

Temporomandibular Disorder and Psychological Distress Relationships in Air Traffic Controllers

Disfunção temporomandibular e relações de sofrimento psíquico em controladores de tráfego aéreo

ABSTRACT

Background: Air traffic controllers (ATC) are subject to high cognitive and operational demands, exposing them to stress, anxiety and depression. Temporomandibular disorder (TMD) is the main disorder of non-odontogenic etiology for chronic facial pain that affects muscles and joints, and has been related to psychological distress. Therefore, ATC could be susceptible to TMD. **Objective:** This study verified the prevalence of TMD and its relationship with psychological distress in ATC. **Methods:** Brazilian ATC of both sexes participated in this study (n: 121; 27.9 ± 4.2 years old). Participants were asked to complete questionnaires about signs and symptoms of temporomandibular disorders: FAI; and about psychological distress: PSS-10; GAD-7; and PHQ-9. Inferential statistical analyzes for comparison between factors and correlation between dependent variables were adopted with 5.0% significance. **Results:** TMD was highly prevalent among ATC. More than half of ATC have at least one psychological disturbing condition; they include anxiety (n:13; 13.7%), stress (n: 58; 47.9%), depression (n: 24; 19.8%), and comorbidities (n: 22; 18.2%) among these psychological distressing conditions. Psychological distress scores (anxiety, stress and depression) were higher in ATC with TMD (p<.01; all comparisons) or need-TMD treatment (p<.01; p= .02; p<.01, respectively) than in ATC without TMD, a some of them achieving clinically meaningful effects. **Conclusion:** TMD is quite prevalent among Brazilian military ATCs, and ATCs who exhibit TMD's signs and symptoms are more psychologically distressed. In order to improve ATC's health and, by extension, flight safety, it is critical that management and preventive measures be implemented in military medicine.

Keywords: Depression. Anxiety. Stress. Temporomandibular disorder. Military Personnel.

RESUMO:

Introdução: Os controladores de tráfego aéreo estão sujeitos a elevadas demandas cognitivas e operacionais, expondo-os ao estresse, à ansiedade e à depressão. A disfunção temporomandibular é a principal desordem de etiologia não odontogênica para dores faciais crônicas que acometem músculos e articulações, e tem sido relacionada ao sofrimento psicológico. Portanto, o ATC pode ser suscetível à DTM. **Objetivo:** Este estudo verificou a prevalência de disfunção temporomandibular (DTM) e sua relação com sofrimento psíquico em ATC. **Métodos:** Participaram deste estudo ATC brasileiros de ambos os sexos (n: 121; 27,9 ± 4,2 anos). Os participantes foram solicitados a preencher questionários sobre sinais e sintomas de DTM: FAI; e sobre sofrimento psíquico: PSS-10; GAD-7; e PHQ-9. Foram adotadas análises estatísticas inferenciais para comparação entre fatores e correlação entre variáveis dependentes com significância de 5,0%. **Resultados:** A DTM foi altamente prevalente entre os ATC. Mais de metade dos ATC têm pelo menos uma condição psicológica perturbadora; incluem ansiedade (n: 13; 13,7%), estresse (n: 58; 47,9%), depressão (n: 24; 19,8%) e comorbidades (n: 22; 18,2%) entre essas condições de sofrimento psicológico. Os escores de sofrimento psicológico (ansiedade, estresse e depressão) foram maiores em ATC com DTM (p<0,01; todas as comparações) ou necessidade de tratamento para DTM (p<0,01; p= 0,02; p<0,01, respectivamente) do que em ATC sem DTM, alguns deles alcançando efeitos clinicamente significativos. **Conclusão:** A DTM é bastante prevalente entre os ATC militares brasileiros, e os ATC que apresentam sinais e sintomas de DTM apresentam maior sofrimento psicológico.

Palavras-chaves: Depressão. Ansiedade. Estresse. Disfunção temporomandibular. Militar.

