

The Relationship between Sleep Quality and Clinical Features of Adolescents with Temporomandibular Disorder

Yang Mi Park¹, Sunhee Lee¹, Kyung-Hee Kim², Yong-Woo Ahn^{1,3}, Sung-Hee Jeong^{1,3}, Soo-Min Ok^{1,3}

¹Department of Oral Medicine, School of Dentistry, Pusan National University, Yangsan, Korea

²Department of Oral Medicine, Busan Paik Hospital, Inje University College of Medicine, Busan, Korea

³Dental Research Institute, Pusan National University Dental Hospital, Yangsan, Korea

Received March 9, 2018
Revised April 4, 2018
Accepted April 6, 2018

Purpose: Many researchers have established a connection between sleep disturbances and the symptoms of temporomandibular disorder (TMD) in adults, but there are a few studies targeted at adolescents with TMD. The aim of this study was to analyze the sleep pattern of adolescents with TMD and to determine the effect of poor sleep quality on their clinical symptoms.

Methods: The subjects were composed of 47 adolescents with TMD. The sleep pattern and preliminary information of patients were measured by self-reported questionnaires; Pittsburgh Sleep Quality Index (PSQI) and Questionnaire for TMD analysis. TMD pain was scored using the Numerical Rating Scale. The Kruskal-Wallis test, Mann-Whitney U test, Fisher's exact test and logistic regression were used for statistical analysis.

Results: The poor sleeping group had statistically more females (25.00% males, 75.00% females) than the good sleeping group. As compared with that of good sleepers, sleep quality of poor sleepers was significantly worse in the items of subjective sleep quality, sleep latency, sleep duration, sleep disturbances, daytime dysfunction and global PSQI score. The sleep time of adolescents was much longer during vacation (7.20 ± 1.38 hours) than during school days (6.10 ± 1.26 hours). Poor sleep of patients was associated with the pain in the ear or in front of the ear, in the face, jaw, throat or temple and in neck or back. Adolescents with pain in those areas had significantly higher proportion of poor sleepers than adolescents with no pain in those areas.

Conclusions: The high ratio of girls in poor sleeping group could reflect the greater prevalence of TMD in women than in men. Pain in peri-temporomandibular joint areas, neck or back could negatively influence sleep quality of adolescents with TMD.

Key Words: Adolescent; Pain; Questionnaires; Sleep; Temporomandibular joint disorders

Correspondence to:

Soo-Min Ok
Department of Oral Medicine, Pusan National University Dental Hospital,
20 Geumo-ro, Mulgeum-eup,
Yangsan 50612, Korea
Tel: +82-55-360-5242
Fax: +82-55-360-5238
E-mail: oksoomin@pusan.ac.kr

INTRODUCTION

Sleep has been recently regarded as an indicator of health rather than simply a reversible behavioral state of perceptual disengagement from and unresponsiveness to the environment.^{1,2)} A great number of studies have shown that sleep disturbances related to cardiovascular, metabolic disorders, depression and chronic pain.³⁻⁶⁾ In data collected from 17,465 university students in 24 countries, subjects

with short sleep duration (less than 7 hours) had higher adjusted odds ratio (OR) of poor health than those with the reference sleep duration (7-8 hours).⁷⁾

Insufficient and poor sleep of adolescents has led to concern about their physical and mental health in society and medical community. Several studies of optimal sleep for teenagers reported they needed 8-11 hours of sleep.^{8,9)} But almost the whole teenagers slept for less than 8 hours particularly on school days. The meta-analysis of worldwide

sleep patterns said that the sleep of teenagers declined with age up 14 min/night per year of age and on school days, Asian adolescents reported sleeping about 1-2 h/day less than adolescent from Europe and Australia.¹⁰ To adolescents undergoing developmental changes in physical and psychological aspects, short sleep could have more negative effect on health than to adults.

