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Organizational Contributions to Air Traffic Controller Mental Health: A Preliminary Study

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The global air traffic control (ATC) system is experiencing a persistent staffing shortage, raising concerns about its impact on controller mental health, safety, and workforce sustainability. Despite extensive research on aviation safety, empirical work on the psychological well-being of air traffic controllers remains limited. This study addresses that gap by evaluating symptoms of anxiety and depression among controllers and identifying organizational factors associated with psychological distress. Using an anonymous survey design, the researchers collected data from 92 air traffic controllers in U.S. and international settings. Anxiety and depressive symptoms were assessed using the Generalized Anxiety Disorder-7 (GAD-7) and Patient Health Questionnaire-9 (PHQ-9), and multiple regression analyses were conducted to examine the predictive effects of staffing levels, traffic volume, and sleep duration. Results indicate that a notable number of participants reported moderate to severe anxiety and depression, exceeding general population estimates. Across all models, staffing levels emerged as the most consistent and significant predictor of both anxiety and depressive symptoms, with higher staffing associated with substantially lower symptom scores. Sleep duration was also a significant predictor of depressive symptoms, with shorter sleep associated with higher depressive symptom scores, whereas traffic volume was not. Additional demographic and employment variables demonstrated limited or inconsistent effects. These findings suggest that psychological distress among air traffic controllers is strongly influenced by organizational conditions, particularly chronic understaffing and inadequate recovery opportunities. Grounded in Maslach and Leiter's areas-of-work-life model of burnout, the results highlight mental health challenges among controllers and underscore the need for organizational and policy-level interventions. Improving staffing levels, optimizing scheduling to support recovery, and developing protected pathways for accessing mental health care are critical steps toward enhancing controller well-being and maintaining the safety and efficiency of the National Airspace System.

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Introduction

Over the past several years, significant media coverage has focused on the pilot shortage and pilots' mental health. However, until recently, there has been little discussion of the severe shortage of air traffic controllers and its potential impact on controller well-being (Duncan, 2023; Russell, 2023; Steel & Ember, 2023). The controller shortage has become a national concern with operational, economic, and safety implications. For example, in response to staffing shortages in the New York region, the Federal Aviation Administration (FAA) authorized airlines to reduce scheduled operations at major airports, including John F. Kennedy International Airport (JFK), LaGuardia Airport, and Newark Liberty International Airport, to minimize delays and disruptions (Duncan, 2023). Despite ongoing hiring initiatives, the FAA continues to face a shortage of approximately 3,000 controllers, while several critical facilities remain significantly understaffed (Wichter & Procell, 2025). The shortage has proven difficult to resolve due to controller retirements, lengthy training timelines, and constraints within the training pipeline, prompting federal efforts to improve recruitment, retention, and training capacity (Craig, 2025; DOT, 2025; Genovese, 2025).

Public awareness of the air traffic controller shortage increased substantially following an investigative report by Steel and Ember (2023), which highlighted concerns about controller fatigue, mandatory overtime, and staffing shortages across the National Airspace System. Drawing on interviews with controllers, pilots, and FAA employees, safety reports, and federal records, the authors described a workforce struggling with high workloads and limited opportunities for recovery. Controllers interviewed for the report described working while fatigued and relying on substances such as caffeine, sleeping aids, and alcohol to cope with stress and sleep disruption. The investigation also documented a 65% increase in significant lapses in control during 2023 compared with the previous year and reported concerns among controllers that staffing shortages could result in a catastrophic accident (Steel & Ember, 2023). Just over one year later, a fatal midair collision occurred near Ronald Reagan Washington National Airport, further intensifying public and industry scrutiny of controller staffing and operational safety (NTSB, 2025).

While these reports have drawn attention to the operational consequences of understaffing, much less is known about the potential relationship between staffing shortages and air traffic controllers' mental health. Existing literature suggests that air traffic control is a high-stress occupation characterized by heavy workloads, shift work, fatigue, and limited recovery opportunities, all of which have been associated with burnout, anxiety, and depression (Imroz et al., 2022; Maslach & Leiter, 1997). However, research specifically examining mental health among air traffic controllers remains limited. The current study seeks to help address this gap by examining anxiety and depressive symptoms among air traffic controllers and exploring the organizational factors associated with those outcomes. Ultimately, the findings may help inform strategies to support controller well-being and improve workforce retention.

