

The Relation between Psychological Stress and Temporomandibular Joint Disorder: A Rapid Review and Meta-Analysis

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Abstract:

Introduction: Stress is one of the problems that often occur in human life that is inevitable. Stress can contribute 50-70% to the onset of most diseases. Psychosomatic and/or psychosocial stress have been associated with pain, including temporomandibular joint disorder. TMD's are not solely related to psychological stress. So there is a need to study the impact of direct stress on temporomandibular joint.

Aims: This study aims to analyze the relationship between temporomandibular joint disorders and psychological stress.

Methods: The research procedure was carried out using the rapid review method by following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analysis) guidelines. Article searches were conducted using keywords in two databases, PubMed, and Scopus. The results of the quantitative analysis will be visualized in table and forest plots.

Results: 11 articles were included in this review after screening process. The quantitative analysis showed a positive and significant relationship between distress (OR 1.21 [95% CI: 1.11, 1.32], $p < 0.00001$), depression (OR 1.35 [95% CI: 1.09, 1.67], $p < 0.00001$), and anxiety (OR 1.47 [1.09, 1.99], $p < 0.00001$) towards temporomandibular joint disorder.

Conclusion: This review shows a significant relationship between temporomandibular joint disorders and psychological stress that can be seen from various dimensions such as distress (OR 1.21 [95% CI: 1.11, 1.32], $p < 0.00001$), depression (OR 1.35 [95% CI: 1.09, 1.67], $p < 0.00001$), and anxiety (OR 1.47 [1.09, 1.99], $p < 0.00001$).

Keywords: TMD, stress, depression, anxiety, rapid review, meta-analysis

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Introduction

Stress is one of the frequent problems in the life of mankind that is already inevitable. This can happen in the school, work, family, or anywhere else environment and can also happen to anyone including children, teenagers, adults, or the elderly.[1,2] Stress in psychology is a response of the body to the demand for

changes in an environment that forces a person to adjust or adapt to the physical demands, the environment, and uncontrolled social situations.[3] The prevalence of stress events in the world is fairly high, with almost more than 450 million people in the world experience stress. WHO states that stress is the disease

with the 4th most ranking in the world.[3,4] There are four dimensions of symptoms that proved sufficient in describing the overall general psychological complaints, namely distress, depression, anxiety, and somatization.[5] Studies has shown that stress can contribute 50-70% to the onset of most diseases.[6] Psychological stress is one of the risk factors that can contribute to temporomandibular joint disorders.[7] Several research studies on temporomandibular joint disorders have shown a relationship between perceived pain and psychosomatic and/or psychosocial aspects.[5,8]

The temporomandibular joint is one of the most important components in the stomatognathic system that includes speech, mastication and exemplification functions.[7] Temporomandibular joint disorders are a state of abnormal and imperfect function of the temporomandibular joints.[9] This term includes a number of clinical problems involving the temporomandibular joint and related structures such as the facial and neck muscles (orofacial) or masticatory muscles.[5,10] One of the etiological factors that can cause temporomandibular joint disorders is psychological factors (stress, anxiety, depression). [5,7,8,11–14] Anxiety and stress can increase the frequency, intensity, and duration of parafunctional habits that can result in masticatory muscle hyperactivity and overload of the temporomandibular joints causing temporomandibular joint disorders.[8,11,12] These phenomena also affect occlusion, such as clenching and bruxism resulting in wear on the surface of the teeth.[5,8,11]

However, the mechanism of how psychological factors affect the development of temporomandibular joint disorders is not yet known. The results of the study on the relationship of temporomandibular joint disorders with psychological stress also have a varied prevalence.[15] TMD's are not solely

related to psychological stress. So there is a need to study the impact of direct stress on temporomandibular joint. Therefore, studies to analyze the relationship between psychological stress and temporomandibular joint disorders are of great importance. Thus, this literature review aims to analyze the relationship between psychological stress and temporomandibular joint disorders.

Method

Search Strategy

This article used a rapid review method by following the guidelines of Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) that focused on the PICO (population, intervention, comparison, and outcome) framework as follows: (1) population: Patients with a diagnosis of temporomandibular joint disorders; (2) intervention: psychological stress status in patients with temporomandibular joint disorders; (3) comparison: healthy individual groups or control groups; (4) outcome: odds ratio or relative risk on the affect of psychological stress on temporomandibular joint disorder.

Literature searches are carried out on PubMed and Scopus using Boolean Operators. The keyword used for the search for articles in this study was ("psychological stress" AND ("temporomandibular joint disorder" OR "TMD" OR "Temporomandibular dysfunction" OR "disc displacement")).

Study Criteria

The inclusion criteria in this study are articles written in English, published in the last 10 years (2011 – 2021) on the relationship of temporomandibular joint disorders caused by psychological stress. The exclusion criteria in this study are articles of research conducted on animals, articles found regarding temporomandibular joint disorders caused by stress due to treatment that can be predisposing factors to temporomandibular

joint disorders, articles found regarding psychological stress caused by temporomandibular joint disorders, articles found regarding research conducted on animals, and articles in the form of literature studies or reviews.

Data Extraction

The data taken from each article includes the name of the researcher along with the year of publication, study design, sample criteria, number of samples, TMD evaluation methods and psychological stress, statistical analysis, and research analysis results, were then retrieved and summarized into tables.

