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THE LACK OF KNOWLEDGE ABOUT STRESS IN AIR TRAFFIC CONTROLLERS: A SYSTEMATIC REVIEW

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ABSTRACT

Introduction: The success of air travels depends on air traffic controllers (ATC). ATCs are responsible for monitoring airspace, keeping the flow of air traffic safe, providing route information, and support for pilots during flight. All these responsibilities can cause an increase in the chance of developing physical and mental stress. **Objective:** the objective of this study was to carry out a systematic review about psychological and physiological stress in ATCs. **Method:** This article is a systematic review about stress in ATCs. Observational studies and randomized controlled trials were included in our sample. The studies quality were assessed by level of evidence and compliance with CONSORT/ STROBE checklists**. Results**: Of the initial 61 articles located in the databases, only 5 composed the final sample. They were all observational studies: 2 cohort studies (level of evidence IV) and 3 cross-sectional studies (level VI). The average overall STROBE score was 22 out of 44 (dp= 8.02). **Conclusion:** Although ATCs had physical and emotional disorders, we cannot say they have increased levels of stress. ATCs' age and years of work experience are positive predictors for stress.

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INTRODUCTION

Excellent communication skills and fast thinking are essential traits in air traffic controllers (ATC). Because they are constantly under great pressure while on duty, ATCs need assertive decision-making skills. Above all, ATCs have an incredibly large responsibility, because one single mistake may have tragic consequences to hundreds of people (Mendes and Santos, 2013). Their stressful daily work routine is associated with high security levels. In addition, they need to reconcile their work demands with social and family duties (Mendes and Santos, 2013). In most countries, the armed forces supervised ATCs, because of their responsibility of maintaining the military airspace. Therefore, ATCs are submitted to rigorous military regulations and laws that are fundamental characteristics of the armed forces (Carrettaand King, 2008). Therefore, ATCs may be more susceptible to stress.

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Some authors report that after 10 years of continuous work, ATCs may develop chronic stress, anxiety and depression (Ribas, Martins and Viana, 2011). Excessive stress may cause psychological and emotional reactions, which lead to mental exhaustion, reduced attention span and loss of short-term memory, as well as anxiety and mood swings (Lipp, 2009; Attell, B.K., Kummrow Brown, K., and Treiber, L.A., 2017). Occupational stress occurs when work demands act as stress factors that surpass the person's ability to cope with such demands and cause negative reactions. "Burnout" refers to the lack of motivation, and the physical, emotional and psychological exhaustion that result from the mismatch between one's poor coping mechanisms and their job demands, which may be extremely stressful and fatiguing (Bianchi, Shonfeld and Laurent, 2015). Because aviation in general comprises several mentally challenging activities, continuous assessment of stress levels in all the professionals involved, including ATCs, is fundamental for keep air space security. Therefore, the objective of this study was to carry out a systematic review about stress in ATCS.