Literature Review

Shortage

A significant shortage of certified air traffic controllers (ATCs) exists in the United States. Unfortunately, the staffing shortage is not a new phenomenon and has not improved. In a review by the U.S. Department of Transportation/Office of Inspector General (DOT/OIG, 2023), 26 air traffic facilities deemed critical to the National Airspace System (NAS) by the Department of Transportation (DOT) were evaluated to determine staffing levels. The results showed that 77% of the 26 facilities were staffed below the Federal Aviation Administration (FAA) 85% threshold. Additionally, 96% of facilities failed to meet authorized staffing requirements for operational supervisors, and 73% failed to meet the required levels for traffic management coordinators (TMCs). Even more concerning, trainees made up 50% or more of staffing at facilities such as NY Terminal Radar Approach Control (TRACON) and Miami Tower, both of which are severely understaffed. According to air traffic facility managers, trainees should constitute less than 30% of the staff to ensure there are sufficient fully qualified controllers to train new hires effectively. Unfortunately, hiring controllers at a rate higher than controller retirements remains an ongoing issue, as the shortage of certified professional controllers (CPCs) threatens the safety of the NAS. The DOT/OIG (2023) recommended that the FAA reevaluate its workforce allocation, update staffing requirements, and enhance training.

The ATC workforce is critically understaffed, which directly affects NAS capacity (Wichter & Procell, 2025). When one area of the NAS is adversely affected by a shortage of controllers, the rest of the NAS is also affected (Duncan, 2023). Due to the organization of U.S. airspace, no specific region is isolated from others. If the FAA cannot find a way to increase the number of qualified controllers, we will continue to see flight cancellations and delays. These cancellations and delays impose a significant financial burden that the United States can ill afford, given current economic conditions. Additionally, staffing shortages could compromise safety, a concern that affects everyone. Many controllers work overtime to help offset the staffing shortages, which has been associated with increased fatigue and stress (Genovese, 2025).

Stress and Complexity

Air traffic control is a high-stress, complex job. Through a comprehensive literature review, Imroz et al. (2022) identified five factors consistently reported in the literature that directly contribute to air traffic controllers' job satisfaction. The first factor was ambiguity in the job function. The job functions of controllers are constantly changing in response to weather, traffic, and other environmental conditions. As a result, controllers must consistently apply high-level cognitive skills and knowledge to complex operations. The second factor influencing controller job satisfaction was the excessive workload. The researchers note that controllers’ jobs entail high performance expectations in high-complexity roles, significant responsibility, and heightened risk perceptions. All of these combined factors make air traffic control the fourth-highest-stress job in the United States. Another factor affecting job satisfaction was the high level of complexity, as well as rotating work schedules that disrupt controllers' circadian rhythms. Paired with the need for precision in job performance, controllers often experience high levels of stress and uncertainty, which can lead to fatigue.

Air traffic controllers experience both physical and mental fatigue due to high stress, long working hours, and the complexity of their tasks. The researchers cited Chen et al. (2019), who reported that 21% of incidents in the Aviation Safety Reporting System (ASRS) were attributed to pilot or controller fatigue. Furthermore, fatigue can lead to mental health issues, which in turn reduce controllers' ability to manage airspace safely. The final factor affecting controller job satisfaction was work-family conflict. Maintaining mental health requires a healthy work-life balance; however, many controllers struggle to achieve it. The rotating schedules, combined with emotional and mental exhaustion from the job, make it challenging for controllers to maintain a healthy work-life balance. The lack of balance, combined with high stress, overwhelming responsibility, and job uncertainty, may create workplace conditions associated with burnout, which is associated with mental, emotional, and physical exhaustion, cynicism, and ultimately can increase human error and compromise safety (Maslach & Leiter, 1997; Maslach et al., 2001).

Fatigue and Inadequate Recovery

Raduntz et al. (2021) assessed the mental workload of air traffic controllers under varying conditions. The researchers examined how participants' heart rate variability responded following an incident. The participants comprised 21 air traffic controllers from various airports and control positions. Raduntz et al. (2021) found that heart rate increased with workload, and that the increase was greater among less-experienced controllers. The findings demonstrated that increased workload has a direct physiological impact that is more severe among less-experienced controllers.

Hembree (2023) investigated the effect of fatigue on overworked air traffic controllers. The author concluded that air traffic controllers are overworked due to understaffing. The lack of rest is causing mental and physical problems that are often not reported to the FAA. According to Hembree (2023), controllers reported that being overworked may be associated with increased errors. Additionally, some controllers reported experiencing depression, anxiety, panic attacks, heart attacks, and other health issues. It is believed that many other controllers are suffering without reporting their physical and mental conditions to anyone. Hembree (2023) expressed concern that the lack of reporting will lead to disaster and increased dangers within the NAS.

Fatigue is a significant physiological issue experienced by controllers. Nealley and Gawron (2015) conducted an exhaustive literature review on fatigue and air traffic control. Focused on evaluating how shift-work, task complexity, workload, and performance affect controller fatigue. The literature revealed correlations between controllers' fatigue and age, family responsibilities, and sleep disorders, and supported the conclusion that fatigue significantly affects controllers' job performance (Nealley & Gawron, 2015).