Quantitative Analysis (Meta-analysis)

Quantitative analysis was carried out to evaluate the relationship between temporomandibular joint disorders and psychological stress. The value of the odds ratio with a 95% confidence interval was analyzed using Software Review Manager 5.4. The results of the analysis will be visualized in the form of tables and forest plots. Heterogeneity will be evaluated using index I^2 . Statistical thresholds of I^2 use as suggested by the Cochrane handbook: 0-

40% (possibly unimportant), 30-60% (may represent medium heterogeneity), 50-90% (may represent substantial heterogeneity), 75-100% (considerable heterogeneity).

Result

Study Search Results

The literature search uses PRISMA flow chart with the following results: at the identification stage, the search of articles using keywords with no filters from 2 databases results in 366 articles on PubMed and 532 articles on Scopus, with a total of 898 articles. The first screening was carried out with deduplication of 161 literature then continued by excluding 448 articles published more than 10 years ago. The screening against the title and abstract found 246 articles that were irrelevant and did not match the inclusion criteria. The last screening was done by reading the entire content of the article and found 32 articles that were irrelevant and did not meet the inclusion criteria. Thus, the number of articles that are appropriate and will be further studied in this study is 11 articles. The flow chart of the search and selection process of articles can be seen in **Figure 1**.

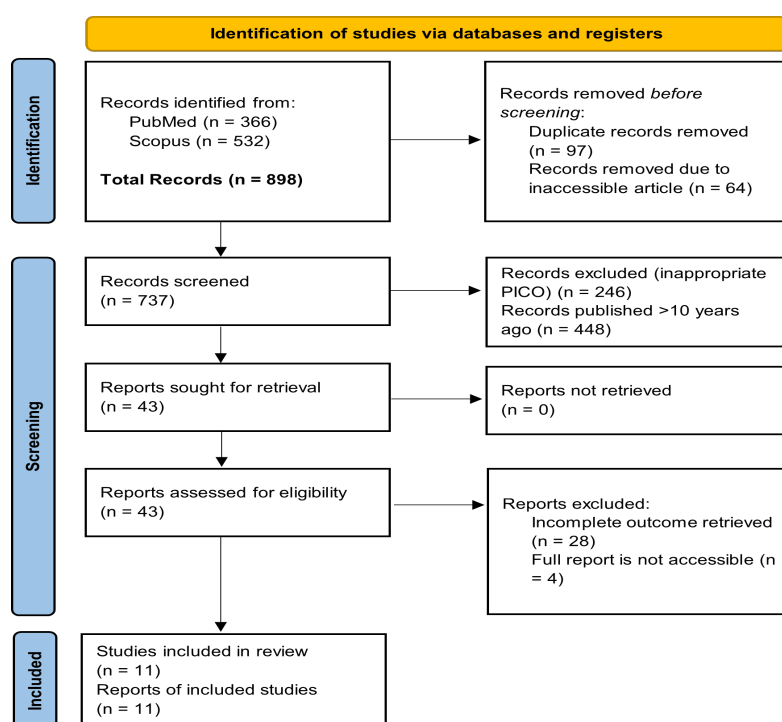


Figure 1. PRISMA flow chart

Study Characteristics

From the 11 articles used in this study, there was one study using the retrospective method,[16] one article using the cohort method,[17] and there were nine articles using the cross-sectional method.[18–26] The research study was conducted in Amsterdam,[16] Finland,[18] Korea,[19,21] Saudi Arabia,[20] Indonesia,[22] The Netherlands,[23] China,[24,25] Japan,[17] and the United Arab Emirates.[26]

In the included studies, stress evaluation was carried out using the General Health Questionnaire-12 (GHQ-12),[18] Depression, Anxiety, and Stress Scale-21 (DASS-21),[22,24,25] Life Events Checklist (LEC),[17] and assessed life events and stress scale.[19,21,23] In studies that used depression and anxiety as one of the dimensions of psychological stress, the evaluation was carried out using the Patient Health Questionnaire-9 (PHQ-9) to measure depression,[16,20] The Generalized Anxiety Disorder-7 (GAD-7) to measure anxiety,[16,19] and Hospital Anxiety and Depression (HAD) Scale.[26]

The diagnosis of temporomandibular joint disorders are done by using Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD),[18,23] Diagnostic Criteria for Temporomandibular Disorders (DC/TMD),[16,19,21,23,24] clinical examination, and anamnesis.[17,19,21,26] Data extraction on the characteristics of the study can be found in **Table 1**.

Meta-Analysis

From the 11 research studies used, the quantitative analysis was carried out by dividing the criteria of psychological stress into 3 groups, namely distress, depression, and anxiety. The results of the studies used have been summarized in **Table 2**.