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1 Background

Air traffic controllers (ATC) are crucial for the safety and management of air traffic flow (INOUE e colab., 2012; JOU e colab., 2013), a specialized technical function that requires agility to deal with complex conditions. In Brazil, ATC are military personnel of the Brazilian Air Force (FAB). Aeronautical professions expose operators to stress, anxiety, depression, and high workload (RODRIGUES e colab., 2018; WU e colab., 2016), requiring high concentration and agility (RODRIGUES e colab., 2018). Airspace is constantly managed, and ATC perform duties on all work shifts, causing recurrent changes in the sleep-wake cycle, contributing to psychological distress (BOIVIN e BOUDREAU, 2014). In summary, the summation of the aforementioned occupational characteristics of ATC predisposes them to the development of psychological distress and, consequently, to its comorbidities.

Temporomandibular disorders (TMD) have been related to psychological distress, so, that might be a risk factor for ATC due to their occupational activities. TMD are musculoskeletal and neuromuscular conditions that affect the masticatory muscles, temporomandibular joint (TMJ), and associated structures (DE LEEUW e KLASSER, 2013), it is the preponderant non-odontogenic etiology disorder for chronic facial pain (FU, 2015) and the main signs and symptoms are muscle and TMJ pain, atypical mandibular kinematics and joint dynamics accompanied by unusual sound (FERENDIUK e colab., 2014; PEREIRA e colab., 2005). TMD has been linked to depression and anxiety (GAMEIRO e colab., 2006), and adults with TMD have higher frequencies of sleep disturbances compared to no-TMD (FU, 2015).

In this scenario, the predisposition of ATC to psychological distress may favor the development of TMD in this population; however, information about it is incipient. Therefore, the objective of this study is to verify the prevalence of TMD among ATC and its relationship to psychological distress. This information is useful to scientifically support actions applied in oral health areas, occupational health, and, especially, flight safety.

2 Method

2.1 Design, Ethical Procedures and Sample Size

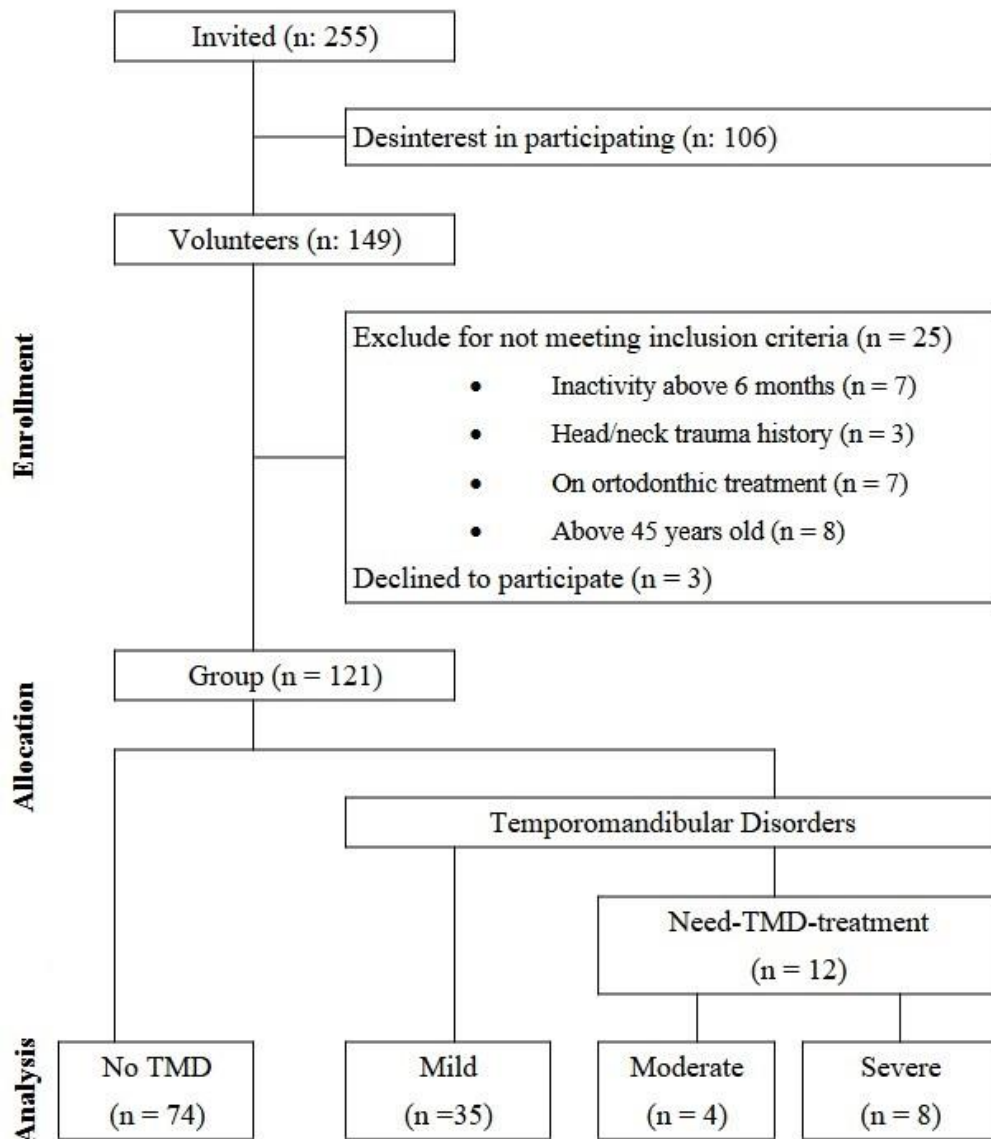
This cross-sectional study investigates the profile of TMD in FAB's military ATC, following the Declaration of Helsinki and approval from the scientific ethics committee of the Air Force Hospital (CAAE n° [36318620.0.0000.8928](https://doi.org/10.70545/ran.v8iEspecial.12811)), Approval Number: 4.690.140. The study was reported