The various symptoms and signs of temporomandibular disorder (TMD) could be influenced by multiple factors; psychological distress, neuroendocrine disorders and sleep disturbances.^{11,12} Many studies have reported the relationship between symptoms of TMD and poor sleep using Pittsburgh Sleep Quality Index (PSQI).¹³⁻¹⁷ Sleep problems were complained by 77%-90% of patients with TMD.^{14,18} Particularly patients with pain-related TMD had poorer sleep quality than healthy controls.¹⁷ Therefore patients were highly expected to check their sleep pattern for proper diagnosis and treatment in TMD clinic.

The pain is main symptom of TMD and its prevalence has reported between 30% and 12%.^{19,20} TMD pain was resulted from multifactorial reasons including physical disorder, psychological and social problems.^{12,21} Adolescents could be more vulnerable to those factors than adults. During adolescence, TMD pain increases according to growing age and pubertal development especially in girls.^{19,22} Various idiopathic pain disorders including TMD are known to be negatively influenced by inadequate sleep.^{12,23-25}

Most literature on sleep of TMD patients have targeted at adults rather than adolescents. This study aimed to investigate the sleep quantity and quality of teenagers with TMD and to evaluate the relationship between their sleep pattern and clinical symptoms.

MATERIALS AND METHODS

1. Subjects

This study was conducted with 47 adolescent patients (mean age±standard deviation [SD], 15.98±1.80 years, 26 females and 21 males) who visited the Department of Oral Medicine, Pusan National University Dental Hospital (Yongsan, Korea). The patients were examined for TMD analysis test and answered two questionnaires; PSQI and Questionnaire for TMD analysis. Numerical Rating Scale

(NRS) was used to measure the pain intensity of patients. The patients selected the proper number to visualize their pain from no pain (NRS 0) to worst possible pain (NRS 10). The informed consent was obtained from all participants. The exclusion criteria included individuals undergoing toothache or painful oral diseases, neuro-psychotic diseases and communication disorder. The study protocol was approved by the Institutional Review Board of Pusan National University Dental Hospital (no. PNUDH-2015-019).

2. PSQI

The PSQI is a valid, reliable and well-known questionnaire for assessing self-perceived sleep quality.¹⁷ 19 individual items make seven component scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Each component score range from 0 to 3 and the sum of the scores result to one global score, which, in excess of 5, is indicative of clinically poor sleep.²⁶ It is the most commonly used tool of self-reported sleep in clinical and research fields in adults.²⁷ Recent studies suggested that it showed adequate reliability and validity in adolescent populations.^{28,29}

3. Questionnaire for TMD Analysis

The questionnaire consisted of the four parts of questions to screen for TMD.³⁰ There were first part with the items to test the function of temporomandibular joint (TMJ), second part for the habits or other factors affecting the symptoms of TMD, third part for behavior responses to pain of TMD and fourth part for other body parts suffering from inflammation or pain.

4. Statistical Analysis

The data did not follow the normal distribution so non-parametric tests were used in this study. The Kruskal-Wallis test was used to find meaningful differences between the groups. The Mann-Whitney U test and Fisher's exact test were used to determine significance of two groups. Logistic regression was used for binary variables that associated with sleep quality. p-values less than 0.05 were considered statistically significant. All statistical analyses were performed using IBM SPSS Statistic ver. 20.0 software (IBM

Co., Armonk, NY, USA).

RESULTS

1. Comparison of Clinical Profiles and PSQI Data between Good and Poor Sleepers in Adolescents with TMD

According to the criteria presented by PSQI,²⁶⁾ the subjects with the global score of 5 or less belonged to a good sleeping group and those with the global score excess of 5 became a poor sleeping group. In comparison with the good sleeping group, the poor sleeping group consisted of more females (25.00% males 75.00% females) and had less sleep duration (mean±SD, 6.57±1.24 hours) (p<0.05). However, the other items appeared no significant differences between PSQI good and poor sleepers (Table 1).

In PSQI scores, poor sleepers had significantly higher values in subjective sleep quality, sleep latency, sleep duration,

sleep disturbances, daytime dysfunction and global PSQI score than good sleepers (p<0.05) (Table 2).