The relationship between temporomandibular joint disorders and psychological stress from 11 research studies has shown positive or significant results with distress as one of the risk factors (OR 1.21 [95% CI: 1.11, 1.32], $p < 0.00001$). However, insignificant results were found when viewed from the gender sub-group on the relationship of distress with temporomandibular joint disorder in men (OR 1.19 [95% CI: 0.85, 1.68], $p = 0.002$) and women (OR 1.13 [95% CI: 0.90, 1.40], $p = 0.09$). Meanwhile, in research studies that did not include gender, significant results were obtained on distress as one of the risk factors for temporomandibular joint disorders (OR 1.29 [95% CI: 1.13, 1.47], $p = 0.04$). Similar things were also found in depression (OR 1.35 [95% CI: 1.09, 1.67], $p < 0.00001$) and anxiety (OR 1.47 [95% CI: 1.09, 1.99], $p < 0.00001$) which were significant as one of the risk factors that could cause temporomandibular joint disorders. In the risk factors of depression, an insignificant association of depression was found to temporomandibular joint disorders occurring in men (OR 1.93 [0.53, 7.02], $p = 0.16$) and women (OR 1.36 [0.78, 2.36], $p = 0.28$). Meanwhile, in depressive symptoms in the form of suicidal ideation, a significant association was found to temporomandibular joint disorders in women (OR 1.47 [1.12, 1.92], $p = 0.35$) and insignificant in men (OR 1.53 [0.64, 3.62], $p = 0.11$). In studies that did not include gender, insignificant results were also obtained in depression as one of the risk factors for temporomandibular joint disorders (OR 1.24 [0.92, 1.67], $p < 0.00001$). The results of the analysis of the 11 included studies were visualized in the form of forest plot in **Figure 2-4**.

Table 1: Summary of Included studies' characteristics

No.	Author, Year	Location	Study Design	Sample Criteria	Number of Samples	TMD Evaluation	Evaluation of Psychological Stress
1	Maurits K.A., et al., 2017	Amsterdam	Retrospective	Patients referred to a specialist clinic for pain and orofacial dysfunction at ACTA (Academic Centre for Dentistry Amsterdam) between September 2013 and March 2015	254	Axis II protocol Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) questionnaire and clinical examination	The Patient Health Questionnaire (PHQ)-9; The Generalized Anxiety Disorder-7 (GAD-7); Anamnesis
2	Tuulainen L. et al., 2015	Finland	Cross-sectional	Adults in Finland	6.155	Clinical examination in accordance with research diagnostic criteria for temporomandibular disorders (RDC/TMD)	General Health Questionnaire-12 (GHQ-12)
3	Hyun A. H., et al., 2018	Korean	Cross-sectional	Teenagers in Korea	1337	Anamnesis, oral clinical examination, and questionnaire	Anamnesis
4	Srivastava K. C., et al., 2021	Saudi Arabia	Cross-sectional	Dental students in Saudi Arabia	246	Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) Axis I and II	Patient Health Questionnaire-9 (PHQ-9) Generalized Anxiety Disorder (GAD)
5	Suhyun P., et al., 2020	Korean	Cross-sectional	KNHANES participants from Korea Centers for Disease Control and Prevention	11.922	Clinical examination and anamnesis according to criteria from WHO	Anamnesis
6	Yep A. U., et al., 2021	Indonesian	Cross-sectional	Students from universities in Jakarta	734	Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) Axis I	Depression, Anxiety, and Stress Scale (DASS-21)
7	Marpaung C., et al., 2018	Dutch	Cross-sectional	Teenagers from 9 Dutch high schools	4.235	Research Diagnostic Criteria for Temporomandibular Disorder (RDC/TMD)	Anamnesis
8	Lei J., et al., 2021	China	Cross-sectional	TMD patients and orofacial Pain Center at Peking University School and Hospital of Stomatology from May 2018 - December 2019	1079	Diagnostic Criteria for Temporomandibular Disorders (DC/TMD)	Depression, Anxiety, and Stress Scale (DASS-21)
9	Lei J., et al., 2016	China	Cross-sectional	Teenagers from high school in Peking, China	578	Questionnaire Diagnostic Criteria for Temporomandibular Disorders (DC/TMD)	Depression, Anxiety, and Stress Scale (DASS-21)
10	Akhter R., et al., 2011	Japanese	Cohort	Students from universities in Japan	492	Questionnaire	Life Events Checklist (LEC) Questionnaire
11	Gaballah K., et al., 2020	UAE	Cross-sectional	Citizens of the United Arab Emirates	2101	Anamnesis by American Academy of Orofacial Pain	Hospital Anxiety and Depression (HAD) Scale