using the Checklist for Analytical Cross-sectional Study – STROOBE. The ideal sample was estimated using a statistical test of proportional comparisons in G.Power software, with a sample size of 117 participants. The results showed sufficient sensitivity to identify significant effects of factors, including small effects, with a level of 0.05, power of 0.9, and effect size of 0.3 - small.

2.2 Participants

Figure 1: Observational study design - allocation into up to 4 groups.



TMD: Temporomandibular Disorders.

Source: authors

Brazilians are starting the FAB's Air Traffic Control technical course through an annual public contest, with military ATCs distributed throughout the country. This study aims to homogenize ATC



characteristics within a representative sample of the region managing air traffic control with Area Control Center (ACC) and Aircraft Approach Control (APP) specialties.

A total of 255 ATCs were invited to participate in the study, and 149 agreed to participate. To avoid bias in the results of the study analyses, the following inclusion criteria were adopted: i. inactive six months of the ATCs (n: 7); ii. ATCs with traumatic injury history at head-neck (n: 3); iii. ATCs with orthodontic treatment in course (n: 7); and iv. participants over 45 years of age (n: 8). In addition, we obeyed the solicitation of some participants to exclude their study data (n: 3). Finally, the data of 121 air traffic controllers was allocated into four groups (Figure 1). This participant sample reached a sufficient margin to ensure representative statistical analyses of this study data.

The average experience of participants is 8 years, with 99 being ACC and 22 being APP of III Integrated Defense Center Air and Air Traffic Control (CINDACTA III, Brazil; Table 1).

Table 1: Age, Anthropometric, TMD, and Psychological Distress by Sex and ATC Specialty

