	No	498 (77.7%)	229 (85.4 %)	
Smartphone Addiction	Yes	286 (44.7%)	70 (26.1%)	**<0.001***
	No	354 (55.3%)	198 (73.9%)	

*p<0.05, Chi-Square Test. Data was given as percentile.

Table 3. Comparison of scale score between TMD and control groups.

Parameters	TMD group (n=641)	Control group (n=268)	*p*
FAI	40 (25-55)	10 (5-15)	**<0.001***
PHQ-4	5 (4-8)	3 (1-4)	**<0.001***
SPAI-SF	30 (23-38)	24 (19-33)	**<0.001***
APIRS	0 (0-2)	0 (0-1)	**<0.001***
FTND	0 (0-2,5)	0 (0-0)	**0.003***

*p<0.05, Mann-Whitney U Test. Data was given as median (interquartile range). FAI, Fonseca Anamnestic Index; FTND, Fagerstrom Test for Nicotine Dependence; APIRS, Addiction Profile Index Risk Scanning Scale; SPAI-SF, Smartphone Addiction Index-Short Form; PHQ-4, Patient Health Questionnaire

Table 4. Comparison of addiction scale scores of addicted individuals according to the presence of TMD.

Parameters	TMD group	Control group	p
FTND (n=269)	4 (3-6)	3 (2-5)	**0.007***
APIRS (n=182)	4 (4-6)	4 (3-6)	0.757
SPAI-SF (n=356)	39 (35-45)	38 (35-42)	0.119

*p<0.05, Mann-Whitney U Test. Data was given as median (interquartile range). FTND, Fagerström Test for Nicotine Dependence; APIRS, Addiction Profile Index Risk Scanning Scale; SPAI-SF, Smartphone Addiction Index-Short Form.

Table 5. Correlation between depression, addiction and TMD severity

Parameters		PHQ-4	SPAI-SF	APIRS	FTND
FAI	Correlation Coefficient	**0.489****	**0.283****	**0.123****	**0.147****
	P	<0.001	<0.001	<0.001	<0.001
PHQ-4	Correlation Coefficient		**0.328****	**0.125****	**0.120****
	P		<0.001	<0.001	<0.001
SPAI-SF	Correlation Coefficient			**0.084***	0.047
	P			0.011	0.156
APIRS	Correlation Coefficient				**0.377****
	P				<0.001

* p<0.05; **, p<0.001. FAI, Fonseca Anamnestic Index; FTND, Fagerström Test for Nicotine Dependence; APIRS, Addiction Profile Index Risk Scanning Scale; SPAI-SF, Smartphone Addiction Index-Short Form; PHQ-4, Patient Health Questionnaire-4.

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843 **Table 6.** Multivariable logistic regression model

Parameters	B	*p*	Odds Ratio (95% C.I)	Sensitivity	Specificity	Accuracy	R^2
TMD According to DC/TMD				99.6 %	98.8%	99.4 %	95.8 %
FAI	1.098	<.001	3.00 (2.28-3.93)				
PHQ-4	.261	.021	1.29 (1.04-1.61)				
SPAI-SF	.104	.003	1.11 (1.04-1.18)				
APIRS	-.032	.854	.96 (0.69-1.35)				
FTND	-.094	.515	.91 (0.68-1.20)				

844 TMD: Temporomandibular Disorders; FAI, Fonseca Anamnestic Index; PHQ-4, Patient
845 Health Questionnaire-4; SPAI-SF, Smartphone Addiction Index-Short Form; Addiction
846 Profile Index Risk Scanning Scale; FTND, Fagerström Test for Nicotine Dependence;
847 APIRS.