Table 2: Summary of included studies' outcomes

No.	Author, year	Variable	Statistical Analysis	OR	95% CI	P Value
1	Maurits K.A., et al., 2017	Depression	Chi-square	1.08	1.04-1.13	0.001
		Anxiety		1.06	1.05-1.10	0.064
		Stress		1.18	0.97-1.42	0.094
2	Tuuliainen L., et al., 2015	Psychological Distress (Male)	Logistic Regression	1.035	0.99-1.08	0.102
		Psychological Distress (Women)		1.032	1.00-1.06	0.032
3	Hyun A. H., et al., 2018	Stress Perception (Male)	Logistic Regression	0.909	0.424-1.949	>0:05 a.m.
		Stress Perception (Women)		0.976	0.527-1.809	>0:05 a.m.
		Depressed Mood (Male)		3.07	1.394-6.76	<0.05
		Depressed Mood (Women)		0.888	0.346-2.279	>0:05 a.m.
		Suicidal Thoughts (Male)		2.564	1.014-6.484	<0.05
		Suicidal Thoughts (Women)		1.051	0.493-2.243	>0:05 a.m.
4	Srivastava K. C., et al., 2021	Anxiety (GAD \geq 1)	Multivariate analysis	1.55	1.33-1.84	0.04
		Depression (PHQ-9 \geq 1)		1.64	1.51-1.78	0.56
5	Suhyun P., et al., 2020	Stress (Male)	Student's T Test; Multivariate analysis	1.558	1.241-2.385	<0.05
		Stress (Female)		1.383	1.068-1.792	<0.05
		Mood disorders (Male)		1.329	0.732-2.412	>0:05 a.m.
		Mood disorders (Women)		1.227	0.877-1.716	>0:05 a.m.
		Suicidal Thoughts (Male)		1.05	0.575-1.919	>0:05 a.m.
		Suicidal Thoughts (Women)		1.54	1.157-2.051	<0.05
		Depression (Male)		0.759	0.128-4.488	>0:05 a.m.
		Depression (Female)		1.636	0.929-2.882	>0:05 a.m.
6	Yep A. U., et al., 2021	Total watershed-21	Multivariate analysis	1.24	1.16-1.33	<0.001
		Anxiety		1.18	1.11-1.26	<0.001
7	Marpaung C., et al., 2018	Stress	Logistic Regression	1.6	1.28-1.99	<0.001
		Feeling Sad		1.55	1.27-1.88	<0.001
8	Lei J., et al., 2021	Stress	Stepwise Logistic Regression	1.482	1.039-2.114	<0.05
9	Lei J., et al., 2016	Depression	Stepwise Logistic Regression	0.73	0.47-1.14	>0.01
		Anxiety		2.16	1.46-3.19	<0.01
		Stress		1.45	0.97-2.18	>0.01
10	Akhter R., et al., 2011	Stress (Moderate/High)	Multiple Logistic Regression	10.56	1.28-87.54	<0.05
11	Gaballah K., et al., 2020	Stress Perception	Chi-square	1.034	0.834-1.282	>0:05 a.m.
		Anxiety (HAD increases)		1.502	1.202-1.878	<0.05