Air Traffic Controller	AAP		ACC		Total	
	Mean	± SD	Mean	± SD	Mean	± SD
Female	(n = 17)		(n = 39)		(n = 56)	
Age [y]	29.0	5.0	27.8	4.1	27.9	4.2
Height [cm]	165.8	5.5	162.7	5.1	163.6	5.4
Weight [kg]	64.4	11.4	65.6	11.5	65.3	11.4
BMI [kg/m ²]	23.3	2.7	24.9	4.7	24.4	4.3
FAI score	15.3	18.5	20.4	19.6	18.8	19.2
Anxiety score	2.3	2.7	3.7	3.8	3.3	3.5
Stress score	11.2	6.5	13.5	7.9	12.8	7.5
Depression score	2.8	2.5	3.9	3.9	3.4	3.6
Male	(n = 5)		(n = 60)		(n = 65)	
Age [y]	30.1	5.2	28.6	5.0	28.3	5.0
Height [cm]	177.4	1.9	175.7	5.1	175.8	5.0 *
Weight [kg]	88.8	5.1	81.2	12.4	81.7	12.2 *
BMI [kg/m ²]	28.2	1.7	26.2	3.3	26.4	3.3 *
FAI score	22.0	13.0	18.9	18.5	19.2	21.2
Anxiety score	2.6	3.6	2.7	3.1	2.7	3.1
Stress score	12.4	6.6	13.4	6.4	13.3	6.4
Depression score	1.2	1.9	2.8	3.6	2.6	3.5
General	(n = 22)		(n = 99)		(n = 121)	
Age [y]	29.2	5.0	28.3	4.7	28.5	4.7
Height [cm]	168.5	6.9	170.5	8.1	170.2	8.0
Weight [kg]	70.0	14.6	75.0	14.2	74.1	14.4
BMI [kg/m ²]	24.4	3.2	25.7	4.0	25.5	3.9
FAI score	16.8	17.4	19.5	20.9	19.0	20.2
Anxiety score	2.4	2.8	3.1	3.4	3.0	3.3
Stress score	11.5	6.4	13.4	7.0	13.1	6.9
Depression score	2.0	2.3	3.2	3.7	3.0	3.5

BMI: Body Mass Index; FAI: Fonseca Anamnestic Index; SD: standard deviation; APP: Aircraft Approach Control specialty; ACC: Area Control Center specialty; *: comparisons with statistical significance (p < .05) and power ($\beta - 1 \geq .79$) by sex factor: female vs. male.

Source: authors



2.3 Materials

2.3.1 Signs and Symptoms of Temporomandibular Disorder

The Fonseca Anamnestic Index (FAI) is a clinically useful tool for assessing the severity of TMD signs and symptoms (FONSECA e colab., 1994). It consists of 10 questions and has high accuracy, sensitivity, and specificity (YAP e colab., 2021, 2022). It has a high correlation ($r = 0.95$) with the modified Helkimo Clinical Index for TMD (FONSECA e colab., 1994). The severity of TMD is determined using a scale of no dysfunction, TMD (low, moderate, and severe), and need-TMD treatment (moderate dysfunction and severe).

2.3.2 State of Psychological Distress

Participants' anxiety was assessed using the Generalized Anxiety Disorder questionnaire (SPITZER e colab., 2006), which has high reproducibility and internal consistency, with a Cronbach's $\alpha = 0.88$. Anxiety classification was determined using its own scale (JOHNSON e colab., 2019; KROENKE e colab., 2007). Stress was assessed using the 10-question Perceived Stress Scale, validated version in Brazilian Portuguese with good reproducibility: Cronbach's $\alpha = 0.83$ (LIST e JENSEN, 2017). The perceived stress rating criteria was determined according to its own scale (MACHADO e colab., 2014). Depression was defined using the nine-item Patient Health Questionnaire, which has a satisfactory Portuguese version: Cronbach's $\alpha = 0.75$ (LAMELA e colab., 2020). Depression classification was defined according to its own scale (SEARLE e colab., 2019).

2.4 Statistical Analyses

JASP statistical software for Windows version 16.1 (JASP Team, Amsterdam, Netherlands) was used for statistical analyses, and G.Power software (Franz Faul, Dusseldorf, Germany) was used for statistical power tests. A significance level of 0.05 was used for all statistical tests, followed by a statistical power of 0.80.

The data was analyzed using mean, standard deviation, and distribution, and ATC was compared between independent groups using ATC specialization and gender as independent variables - t-Student/ Mann-Whitney/ Fisher's Exact test (Table 1). Comparison tests were conducted between groups to confirm relationships between TMD and need-TMD-treatment, and Spearman's Correlation Coefficient tests were conducted on FAI score. (Table 2). The study used Fischer's Exact tests to assess the impact of ATC's psychological distress on TMD prevalence and the need for TMD treatment, accompanied by the calculation of the prevalence ratio (PR) to confirm the magnitude of these effects on the respective classification variables (Table 3).