2. Comparison of Clinical Profiles and PSQI Data between School Vacation and School Days in Adolescents with TMD

Because sleep pattern of teenagers could be changed by school schedule, TMD patients were categorized into school vacation and school days groups according to when they visited in clinic. The students had spent more time to sleep during school vacation (7.20±1.38 hours) than during school days (6.10±1.26 hours) (p<0.05) (Table 3). In PSQI scores, the students during vacation had also more sleep duration than those during school days (p<0.05) (Table 4). The other items showed no significant differences between school vacation and school days.

3. Comparison of Questionnaire for TMD Analysis between PSQI Good and Poor Sleepers

To evaluate the association between pain and sleep, patients with or without self-reported pain were divided into good and poor sleeping group according to PSQI. In comparison with non-painful group, painful group in following areas were significantly more poor sleepers: in the ear or in front of the ear, in the face, jaw, throat or temple and in the neck or back (p<0.05) (Table 5). Logistic regression analyses appeared that the same factors associated with poor sleep: pain in the ear or in front of the ear, in the face, jaw, throat or temple and in the neck or back (p<0.05) (Table 6). The OR were 3.97 (95% confidence interval [CI], 1.15-13.64),

Table 1. Clinical profiles of good and poor sleepers in adolescents with temporomandibular disorder

Variable	Good sleeper (n=27)	Poor sleeper (n=20)	p-value
Gender			0.037*
Male	16 (59.30)	5 (25.00)	
Female	11 (40.70)	15 (75.00)	
Age (y)	15.56±1.85	16.55±1.61	0.550
Duration (y)	1.28±1.21	1.80±2.00	0.714
Numerical Rating Scale	3.20±2.46	4.23±2.20	0.117
Sleep duration (h)	7.77±1.49	6.57±1.24	0.010*
Bed time (h:min)	24:21±1:16	24:56±1:31	0.241

Values are presented as number (%) or mean±standard deviation. *Significant difference between the groups (p<0.05).

Table 2. PSQI scores of good and poor sleepers in adolescents with temporomandibular disorder

PSQI	Good sleeper (n=27)	Poor sleeper (n=20)	p-value
Subjective sleep quality	0.74±0.59	1.25±0.55	0.006*
Sleep latency	0.52±0.64	2.00±0.73	0.000*
Sleep duration	0.56±0.70	1.10±0.91	0.030*
Habitual sleep efficiency	0	0.10±0.31	0.097
Sleep disturbances	0.67±0.48	1.20±0.52	0.001*
Use of sleep medication	0.04±0.19	0.05±0.22	0.829
Daytime dysfunction	0.67±0.83	2.15±0.75	0.000*
Global PSQI score	3.19±1.64	7.85±1.42	0.000*

PSQI, Pittsburgh Sleep Quality Index. Values are presented as mean±standard deviation. *Significant difference between the groups (p<0.05).

Table 3. Clinical profiles of school vacation and school days in adolescents with temporomandibular disorder

Variable	School vacation (n=37)	School days (n=10)	p-value
Gender			0.150
Male	19 (51.35)	2 (20.00)	
Female	18 (48.65)	8 (80.00)	
Age (y)	15.81±1.78	16.60±1.84	0.184
Duration (y)	1.24±1.24	2.66±2.30	0.089
Numerical Rating Scale	3.47±2.59	4.25±1.27	0.255
Sleep duration (h)	7.20±1.38	6.10±1.26	0.024*
Bed time (h:min)	24:28±1:17	25:01±1:04	0.332

Values are presented as number (%) or mean±standard deviation. *Significant difference between the groups (p<0.05).

Table 4. PSQI scores of school vacation and school days in adolescents with temporomandibular disorder

PSQI	School vacation (n=37)	School days (n=10)	p-value
Subjective sleep quality	0.95±0.66	1.00±0.47	0.787
Sleep latency	1.14±1.00	1.20±1.03	0.839
Sleep duration	0.59±0.69	1.50±0.97	0.006*
Habitual sleep efficiency	0.03±0.16	0.10±0.32	0.316
Sleep disturbances	0.86±0.59	1.00±0.47	0.476
Use of sleep education	0.05±0.22	0	0.457
Daytime dysfunction	1.16±1.07	1.80±1.03	0.117
Global PSQI score	4.78±2.84	6.60±2.17	0.065

PSQI, Pittsburgh Sleep Quality Index.