Table 1. Description of the selected studies

Author	Samplesize	Characteristics of participants	Variables	Research tool	Results
Zeier, 1994	205 ATCs	199 male 6 female Average age 42 years	Physical, emotional and social aspects Salivary cortisol dosages Measurements in February (lighter workload) and in May (heavier workload)	Questionnaires -Van Zerzen- physical -Beck – depression -Ulrich- emotional	10 a 15% of the sample had higher levels and symptoms of psychological stress and depression. Higher levels of salivary cortisol were related to heavier workload but not to signs of physical and emotional stress. Absenteeism was strongly related to depression and exhaustion. Although ATCs are under great pressure, their level of stress is similar to other professionals.
DELL´Erba, Venturi & Rizzo, 1994	109 ATCs	109 male Average age 40.3 years Professional experience 20.21	Social demograhics Assessment of physical exhaustion (PE) and emotional exhaustion (EME)	RomeBurnoutInventory (RBI)	PE = inadequate internal consistency (α= .22) EME = greater with anxiety (p=.023), depression (p=.007) and loss of emotional control(p= .001). Burnout increases with age, work experience and stress factors at work.Support from family and friends has a negative impact on stress.
Costa, 2000	762 ATCs	100% male Average age 43.6 years Professional experience 19.3	Clinical and emotional symptoms	-Standard Shiftwork Index- for clinical symptoms -Modified version of the Royal Air Force/ Institute of Aviation Medicine (RAF IAM)- for stress factors	Prevalence of physical and emotional disorders in ATCs was lower or similar to general population, except for heart ischemia. ATCs had higher prevalence rates of heart ischemia according to their age: between 40-44 years (2.10/0.92%); 45-49 years (2.59/1.30%); 50-54 years (4.26/1.19%); 55-59 years (5.26/1.88%).
Martinussen & Richardsen, 2006	209 ATCs	29 female 181 male Average age 40.3 years	Demographic, social Clinical and psychological, related to stress	Questionnaire MBI-GS (assesses 3 aspects: exhaustion, cynicism and inefficacy)	ATCs had lower exhaustion scores (1.72) than journalists (2.63) and construction workers (2.55), but higher than police officers (1.38).Burnout rates increase with age. Emotional exhaustion hadhigher correlation with health problems, especially less severe symptoms such as back pain or sleep disorders. Burnout predisposes to psychosomatic disorders (r^2= .48) and absenteeism (r^2= .4). Conflict at work is a predicting factor for all three aspects of Burnout.
Ribas, Martins & Viana, 2011	30 ATCs 15 operators of the Air Force Information Service (AIS)	4 study groups: - AIS > 10: n= 8 aged 30-45 years, over 10 years of work experience. - AIS < 10: n= 7 aged 18-29 years, less than 10 years of work experience - ATC >10: n= 15 aged 30-45 years, over 10 years of work experience. -ATC<10: n=15 aged 18-29 years, less than 10 years of work experience	Hematology, Hemoglobin Platelet count, Nitric oxide Immunology: leukocyte and monocyte count; Cortisollevels.	Bloodsamples	Stress seems to affect the immunological response of ATCs with over 10 years of work experience. Dosages at 8 and 14 h: - ATC>10: Hemoglobin (14.44/14.35) Monocytes (.905/ .799) Leukocytes (5.393/5.733) Cortisol (9.91/9.61) -ATC < 10: Hemoglobin (14.81/14.93) Monocytes (.820/ .799) Leukocytes (5947/6180) Cortisol (10.77/5.93) - AIS > 10: Hemoglobin: (15.33/15.03) Monocytes (.914/ .888) Leukocytes (6.388/6.388) Cortisol (9.21/6.49) - AIS < 10: Hemoglobin (15.47/15.36) Monocytes(.734/ .733) Leukocytes (6871/7243) Cortisol (10.71/7.96) Phagocytosis rate: AIS > 10: 27.13 AIS < 10: 25.86 ATC > 10: 22.80 ATC< 10: 26.07

MATERIALS AND METHODS

We performed a systematic review to evaluate the available knowledge on stress in air traffic controllers (ATCs).

Eligibility criteria: We included in our sample controlled trials and observational studies (cohort, case-control and cross-sectional) on the diagnosis of stress in ATCs, published either in English or Portuguese, between 1990 and 2017, about psychological and physiological stress. The option for select articles since 1990 is due a lack of publications on the subject. We excluded studies that the subject was: work procedures, management, professional self-image, as well as qualitative studies, case reports, letters, editorials, personal experience

Table 2. Study design results

	Zeier, 1994	Dell'Erba, Venturi & Rizzo, 1994	Costa, 2000	Martinussen & Richardsen, 2006	Ribas, Marins & Viana, 2011	Average	Standart Deviation	Compliance
Titleand Abstract 2/2	1/2	1/2	0/2	1/2	0/2	.6	.48	30%
Introduction 4/4	4/4	4/4	0/4	4/4	4/4	3.2	1.6	80%
Methods 18/18	15/18	6/18	2/18	4/18	5/18	6.4	4.49	35%
Results 10/10	8/10	4/10	7/10	7/10	6/10	6.4	1.35	64%
Discussion 8/8	8/8	5/8	2/8	6/8	6/8	5.4	1.95	67.5%
Funding 2/2	0/2	0/2	0/2	0/2	0/2	0	0	0%
Total 44/44	36/44	20/44	11/44	22/44	22/44	22	8.02	50%

reports, dissertations, theses, conference presentations and specialists' personal views. Articles were retrieved from the Pubmed, LILACS and BVS (VHL) databases.