To broaden and enrich the discussion of this study, the proportion (in percentage) of ATC with TMD and need-TMD treatment in this study was compared to the proportions of the adult



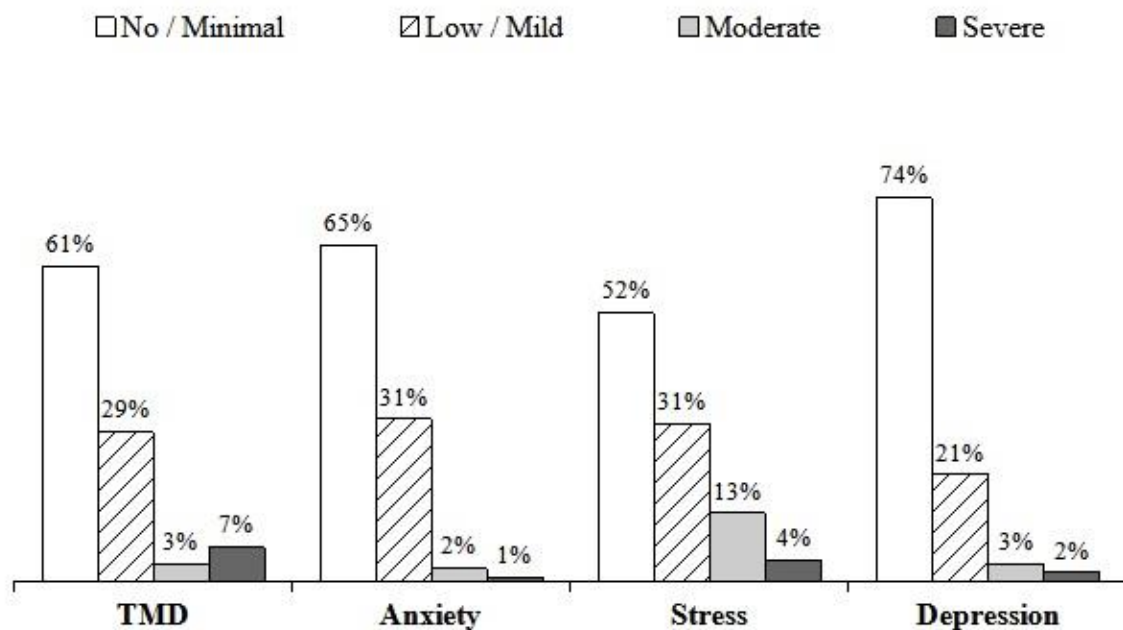
population in the studies by Valesan and co-authors (2021) and Okeson (2008), respectively, using the Goodness-of-fit Chi-squared test.

3 Results

The study found that air traffic control specialty and gender did not significantly influence psychological distress and TMD among volunteers ($p > .05$; Table 1). There was no difference ($p > .05$) in TMD prevalence in ATC based on sex, with 22 women having TMD (39.3%), 6 needing TMD treatment (10.7%), and 25 men having TMD (38.5%) and 6 had need-TMD-treatment (9.2%).

A study of 121 ATC found that 38.8% have TMD, with 12 (9.9%) need-TMD treatment, 47.9% did not show any distress, while 52.1% had at least one psychological distress. Of those, 22.2% had anxiety, 88.8% had stress, 32.1% had depression, and 34.9% had comorbidities. The results suggest that a significant portion of ATC have TMD (Figure 2).

Figure 2. Temporomandibular prevalence and state of psychological distress of air traffic controllers.