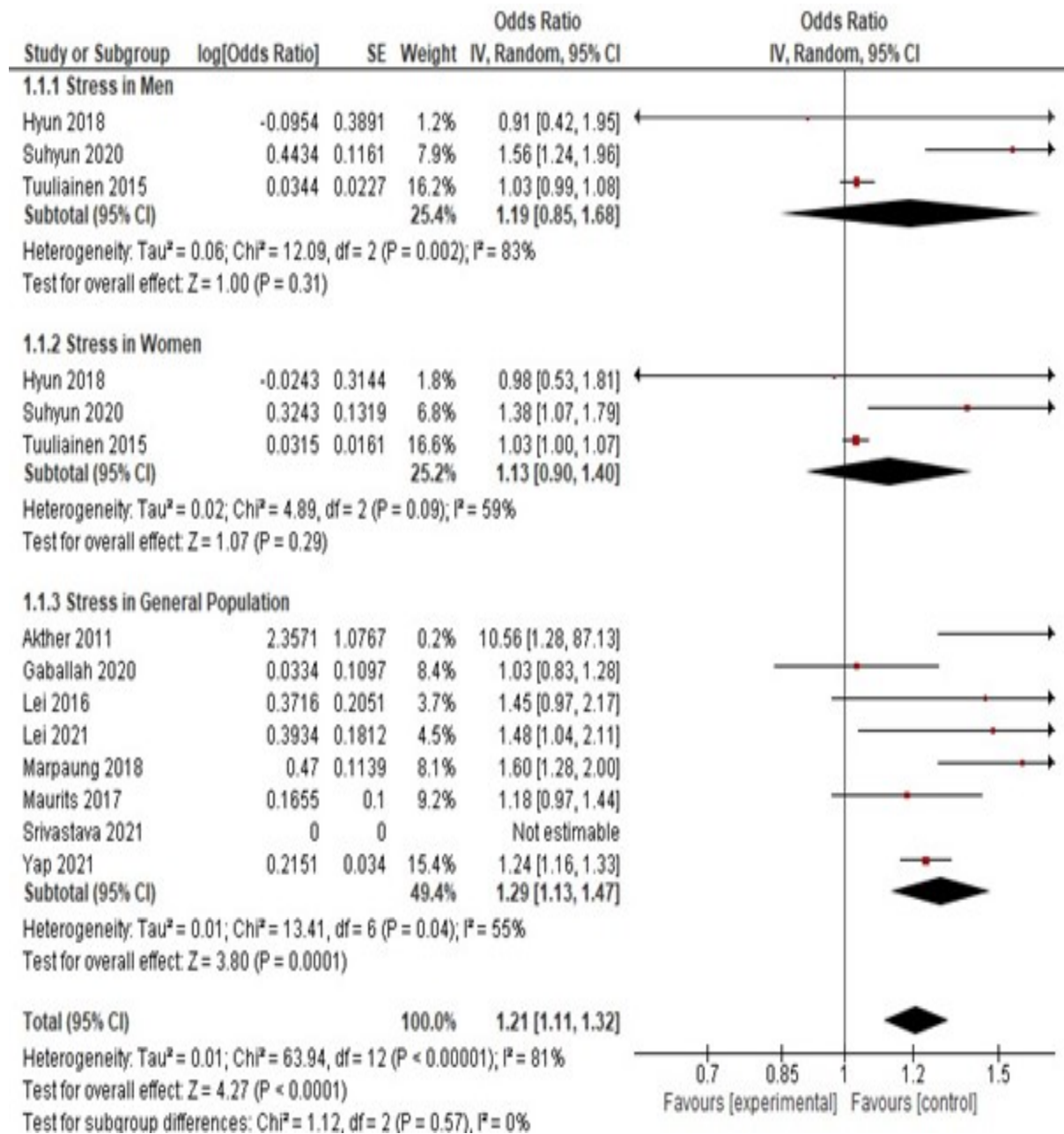


Figure 2: Results of Stress Analysis on Temporomandibular Joint Disorders

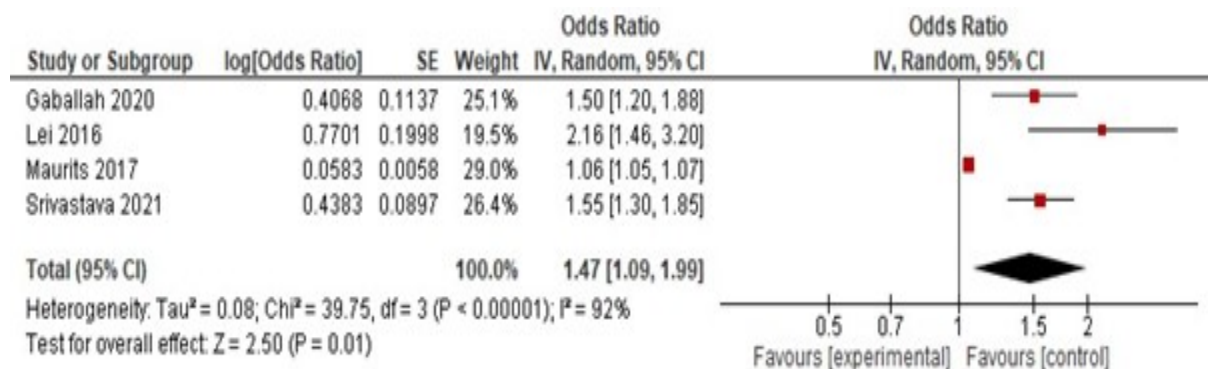


Figure 3: Results of Anxiety Analysis on Temporomandibular Joint Disorders

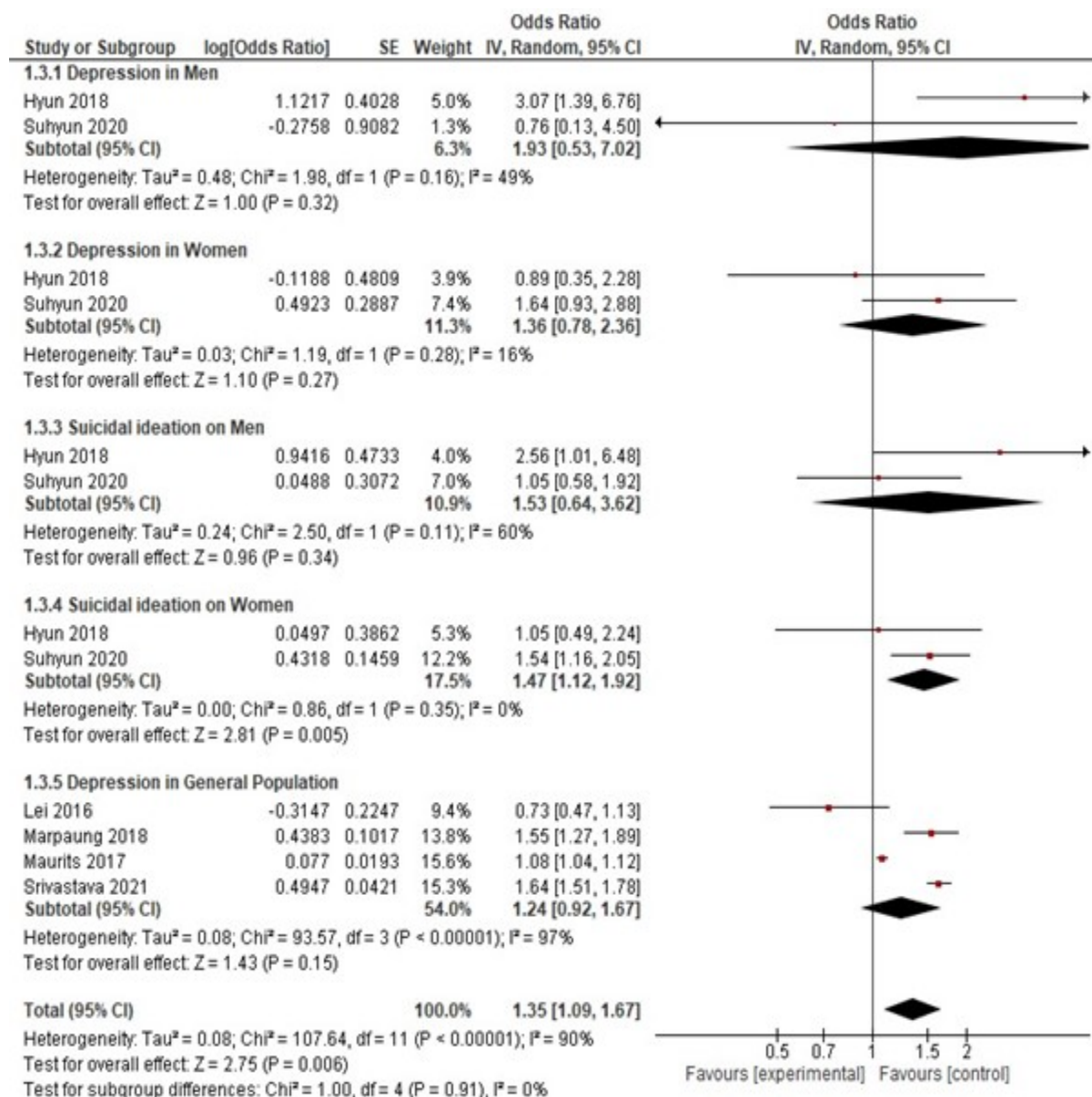


Figure 4: Results of Depression Analysis on Temporomandibular Joint Disorder

Discussion

In this rapid review, we found a positive correlation between temporomandibular joint disorders and psychological stress. This has been shown from the results of quantitative analysis or meta-analysis. Distress, depression, and anxiety as dimensions of psychological stress have proven to be one of the significant risk factors that can cause temporomandibular joint disorders.

A similar point has also been stated in a study (Lia et al.), that there is a relationship between temporomandibular joint disorders

and depression, anxiety, oral parafunction, especially bruxism, and hysteria in adolescents.[27] In a study conducted on pilots in China (Yu et al.), significant results were presented that pilots who had distress symptoms in the form of anxiety were more at risk of developing temporomandibular joint disorders.[28] In another research study (Augusto et al.), there were results that reinforced the assumption that there was a relationship between temporomandibular joint disorders and parafunctional habits due to stress.[29] In addition, there was a research study (Osiewicz et al.) that suggested that there

was a significant association between depression and pain from temporomandibular joint disorders.[30] Several other studies (Fernandes et al.; Calixtre et al.; Minghelli et al.) also showed a significant correlation between anxiety and depression with the onset of signs and symptoms of temporomandibular joint disorders.[31–33]

In the studies included in this study, there were various types of stress used. There were studies using stress,[16–19,21–26] depression,[16,20,21,25] and anxiety.[16,20,22,25,26] In addition, there were also studies that used symptoms from depression as parameters used, such as depressed mood,[19] suicidal thoughts,[19,21] and mood disorders including persistent feelings of sadness.[21,23]

Temporomandibular joint disorders associated with psychological stress are generally caused by pain and spasms of masticatory muscles due to muscle hyperactivity and muscle dysfunction resulting in parafunctional function and malocclusion influenced by psychological factors.[13] When a person is stressed, they will try to find ways to overcome it which often include parafunctions that affect occlusion, such as clenching and bruxism resulting in wear on the surface of the teeth.[5,8,11] Severe stress can cause changes in the body because the bodies' muscles, including the temporomandibular muscles, have been prepared to deal with any form of threat or load that exceeds its normal capabilities. Changes in the muscles are in the form of increased muscle activity or hyperactivity.[12]