The values are presented as mean±standard deviation.

*Significant difference between the groups (p<0.05).

Table 5. The ratio of good and poor sleepers in patients with or without following pain

Pain status	Good sleeper (n=27)	Poor sleeper (n=20)	p-value
In front of the ear or in the ear			0.039*
No pain	17 (63.00)	6 (30.00)	
Pain	10 (37.00)	14 (70.00)	
In the face, jaw, throat or temple			0.039*
No pain	17 (63.00)	6 (30.00)	
Pain	10 (37.00)	14 (70.00)	
In neck or back			0.032*
No pain	21 (77.80)	9 (45.00)	
Pain	6 (22.20)	11 (55.00)	

Values are presented as number (%).

*Significant difference between the groups (p<0.05).

3.97 (95% CI, 1.15–13.64), and 4.28 (95% CI, 1.21–15.15), respectively. Other items of TMD questionnaire had no associations with poor sleep (data not shown).

DISCUSSION

Sleep occupies almost one third of our whole life. The sleep duration is not the meaningless time, but the important time that human needs to maintain good health. Extensive research has been done into a bidirectional relationship between sleep and health; sleep disturbances contribute to the development of or deterioration of diverse medical and psychiatric disorders and vice versa.^{1,31-33} Previous study reported the TMD symptom in Asian adolescents were related to sleep disturbance and daytime

Table 6. Logistic regression analyses for prediction of poor sleep quality

Predictor variable	N	p-value	Odds ratio	95% confidence interval
Pain in front of the ear or in the ear				
No	27			
Yes	20	0.029*	3.97	1.15-13.64
Pain in the face, jaw, throat or temple				
No	27			
Yes	20	0.029*	3.97	1.15-13.64
Pain in neck or back				
No	27			
Yes	20	0.024*	4.28	1.21-15.15

*Significant difference between the groups (p<0.05).

dysfunction,³⁴ but this was a rare study on sleep and adolescents with TMD. The relation between inadequate sleep and TMD symptoms has been studied considerably in adults, but there are few studies on this topic in adolescents.

This study on sleep and adolescents with TMD showed that poor sleeping group (25.00% males, 75.00% females) had significantly more girls than good sleeping group (59.30% males, 40.70% females). This was the similar result of the previous study that sleep duration of female students was obviously shorter than that of male students.³⁵ Numerous papers reported that TMD pain was more prevalent in adult women than in men,³⁶⁻³⁸ and in teenage girls than in boys.^{39,40} These differences between the sexes have been considered responsible for estrogens, different pain processing mechanism and psychological factors.^{41,42} In addition, this study suggested that the girls' poor sleep quality could explain the reason for high prevalence of TMD in females.

In analysis of PSQI, poor sleepers were obviously worse in subjective sleep quality, sleep latency, sleep duration, sleep disturbances, daytime dysfunction and global PSQI score than good ones (p<0.05). These were the same results that the Korean adults with TMD answered the questions of PSQI.⁴³ The poorly sleeping adolescents with TMD showed the higher mean scores in sleep latency, daytime dysfunction and global PSQI score than adult patients. The teenagers' high score in the item of sleep latency could be interpreted that they could not fall asleep easily at night because

they used to return home late at night after private tutoring or they usually used smartphones and computers until going to bed (sleep latency score (mean \pm SD);⁴⁴⁾ adolescents vs. adults, 2.00 \pm 0.73 vs. 0.95 \pm 0.69). At daytime, adolescents generally attended the classes requiring high concentration, and consequently they could not function more effectively in the daytimes than adults (daytime dysfunction score (mean \pm SD); adolescents vs. adults, 2.15 \pm 0.75 vs. 1.66 \pm 0.73). The other scores of items were slightly lower in adolescents than in adults, but global PSQI score in adolescents (7.85 \pm 1.42) was a little higher than that in adults (7.50 \pm 2.35). This means that the teenagers inadequately sleeping at night have poorer quality of sleep than adults in that situation. Therefore the poor sleep quality could be reflected much more in the symptoms of TMD to adolescents than to adults.