Skypalova et al. (2022) conducted a quantitative survey to examine the effect of shift work on employee well-being. Participants included 1,049 shift workers from the Czech Republic, representing a variety of industries and ages ranging from 18 to 65. Results were analyzed using descriptive statistics, pivot tables, Pearson correlation coefficients, ANOVAs, t-tests, and chi-square tests. The authors concluded that shift work is one of the most physically and mentally demanding work schedules with the potential to cause anxiety and depression. Skypalova et al. (2022) found that 67% of participants experienced physical fatigue due to shift work. Additional issues included sleep disorders, depression (27%), headaches, and digestive issues. Interestingly, no statistically significant association was found between workers' industries and the negative impacts they reported resulting directly from shift work. The findings suggest that shift work has definite physical and mental impacts. However, the data suggest that allowing workers to choose their work schedules may have positive effects, mitigating the adverse physical and mental effects of shift work and improving productivity. This finding is also consistent with the areas-of-work-life model, specifically the control dimension, which refers to an employee's ability to influence their work or workplace (Maslach & Leiter, 1997).

Similar to Skypalova et al. (2022), Lee and Park (2022) conducted a study to identify a connection between workers' shifts and their experience of depression and anxiety. Participants included 269 full-time employees, a mix of shift and day workers, of both genders. The authors found that symptoms of depression and anxiety were significantly higher in women who worked 40 or more hours each week and identified as day workers, compared to those who worked fewer than 40 hours. Additionally, both male and female shift workers and male day workers who worked more than 52 hours a week showed significantly higher symptoms of depression and anxiety compared to those working less than 40 hours. The results were consistent across gender and shift types. These findings suggest that employees working extended hours may report higher levels of depression and anxiety symptoms.

Additionally, Bongo and Seva (2021) conducted a quantitative study examining how workload influences controller fatigue and, in turn, how fatigue affects situational awareness among controllers. A total of 13 controllers at an air traffic facility in Manila, Philippines, participated in the study. The researchers collected both objective and subjective (self-reported) data, including acoustic probes (SPAM) and the Samn-Perelli fatigue scale. The results indicated that controllers' decision-making ability was impaired by fatigue. Additionally, a loss of situational awareness was associated with fatigue; however, experienced controllers were less affected than less experienced controllers, which aligns with Raduntz et al.'s (2021) findings. As controllers grew more fatigued, they relied more heavily on radar and other auxiliary equipment to verify their accuracy. As fatigue increased, overall situational awareness declined, and controllers tended to rely more on internal memory, which further reduced accuracy. An inverse relationship was found between fatigue and workload, which the researchers attributed to the time of day: evening shifts had the highest traffic, whereas controllers experienced the least fatigue. Conversely, night shifts had the lowest traffic volume, and controllers experienced the greatest fatigue.

Chang et al. (2019) assessed fatigue levels among controllers at the Taiwan Taoyuan control tower to identify contributing factors. Thirty-two controllers participated, completing the Samn-Perelli fatigue scale surveys at specified times during their shifts. The analyses indicated that controllers experience higher levels of fatigue when working night shifts, most likely due to disruption of their circadian rhythms. Additional findings include variability in fatigue levels across each controller's shift, influenced by break timing and shift start and end times, as well as evidence of impairment following "successive days of sleep restriction" (Chang et al., 2019, p. 7).

The study conducted by Chang et al. (2019) demonstrated the importance of breaks for controller recovery. Bennett et al. (2020) conducted a study to examine the impact of microbreaks on employees' well-being and recovery. Bennett et al. (2020) also explored how different activities during microbreaks affected workers' recovery. The mixed-methods study included two separate data collections. The researchers' qualitative findings identified four themes related to microbreaks: outcomes, duration, activities, and recovery. Participants reported that microbreaks helped them restore energy and attention, though the ideal duration varied among individuals. Participants described psychological detachment, enjoyment, and relaxation as benefits of taking microbreaks. The quantitative data demonstrated that participants were able to recover from fatigue more quickly than they were able to regain vigor and attention. Furthermore, one-minute work breaks were more effective than longer breaks, a finding that may be important in high-demand occupations such as air traffic control.

Mental Health Impacts

Research shows that high workloads and poor social interactions at work are related to mental and physical health problems. Repetti (1993) conducted a three-day study of 52 air traffic controllers at a major international U.S. airport to assess how social interactions and workload affect their physical and mental health. The results demonstrated a link between social interactions at work and the participants' moods. Additionally, a significant connection was found between increased traffic volume and negative mood. Poor social interactions also increased the number of health complaints. Repetti (1993) concluded that negative social interactions significantly affected controllers' moods.