Source: authors

A significant percentage of ATCs exhibit high levels of stress. The TMD of ATCs showed a direct relationship with anxiety, stress, and depression profiles, with moderate levels of significant correlation. Anxiety scores were significantly higher in ATCs with TMD (mean difference [range]: 4.0 [2.0 to 5.0] points) and those need-TMD treatment (mean difference [range]: 3.0 [2.0 : 5.0] points) compared to those without disorder (Table 2). These differences are clinically relevant anxiety (TOUSSAINT e colab., 2020). The perceived stress of ATC with TMD or need-TMD



treatment was significantly higher than no-TMD, respectively (mean difference [range]: 4.0 [2.0 : 7.0]; and 4.5 [0.7 : 8.2] points). These results reveal a significant difference in perceived stress symptoms between ATC with TMD and no-TMD, exceeding the clinically important threshold for stress (DRACHEV e colab., 2020).

Table 2: Comparisons of TMD and age, anthropometric and state of psychological distress of ATC; and correlations between them

	no TMD [n: 74]		TMD ^a [n: 47]			need-TMD treatment ^a [n: 12]			FAI score [n: 121]	
	M	SD	M	SD	<i>p</i>	M	SD	<i>p</i>	<i>Coef</i>	<i>p</i>
Age [y]	28.0	5.0	29.0	4.6	.20	28.0	3.6	.89	0.15	.11
ATC time [years]	7.5	4.7	8.8	4.7	.09	7.5	3.3	.74	0.14	.11
Weight [kg]	73.1	13.8	75.8	15.3	.32	71.5	8.6	.85	0.05	.62
Height [cm]	170.4	7.3	169.8	9.1	.67	170.1	7.3	.88	-0.05	.60
BMI [kg/m ²]	25.0	3.4	26.2	4.6	.19	24.7	2.8	.97	0.08	.41
Anxiety score	1.6	2.2	5.1	3.6	<.01 *	6.2	4.1	<.01 *	0.61	<.01 *
Stress score	11.3	5.9	15.9	7.5	<.01 *	15.8	7.0	.02	0.36	<.01 *
Depression score	1.9	3.0	4.8	3.6	<.01 *	5.6	3.1	<.01 *	0.55	<.01 *

ATC: Air Traffic Controller. BMI: Body Mass Index; TMD: Temporomandibular Disorder. FAI: Fonseca Anamnestic Index; M: mean; SD: standard deviation; *Coef*: Spearman's correlation coefficient; a: Comparisons was performed with no-TMD group; *: statistical significance ($p < .05$) and power ($\beta -1 > .94$).

Source: authors

The study found that ATC with TMD or need-TMD treatment had significantly higher depression scores compared to no-TMD, respectively (mean difference [range]: 3.0 [2.0 to 4.0]; and 3.0 [2.0 to 5.0] points). ATC with psychological distress had a higher prevalence of TMD and need-TMD treatment, with increase nearly four times and 18 times respectively (Table 3). This indicates a correlation between ATC with TMD and anxiety, stress, and depression symptoms, highlighting the significant impact of ATC psychological distress profiles on TMD prevalence.

4 Discussion

This study aimed to investigate the prevalence of TMD in ATC and its relationship with psychological distress, focusing on the high stress level of the public (INOUE e colab., 2012; WU e colab., 2016). TMD mainly affecting adult women aged 20-40 (CASANOVA-ROSADO e colab., 2005; GONÇALVES e colab., 2010; LIST e JENSEN, 2017; MANFREDINI e colab., 2011),



however, gender was not a significant factor in TMD prevalence in this study. Adult TMD prevalence was approximately 31.0% (VALESAN e colab., 2021), with 5.0% need-TMD treatment (OKESON, 2008). Comparing the results of present study with those by VALESAN e colab. (2021) and OKESON (2008), the ATC population did not show a higher TMD prevalence than the adult population ($X^2_{(1)}$: 3.48; p : 0.62), but those with need-TMD treatment had a significantly higher prevalence ($X^2_{(1)}$: 6.16; p : 0.013).