The teenagers have a tendency to stay up later at night with increasing age, but need to wake up early to attend classes on school days.⁴⁵⁾ These circumstances resulted in less sleep time on school nights; the mean school-night sleep time for Asian adolescents (7.64 hour) was significantly less than that of European adolescents (8.44 hour).⁴⁶⁾ In the result of this study, the students had spent more time to sleep during school vacation (7.20 \pm 1.38 hours) than during school days (6.10 \pm 1.26 hours). These sleep duration of both school days and vacation in Korean adolescents was shorter than the mean school-night sleep time in Asian adolescents. Insufficient sleep of teenagers with TMD could lower the pain threshold, deteriorate the symptoms and result in unfavorable prognoses.⁴⁷⁾

Previous papers showed that the painful patients with TMD scored highly in PSQI and had low quality for sleep.^{15,48)} But in other papers, poor sleep quality was not connected with pain intensity of TMD.^{13,16)} In the data of this study, adolescents with pain in the ear or in front of the ear, in the face, jaw, throat or temple and in the neck or back had higher probability of poor sleep than adolescents without pain in those areas. For whole patients, poor sleep did not appear to have a direct significant relation with pain intensity. These suggested that self-reported pain intensity, which had subjectively rated with differences among individuals, appeared a controversial relation with poor sleep and painful peri-TMJ areas and neck or back

could be a predictor of poor sleep in adolescents with TMD.

This study had several limitations. The sample number of patients was too small and having more patients would have given a more statistically significant results. In the survey of patient's pain, the data was limited of its severity, condition and duration. Detailed and objective information for pain could help to accurately explain the relation between inadequate sleep and painful TMD. Therefore further study would be needed with objective data from polysomnography and psychological investigation in adolescents with TMD.

This study provided meaningful results of the association between poor sleep and clinical characteristics in adolescents with TMD. Statistically many number of girls in poor sleeping group suggested that poor sleep quality could contribute the greater prevalence of TMD in females than in males, in company with other observed gender differences. Pain in the ear or in front of the ear, in the face, jaw, throat or temple and in the neck or back could raise the possibility of poor sleep. Insufficient and poor sleep in juvenile could influence to show worse symptoms of TMD than in adults and be a contributing factor to exacerbate the pain and develop into chronic pain. Therefore sleep quality of adolescents was intensively considered to diagnose and treat TMD patients.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

1. Zee PC, Turek FW. Sleep and health: everywhere and in both directions. *Arch Intern Med* 2006;166:1686-1688.
2. Carskadon MA, Dement WC. Normal human sleep: an overview. In: Kryger MH, Roth T, Dement WC, eds. *Principles and practice of sleep medicine*. 5th ed. St. Louis: Elsevier saunders; 2011. pp. 16-26.
3. Schwartz S, McDowell Anderson W, et al. Insomnia and heart disease: a review of epidemiologic studies. *J Psychosom Res* 1999;47:313-333.
4. Gangwisch JE, Heymsfield SB, Boden-Albala B, et al. Short sleep duration as a risk factor for hypertension: analyses of the first National Health and Nutrition Examination Survey. *Hypertension* 2006;47:833-839.