The most underlying thing about the occurrence of a psychological response to stress is the hypothalamic-pituitary-adrenocortical (HPA) axis activation. Activation of the HPA-axis will stimulate the secretion of cortisol produced by the adrenal cortex.[8,14] Therefore, patients with severe stress will experience an increase in cortisol in the saliva indicating

the presence of an endocrine response to stress that can cause pain.[12] Some studies (Jones et al.; Korszun et al.) has also shown a link between temporomandibular joint disorders and biochemical stressors such as cortisol.[34,35]

Stress is a systemic event that can affect mastication function, including masticatory muscles. When an individual is at a high level of emotions, such as fear, frustration, or anger; there can be modifications to muscle activity that give rise to hyperactivity. Long-lasting and persistent muscle hyperactivity will trigger muscle fatigue which could lead to muscle cramps. Muscle cramps can trigger changes in mastication patterns, disharmony of the relationship between the teeth of the upper jaw and the lower jaw, and an imbalance in the distribution of load which can cause disruption of the temporomandibular joint and the surrounding area.[12]

In addition, stress can affect the body by activating the hypothalamus to prepare the body to respond to autonomic nerves. The hypothalamus will increase the activity of the efferent gamma causing the infratus fibers and muscle spindles to contract. The spindle will become more sensitive and cause an increase in the tone of the head and neck muscles including mastication muscles. Increased muscle tone will increase the risk of muscle fatigue which will result in an increase in interarticular pressure in the temporomandibular joint.[12]

Based on current research, the results of the review on this study shows a relationship between temporomandibular joint disorders and psychological stress. However, some of the included studies showed extensive heterogeneity in some aspects, such as varying populations and characteristics of research samples. Variations can also be seen in the age of the sample, ranging from adolescents to adults that may be correlated with different clinical manifestations. In addition, the use of parameters for the evaluation of stress and disorders of

different temporomandibular joints can give rise to bias. As in some studies that use the parameters of stress evaluation and stress disorder temporomandibular with anamnesis and unvalidated questionnaires. Although there are some limitations of studies, the studies selected in this review suggest that psychological stress is very likely to be one of the risk factors for the occurrence of temporomandibular joint disorders.