Table.3. Prevalence ratio for Temporomandibular Disorder according to state of psychological distress

	TMD				need-TMD-treatment			
	n	f.(%)	p	PR	n	f.(%)	p	PR
No Psychological Distress	58	14 (24.1)	(ref)		46	2 (4.3)	(ref)	
Anxiety	1	1 (100.0)	.26	4.1	0		na.	
Stress	36	14 (38.9)	.17	1.6	23	1 (4.3)	1.0	1.0
Depression	4	3 (75.0)	.06	3.1	3	2 (66.7)	.02 *	15.3
Any Psychological Distress	63	33 (52.4)	< .01 *	2.2	40	10 (25.0)	.01 *	9.2
Anxiety + Stress	2	2 (100.0)	.07	4.1	0		na.	
Anxiety + Depression	0		na.		0		na.	
Stress + Depression	10	4 (40.0)	.44	1.6	9	3 (33.3)	.03 *	7.6
Anxiety + Stress + Depression	10	9 (90.0)	< .01 *	3.7	4	3 (75.0)	< .01 *	17.7

TMD: Temporomandibular Disorder. *f.* absolute frequency. %: relative frequency. *PR*: prevalence ratio; (ref): reference group to comparisons with; *: statistical significance ($p < .05$) and power ($\beta - 1 > .90$) for Fisher's Exact test; na.: no analysis.

Source: authors

This study reveals that the ATC's TMD susceptibility profile is similar to previous studies on military personnel. In a study of 300 Malaysian Army male paratroopers (30.1 ± 5.9 years), 43.0% had positive TMD signs and symptoms (DOLLAH e colab., 2019). In another study with 2043 Singapore Armed Forces personnel, 36.0% reported at least one TMD sign or symptom (TAY e colab., 2019).

A study in Brazil found that 49.3% of military police officers (24.8 ± 3.4 years) had TMD, with 10.8% need-TMD treatment (CAVALCANTI e colab., 2011). This indicates that the military



profession is a significant factor in the involvement of TMD, including in the ATC profession. However, ATC are exempt from exposure to imminent risks to their physical integrity compared to police officers, infantry, and paratroopers. Therefore, there are another factors that influence TMD in ATC.

It is peculiar to ATC to make decisions about aircraft trajectories to ensure the safety of the flow of flights. This operational context configures a factor in which ATC are subjected to psychological distress such as stress (RODRIGUES e colab., 2018), depression (STEVELINK e colab., 2020) and anxiety (COLLINS e colab., 1991; POMYTKINA e colab., 2021), corroborating with our study. The expressive prevalence of psychological distress in the ATC, especially in terms of stress, indicates that the air traffic control environment is an influential factor in the psychological status of the ATC.

The prevalence of TMD symptoms in ATC was higher with presence of psychological distress, particularly with severe symptoms. Individuals with TMD have higher depression, anxiety, and stress scores compared to those without TMD (DOLLAH e colab., 2019; TAY e colab., 2019). A prospective cohort study found a higher incidence of TMD in individuals with altered psychological status. A relative risk for TMD with joint pain or TMD with muscle pain was greater than 1.7 for individuals with depression or anxiety (KINDLER e colab., 2012). A case-control experimental design study found that individuals with need-TMD-treatment showed higher psychological distress scores compared to other participants (YAP e colab., 2022). Patients with TMD also have comorbid anxiety (OKESON, 2008) and a high prevalence of depression (CANALES e colab., 2018; OKESON, 2008). The psychologically challenging environment of ATC can indirectly favor the development of TMD in ATC, considering the association between TMD and psychological status.

ATC job is performed by varying work periods, causing frequent alternations between day and night work. Changes in circadian and sleep-wake cycles are known to be harmful to the subject's psychophysiological profile (BOIVIN e BOUDREAU, 2014). Cross-sectional observational study carried out with 510 Chinese (31.06 ±14.40 years old) related TMD, psychological states and sleep disorders, and found an increase in the prevalence of TMD with myofascial pain due to the comorbidity between sleep disorders and psychological distress (FU, 2015). Therefore, the shift work performed by the ATC has the potential to influence the psychological distress and the TMD of the ATC.

The prevention and monitoring of TMD in ATC is crucial, as dentistry professionals recognize ATC as a susceptible group to mandibular joint disorders, and regular dental follow-ups and coordination among professionals are recommended.



5 Conclusion

Military air traffic controllers have a high prevalence of temporomandibular disorders and a relationship with psychological distress. The prevention actions and monitoring of TMD in ATC is relevant in military medicine.

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