5. Gangwisch JE, Heymsfield SB, Boden-Albala B, et al. Sleep duration as a risk factor for diabetes incidence in a large U.S. sample. *Sleep* 2007;30:1667-1673.
6. Yaggi HK, Araujo AB, McKinlay JB. Sleep duration as a risk factor for the development of type 2 diabetes. *Diabetes Care* 2006;29:657-661.
7. Steptoe A, Peacey V, Wardle J. Sleep duration and health in young adults. *Arch Intern Med* 2006;166:1689-1692.
8. Matricciani L, Blunden S, Rigney G, Williams MT, Olds TS. Children's sleep needs: is there sufficient evidence to recommend optimal sleep for children? *Sleep* 2013;36:527-534.
9. Hirshkowitz M, Whiton K, Albert SM, et al. National Sleep Foundation's sleep time duration recommendations: methodology and results summary. *Sleep Health* 2015;1:40-43.
10. Olds T, Blunden S, Petkov J, Forchino F. The relationships between sex, age, geography and time in bed in adolescents: a meta-analysis of data from 23 countries. *Sleep Med Rev* 2010;14:371-378.
11. Diatchenko L, Nackley AG, Slade GD, Fillingim RB, Maixner W. Idiopathic pain disorders—pathways of vulnerability. *Pain* 2006;123:226-230.
12. Smith MT, Wickwire EM, Grace EG, et al. Sleep disorders and their association with laboratory pain sensitivity in temporomandibular joint disorder. *Sleep* 2009;32:779-790.
13. Lindroth JE, Schmidt JE, Carlson CR. A comparison between masticatory muscle pain patients and intracapsular pain patients on behavioral and psychosocial domains. *J Orofac Pain* 2002;16:277-283.
14. Yatani H, Studts J, Cordova M, Carlson CR, Okeson JP. Comparison of sleep quality and clinical and psychologic characteristics in patients with temporomandibular disorders. *J Orofac Pain* 2002;16:221-228.
15. Bertoli E, de Leeuw R, Schmidt JE, Okeson JP, Carlson CR. Prevalence and impact of post-traumatic stress disorder symptoms in patients with masticatory muscle or temporomandibular joint pain: differences and similarities. *J Orofac Pain* 2007;21:107-119.
16. Porto F, de Leeuw R, Evans DR, et al. Differences in psychosocial functioning and sleep quality between idiopathic continuous orofacial neuropathic pain patients and chronic masticatory muscle pain patients. *J Orofac Pain* 2011;25:117-124.
17. Rener-Sitar K, John MT, Pusalavidyasagar SS, Bandyopadhyay D, Schiffman EL. Sleep quality in temporomandibular disorder cases. *Sleep Med* 2016;25:105-112.
18. Riley JL 3rd, Benson MB, Gremillion HA, et al. Sleep disturbance in orofacial pain patients: pain-related or emotional distress? *Cranio* 2001;19:106-113.
19. Hirsch C, Hoffmann J, Türp JC. Are temporomandibular disorder symptoms and diagnoses associated with pubertal development in adolescents? An epidemiological study. *J Orofac Orthop* 2012;73:6-8, 10-18.
20. Janal MN, Raphael KG, Nayak S, Klausner J. Prevalence of myofascial temporomandibular disorder in US community women. *J Oral Rehabil* 2008;35:801-809.
21. Suvinen TI, Reade PC, Kempainen P, Könönen M, Dworkin SF. Review of aetiological concepts of temporomandibular pain disorders: towards a biopsychosocial model for integration of physical disorder factors with psychological and psychosocial illness impact factors. *Eur J Pain* 2005;9:613-633.
22. LeResche L, Mancl LA, Drangsholt MT, Saunders K, Von Korff M. Relationship of pain and symptoms to pubertal development in adolescents. *Pain* 2005;118:201-209.
23. Lei J, Liu MQ, Yap AU, Fu KY. Sleep disturbance and psychologic distress: prevalence and risk indicators for temporomandibular disorders in a Chinese population. *J Oral Facial Pain Headache* 2015;29:24-30.
24. Nicassio PM, Moxham EG, Schuman CE, Gevirtz RN. The contribution of pain, reported sleep quality, and depressive symptoms to fatigue in fibromyalgia. *Pain* 2002;100:271-279.
25. Morin CM, Gibson D, Wade J. Self-reported sleep and mood disturbance in chronic pain patients. *Clin J Pain* 1998;14:311-314.
26. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res* 1989;28:193-213.
27. Mollayeva T, Thurairajah P, Burton K, Mollayeva S, Shapiro CM, Colantonio A. The Pittsburgh sleep quality index as a screening tool for sleep dysfunction in clinical and non-clinical samples: a systematic review and meta-analysis. *Sleep Med Rev* 2016;25:52-73.
28. de la Vega R, Tomé-Pires C, Solé E, et al. The Pittsburgh Sleep Quality Index: Validity and factor structure in young people. *Psychol Assess* 2015;27:e22-e27.
29. Ji X, Liu J. Subjective sleep measures for adolescents: a systematic review. *Child Care Health Dev* 2016;42:825-839.
30. Solberg WK. Temporomandibular disorders: data collection and examination. *Br Dent J* 1986;160:317-322.
31. Liu Y, Tanaka H; Fukuoka Heart Study Group. Overtime work, insufficient sleep, and risk of non-fatal acute myocardial infarction in Japanese men. *Occup Environ Med* 2002;59:447-451.
32. Punjabi NM, Shahar E, Redline S, Gottlieb DJ, Givelber R, Resnick HE; Sleep Heart Health Study Investigators. Sleep-disordered breathing, glucose intolerance, and insulin resistance: the Sleep Heart Health Study. *Am J Epidemiol* 2004;160:521-530.
33. Kohatsu ND, Tsai R, Young T, et al. Sleep duration and body mass index in a rural population. *Arch Intern Med* 2006;166:1701-1705.
34. Lei J, Fu J, Yap AU, Fu KY. Temporomandibular disorders symptoms in Asian adolescents and their association with sleep quality and psychological distress. *Cranio* 2016;34:242-249.
35. Ojio Y, Nishida A, Shimodera S, Togo F, Sasaki T. Sleep duration associated with the lowest risk of depression/anxiety in adolescents. *Sleep* 2016;39:1555-1562.
36. LeResche L. Epidemiology of temporomandibular disorders: implications for the investigation of etiologic factors. *Crit Rev Oral Biol Med* 1997;8:291-305.
37. Wang J, Chao Y, Wan Q, Zhu Z. The possible role of estrogen in the incidence of temporomandibular disorders. *Med Hypotheses* 2008;71:564-567.
38. Ghurye S, McMillan R. Pain-related temporomandibular disorder - current perspectives and evidence-based management. *Dent Update* 2015;42:533-536, 539-542, 545-546.