Study selection

All titles and abstracts of the citations were screened independently by two reviewers, if there was a disagreement, a third research decided about the article selection. Articles were retrieved from the PubMed database using MeSH descriptors (*Aviation, Stress Psychological, Stress Physiological*) and keywords (*air control* and *air traffic controller*). Search strategies in the LILACS and VHL databases were based on DeCSterms *Aviation, Stress Psychological, Stress Physiological*, and keywords *air control* and *air traffic controller.*

Quality Assessment

To analyze the quality of the study sample, the selected articles were assessed according to their level of evidence and research structure. The level of evidence of the articles in this review was analyzed according to evidence-based practice criteria (Galvão, Sawada and Trevizan, 2004). Study design was analyzed according to guidelines from STROBE. The STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) initiative was developed for better assessment of observational studies. The STROBE checklist has 22 items, including title and abstract, methods, results, discussion and funding information (Von Elm *et al*., 2008).
Three independent researchers assessed 22 items of the selected articles, using STROBE for observational studies and CONSORT for RCTs. The researchers rated each item 0 to 2, according to the following criteria: 0 if the study did not have the information required, 1 if it had incomplete information and 2 if the required information was fully described. Each article had its overall score determined. For the total and for every item on the checklist, we determined the average score of the sample, its standard deviation and rate of compliance with the STROBE guidelines.

RESULTS

Search Results

Initially, 62 articles were located on the searched databases by their title and abstract. However, 41of them were excluded according to our inclusion and exclusion criteria. Twenty studies were retrieved and assessed in full, but only 5 were selected for the final sample of this review. They were all published in English.

Description of the selected studies

In Table 1, we present a brief summary of the 5 selected studies with the following data: author, study sample, characterization of the sample, study variables, research tools and study outcomes.

Study design assessment

Table 2 shows the STROBE score of each one of the sample studies, their average and standard deviation. The study by Zeier, 1994 had the highest overall score (36/44), whereas the study by Costa, 2000 had the lowest score (11/44) of all.

DISCUSSION

Although the correlation between ATC's work and the development of stress may seem apparent at first, there is actually a very small number of studies on the subject. For this review, only 5 studies were selected for analysis, because most of the pre-selected studies were related to other issues, such asshift patterns, work procedures, the professional's self-image and attention span at work, with no mention to stress levels. Our final sample for this review consisted of studies from four countries: Italy (2), Brazil (1), Norway (1) and Switzerland (1). One possible explanation for the small number of studies on the subject may be the close relation ATCs have with the armed forces (Mendes and Santos, 2013; Carreta and King, 2008). Air traffic control in most countries is performed by either militaries themselves or civilians employed by the armed forces, since control and defense of a country's airspace are simultaneous and intertwined activities. The rigid structure and ideals of the armed forces value authority, force and power, as well as hierarchy, with very little flexibility (Mendes and Santos, 2013). This environment does not welcome research that might expose institutional issues, which makes it more difficult for researchers to have access to ATCs and thus evaluate their level of stress more thoroughly.