The diagnosis of TMD is usually based on history and physical examination. Physical examination to support the diagnosis of TMD is abnormal mandibular movement, decreased range of jaw movement, tenderness on the masticatory muscles, and signs of bruxism. It should also be noted that malocclusions may contribute to the manifestation of TMD. We can also use imaging to support the diagnosis of TMD. Plain radiography (transcranial and transmaxillary views) and panoramic radiography can be used to assess acute fractures, dislocations, and severe degenerative articular disease. Computed tomography can be used to evaluate subtle bone morphology. Magnetic resonance imaging is the optimal modality for comprehensive joint evaluation with signs and symptoms of TMD. Magnetic resonance imaging is usually performed in patients with persistent symptoms, patients who have underwent conservative therapy with ineffective result, or in patients suspected of having internal joint disorders. Ultrasonography can be used to diagnose internal derangement of the TMJ.[36]

The initial treatment goals for patient with TMD should focus on relieving pain and temporomandibular joint dysfunction. Supportive patient education is the recommended initial treatment for TMD, with additional action like jaw rest, a soft diet, warm moist compresses, and passive stretching exercises. Physical therapy may also be used to relieve symptoms associated with TMD. Cognitive therapy and biofeedback can also be used to treat short-

term and long-term pain in patients with TMD symptoms. Cognitive therapy that can be done is reducing stress, eliminating parafunctional habits, and avoiding extreme mandibular movements. Surgical intervention can be performed in patients whose symptoms do not improve after conservative therapy.[36]

Conclusion

This review shows a significant association between temporomandibular joint disorders and psychological stress which can be seen from various aspects such as distress (OR 1.21 [95% CI: 1.11, 1.32], $p < 0.00001$), depression (OR 1.35 [95% CI: 1.09, 1.67], $p < 0.00001$), and anxiety (OR 1.47 [1.09, 1.99], $p < 0.00001$). Further study is needed to evaluate the direct stress impact on temporomandibular joint.

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References

1. Lumban Gaol NT. Teori Stres: Stimulus, Respons, dan Transaksional. *Bul Psikol.* 2016;24(1):1.
2. Sukadiyanto. Stress dan Cara mengatasinya. *Cakrawala Pendidik.* 2010;29(1):55–66.
3. Ambarwati PD, Pinilih SS, Astuti RT. Gambaran Tingkat Stres Mahasiswa. *J Keperawatan Jiwa.* 2019;5(1):40.
4. Perwitasari DT, Nurbeti N, Armyanti I. Faktor-Faktor yang Mempengaruhi Tingkatan Stres pada Tenaga Kesehatan di RS Universitas Tanjungpura Pontianak. *J Cerebellum* [Internet]. 2016;2(3):553–61. Available from:

- <https://journal.untan.ac.id/index.php/jfk/article/view/14451>
5. Sójka A, Stelcer B, Roy M, Mojs E, Pryliński M. Is there a relationship between psychological factors and TMD? *Brain Behav.* 2019;9(9):1–11.
 6. Musradinur. Stres Dan Cara Mengatasinya Dalam Perspektif Psikologi. *J EDUKASI J Bimbingan Konseling.* 2016;2(2):183.
 7. Okeson JP. *Management of Temporomandibular Disorders and Occlusion.* Elsevier. 2008.
 8. Saccomanno S, Bernabei M, Scoppa F, Pirino A, Mastrapasqua R, Visco MA. Coronavirus lockdown as a major life stressor: Does it affect tmd symptoms? *Int J Environ Res Public Health.* 2020;17(23):1–13.
 9. Driscoll CF, Freilich MA, Guckes AD, Knoernschild KL, McGarry TJ, Goldstein G, et al. The Glossary of Prosthodontic Terms: Ninth Edition. *J Prosthet Dent.* 2017;117(5):1–105.
 10. Chisnoiu AM, Picos AM, Popa S, Chisnoiu PD, Lascu L, Picos A, et al. Factors involved in the etiology of temporomandibular disorders - a literature review. *Clujul Med.* 2015;88(4):473–8.
 11. Cavallo P, Carpinelli L, Savarese G. Perceived stress and bruxism in university students. *BMC Res Notes.* 2016;9(1):1–6.
 12. Husada LE, Susiana S, Theresia E. Hubungan antara stres dengan gangguan sendi temporomandibula pada mahasiswa program profesi kedokteran gigi. *Padjadjaran J Dent Res Students.* 2019;3(2):129.
 13. Aulia IN, Syamsudin E, Satria TB. Laporan penelitian Korelasi antara gangguan sendi temporomandibular dengan tingkat stres pada personel korps Pasukan Khas Tentara Nasional Indonesia Angkatan Udara di Jakarta. 2021;19–24.
 14. Staniszewski K, Lygre H, Bifulco E, Kvinnsland S, Willassen L, Helgeland E, et al. Temporomandibular Disorders Related to Stress and HPA-Axis Regulation. *Pain Res Manag.* 2018;2018:1–7.
 15. De Medeiros RA, Vieira DL, Da Silva EVF, De Rezende LVML, Dos Santos RW, Tabata LF. Prevalence of symptoms of temporomandibular disorders, oral behaviors, anxiety, and depression in dentistry students during the period of social isolation due to COVID-19. *J Appl Oral Sci.* 2020;28:1–8.
 16. van Selms M, Muzalev K, Visscher C, Koutris M, Bulut M, Lobbezoo F. Are Pain-Related Temporomandibular Disorders the Product of an Interaction Between Psychological Factors and Self-Reported Bruxism? *J Oral Facial Pain Headache.* 2017;31(4):331–8.
 17. Akhter R, Morita M, Esaki M, Nakamura K, Kanehira T. Development of temporomandibular disorder symptoms: A 3-year cohort study of university students. *J Oral Rehabil.* 2011;38(6):395–403.
 18. Tuulainen L, Sipilä K, Mäki P, Könönen M, Suominen A. Association Between Clinical Signs of Temporomandibular Disorders and Psychological Distress Among an Adult Finnish Population. *J Oral Facial Pain Headache.* 2015;29(4):370–7.
 19. Heo HA, Park S, Pyo SW. Association of temporomandibular disorder and high frequency of suicide ideation in Korean adolescents: a cross-sectional survey. *Acta Odontol Scand* [Internet]. 2018;76(5):374–9. Available from: <https://doi.org/10.1080/00016357.2018.1471517>
 20. Srivastava KC, Shrivastava D, Khan ZA, Nagarajappa AK, Mousa MA, Hamza MO, et al. Evaluation of temporomandibular disorders