39. Drangsholt M, LeResche L. Temporomandibular disorder pain. In: Crombie IK, Croft PR, Linton SJ, LeResche L, Von Korff M, eds. *Epidemiology of pain*. Seattle: IASP Press; 1999. pp. 203-233.
40. Nilsson IM. Reliability, validity, incidence and impact of temporomandibular pain disorders in adolescents. *Swed Dent J Suppl* 2007;(183):7-86.
41. Ribeiro-Dasilva MC, Fillingim RB, Wallet SM. Estrogen-induced monocytic response correlates with TMD pain: a case control study. *J Dent Res* 2017;96:285-291.
42. Abrahamsen R, Zachariae R, Svensson P. Effect of hypnosis on oral function and psychological factors in temporomandibular disorders patients. *J Oral Rehabil* 2009;36:556-570.
43. Song KW, Kim ME. Sleep quality of patients with temporomandibular disorders: relationship to clinical and psychological characteristics. *J Oral Med Pain* 2015;40:155-162.
44. Johansson AE, Petrisko MA, Chasens ER. Adolescent sleep and the impact of technology use before sleep on daytime function. *J Pediatr Nurs* 2016;31:498-504.
45. Group ASW. School start times for adolescents. *Pediatrics* 2014; 134:642-649.
46. Gradisar M, Gardner G, Dohnt H. Recent worldwide sleep patterns and problems during adolescence: a review and meta-analysis of age, region, and sleep. *Sleep Med* 2011;12:110-118.
47. Finan PH, Goodin BR, Smith MT. The association of sleep and pain: an update and a path forward. *J Pain* 2013;14:1539-1552.
48. Vazquez-Delgado E, Schmidt JE, Carlson CR, DeLeeuw R, Okeson JP. Psychological and sleep quality differences between chronic daily headache and temporomandibular disorders patients. *Cephalalgia* 2004;24:446-454.