This connection also has an impact on the type of study available. No randomized controlled trials were found in our search, and the reason for the lack of RCTs may be due to the need for longer and greater involvement of the researchers with the ATCs, depending on the study design and intervention evaluated. Since our sample comprised only observational studies, we employed the STROBE Statement to evaluate the study design. STROBE provides a checklist of items that should be included by researchers in their articles in order to report observational studiesas clearly as possible. STROBE may also be employed as an instrument to evaluate the quality of an article and the errors made by the authors. In this review, the studies had an average STROBE score of 22 out of 44 points. In other words, only 50% of the items evaluated in our

sample studies complied with the checklist, which demonstrates that the authors failed to report their research and results in the most adequate fashion. When the articles are analyzed by sections, it becomes clear that the major mistakes are usually in the title and abstract, methods and funding sections. Thorough diagnosis of stress depends on the presence of both physical and emotional symptoms that may be more or less intense (Noble, 2002). Four out of all the evaluated studies assessed both physical and emotional aspects of stress. However, each study employed a different tool for the analysis: the MBI-GS questionnaire, the Standard Shiftwork Index, a modified version of the Royal Air Force/ Institute of Aviation Medicine (RAF IAM) survey, the Maintenance of Wakefulness Test (MWT) and the Rome Burnout Inventory (RBI). Different assessment tools focus on different aspects of stress, and therefore their results are less comparable. The study by Ribas, Martins and Viana, 2011 was the only one that focused solely on the physical aspects of stress (cortisol levels and hematological changes). Although these physical changes may suggest that ATCs will develop stress over time, they cannot be employed as a definitive diagnostic tool, because the study left out the psychological changes associated with stress. Martinussen and Richardsen, 2006 and Zeier, 1994 did not find increased burnout rates in ATCs when compared with other professionals, such as journalists or construction workers, despite the ATC's highly demanding careers. Costa reported similar or lower prevalence of most physical and emotional disorders in ATCs when compared with the general population. Heart ischemia, however, was more prevalent in ATCs and its rate increased with age: 40-44 years (2.10/0.92%); 45-49 years (2,59/1,30%); 50-54 years (4.26/1.19%) and 55-59 years (5.26/1.88%). On the one hand, these results may seem unexpected due to the ATC's job attributions and work conditions. On the other, they may be explained partly by the selection process for the job. During military training, those with greater physical and mental resilience and concentration, and longer attention span are gradually directed to air traffic controltraining courses. Therefore, there is a selection of individuals who are more resistant and less prone to stress (Itani, 2009).

The most frequent physical disorders observed in ATCs are gastrointestinal disorders (gastritis, peptic ulcers and inflammatory bowel disease), back/chronic pain, and sleep disorders. DELL´Erba, Venturiand Rizzo, 1994 reported that physical complaints are correlated with anxiety (p= .023), depression (p= .007) and loss of emotional control (p= .001), and lead to increased rates of absenteeism. It is also important to note that all the studies reported an association between stress, age and years of experience. The rates of several stress symptoms (emotional exhaustion and physical disorders) increase with the ATC's age and years of experience. This may be observed, for example, in blood cortisol levels, which increase in situations of stress. Ribas, Martins andViana, 2011showed that ATCs with over 10 years of work experience and older age had higher blood cortisol levels than younger ATCs with less than 10 years of experience. Like the alterations finding with cortisol, stress may cause others hormonal changes. Recently studies show that psychological stress could be a risk factor for lipid disorders (Assadi, 2017) and myocardial ischemia in patients with coronary heart disease (Boyle *et al*., 2013). The main limitation of this article was the low number of publications on stress in air traffic controllers. Only five articles were found, and each one analyses different aspects of stress (psychological or physic). Another difficulty was the use of different stress scales for diagnostic, this characteristic harm to compare the finding results. Few countries have the concern to study this population, maybe cause the association with military activity.

Conclusion

After evaluating the selected studies, we cannot state that ATCs undoubtedly have increased rates of stress when compared with other professionals or the general population, even if they may seem under greater pressure because of their career demands. This lack of strong evidence is due to the low quality level of the analyzed studies, which were all observational with numerous methodological flaws. For that reason, we believe further research is necessary, in greater compliance with the recommended guidelines for carrying out such studies. Ideally, randomized controlled trials either employing the same tools for diagnosing stress or evaluating an intervention to reduce stress in ATCs, should be carried out in different populations in order to assess ATCs' burnout and its consequences properly.

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