- among dental students of Saudi Arabia using Diagnostic Criteria for Temporomandibular Disorders (DC/TMD): a cross-sectional study. *BMC Oral Health* [Internet]. 2021;21(1):211. Available from: <https://doi.org/10.1186/s12903-021-01578-0>
21. Park S, Heo HA, Yun KI, Pyo SW. High prevalence of stress and suicidal ideation in women with temporomandibular disorder: A population-based cross-sectional survey. *Cranio - J Craniomandib Pract* [Internet]. 2020;00(00):1–7. Available from: <https://doi.org/10.1080/08869634.2020.1721174>
 22. Yap AU, Marpaung C, Rahmadini ED. Psychological well-being and distress: Their associations with temporomandibular disorder symptoms and interrelationships. *Oral Surg Oral Med Oral Pathol Oral Radiol* [Internet]. 2021;132(2):163–71. Available from: <https://doi.org/10.1016/j.oooo.2021.02.012>
 23. Marpaung C, Lobbezoo F, Van Selms MKA. Temporomandibular Disorders among Dutch Adolescents: Prevalence and Biological, Psychological, and Social Risk Indicators. *Pain Res Manag*. 2018;2018:1–7.
 24. Lei J, Yap AU, Zhang M, Fu KY. Temporomandibular disorder subtypes, emotional distress, impaired sleep, and oral health-related quality of life in Asian patients. *Community Dent Oral Epidemiol*. 2021;49(6):543–9.
 25. Lei J, Fu J, Yap AUJ, Fu KY. Temporomandibular disorders symptoms in Asian adolescents and their association with sleep quality and psychological distress. *Cranio - J Craniomandib Pract*. 2016;34(4):242–9.
 26. Gaballah K, Alkubaisy A, Baker AA, Bawzeer A, Awad R. Revisiting the Risk Factors for Multiple Symptoms of Temporomandibular Disorders: A structured Cross-sectional Study. *Open Dent J*. 2020;14(1):503–10.
 27. Kartika, Lia. Himawan L. Penatalaksanaan Kasus Gangguan Sendi Temporomandibula dengan Latihan Rahang (Laporan Kasus). 2007;14(1):12–7.
 28. Yu Q, Liu Y, Chen X, Chen D, Xie L, Hong X, et al. Prevalence and associated factors for temporomandibular disorders in Chinese civilian pilots. *Int Arch Occup Environ Health*. 2015;88(7):905–11.
 29. Augusto VG, Bueno Perina KC, Gontijo Penha DS, dos Santos DCA, Oliveira VAS. Temporomandibular dysfunction, stress and common mental disorder in university students. *Acta Ortop Bras*. 2016;24(6):330–3.
 30. Osiewicz M, Lobbezoo F, Ciapała B, Pytko-polończyk J, Manfredini D. Pain predictors in a population of temporomandibular disorders patients. *J Clin Med*. 2020;9(2):5.
 31. Fernandes G, de Godoi Gonçalves DA, de Siqueira JTT, Camparis CM. Painful temporomandibular disorders, self reported tinnitus, and depression are highly associated. *Arq Neuropsiquiatr*. 2013;71(12):943–7.
 32. Minghelli B, Morgado M, Caro T. Association of temporomandibular disorder symptoms with anxiety and depression in Portuguese college students. *J Oral Sci*. 2014;56(2):127–33.
 33. Calixtre LB, Da Grüniger BLS, Chaves TC, De Oliveira AB. Is there an association between anxiety/depression and temporomandibular disorders in college students? *J Appl Oral Sci*. 2014;22(1):15–21.
 34. Korszun A, Young EA, Singer K,

- Carlson NE, Brown MB, Crofford L. Basal circadian cortisol secretion in women with temporomandibular disorders. *J Dent Res.* 2002;81(4):279–83.
35. Jones DA, Rollman GB, Brooke RI. The cortisol response to psychological stress in temporomandibular dysfunction. *Pain.* 1997;72(1–2):171–82.
36. Gauer RL, Semidey MJ. Diagnosis and Treatment of Temporomandibular Disorders. 2015;