Repetti's (1993) findings indicated a potential for long-term mental health impacts resulting from short-term negative moods. The controller participants who handled increased workloads were more withdrawn upon returning home. Repetti (1993) noted that controllers smoked more and drank more coffee as workloads increased, suggesting they self-medicated to cope with high stress and workload. These findings are significant, as they suggest that both workload and workplace relationships affect controllers' mental health, providing early evidence that organizational conditions significantly influence controller well-being.

More recently, Lagerberg and Lane (2023) conducted a qualitative study to evaluate the mental and physical health of air traffic controllers. The authors used an interview protocol to interview an unspecified number of air traffic controllers. The researchers found that controllers failed to seek help for both mental and physical health conditions out of fear of losing their jobs. ATC is a unique career that pays well and does not require a college degree. Controllers recognize this and are careful not to do anything that might result in a medical suspension. The participants acknowledged that using alcohol as a form of stress management is not a healthy coping mechanism. All participants had experienced burnout or knew someone experiencing burnout at the time of the interviews. Some controllers disclosed health problems such as being overweight, insomnia, mental health impacts from relationship issues, and cardiovascular problems. The results of Lagerberg and Lane's (2023) study support the idea that controllers are hesitant to seek help and will protect their jobs at all costs, regardless of potential negative impacts on health and NAS safety.

The effects of stress and the need for organizational support are further discussed by Allen (2024). Allen (2024) quotes industry professionals who argue for increased access to mental health support for air traffic controllers to improve controller well-being and overall NAS safety. According to Allen (2024), controllers are exposed to both acute and chronic stress, including high workloads and fatigue, as part of their profession. Controllers experience frequent high-stress situations and fatigue due to the nature of their work and the shortage of certified controllers. In addition, the controller shortage necessitates overtime, which has been associated with increased stress and fatigue. Prior research has associated chronic stress and fatigue with anxiety and depressive symptoms, raising concerns about the long-term effects on the controller workforce. Despite these concerns, many controllers often avoid seeking help for mental health issues because they fear losing their medical certification to control. The article by Allen (2024) also emphasizes the need for mental health interventions that do not risk the immediate loss of medical clearance. Additionally, Allen (2024) advocates for proactive risk management by integrating psychosocial risk management (PsRM) strategies into air traffic control to better identify potential mental health hazards and implement appropriate mitigation measures.

The concept of PsRM was further explored by Saik et al. (2024). The researchers employed a systems analysis approach to develop a process for more effective management of psychosocial risks (PsRs) in the workplace. The method identifies interactions among psychosocial risk factors, their likelihood of occurrence, and the resulting consequences, including severity. The authors created a new model using the bow-tie technique, which involved identifying threats, prevention measures, hazards, mitigation measures, and consequences, all related to psychosocial issues. Psychosocial risks also relate to employees' mental health, such as harassment and exposure to long-term high stress. ATC involves many psychosocial hazards linked to stress, which can lead to mental health disorders like anxiety and depression. The study by Saik et al.

(2024) presents a model for identifying potential psychosocial hazards, assessing the severity of consequences, and developing mitigation and prevention strategies. Given the high-stress nature of air traffic control and the ongoing staffing shortage, PsRM provides a useful framework for understanding how organizational factors may be associated with controller mental health outcomes and for developing targeted prevention strategies.

Collectively, the literature suggests that air traffic controllers operate in an environment characterized by significant stress, including high workload, fatigue, inadequate recovery, and barriers to seeking mental health support (Allen, 2024; Bongo & Seva, 2021: Chang et al., 2019; Hembree, 2023; Lagerberg & Lane, 2023; Nealley & Gawron, 2015; Raduntz et al., 2021; Repetti, 1993; Skypalova et al., 2021). While awareness of mental health in aviation has increased in recent years, meaningful change requires more than simply expanding access to treatment. According to DeHoff and Cusick (2018), "…visible change develops slowly" (p. 12). The airlines and unions now emphasize pilot mental health and encourage pilots to seek help when needed. The push is slowly spreading to air traffic control. However, these new initiatives will be successful only if they ensure the confidentiality of pilots' and controllers' information. Furthermore, pilots and controllers need better education on mental health and how to seek help (DeHoff & Cusick, 2018). As the aviation industry continues to expand its focus on mental health, addressing organizational stressors and reducing barriers to care remain critical to protecting both workforce well-being and aviation safety.

Avoidance of Mental Health

Pilots and controllers often avoid seeking therapy for mental health issues. The Aviation Medicine Advisory Service (AMAS, 2024) published an article that reviews various mental health disorders and their treatments. The authors also discuss reporting requirements and the conditions that may result in the suspension or revocation of FAA medical clearance. The article focuses on aviation medicine, particularly on pilots and controllers. Compared to other industries, pilots and controllers are more likely to avoid seeking help for mental health problems. The authors suggest that this reluctance stems from personality traits common in aviation personnel: "confident, independent, always in control, able to compartmentalize problems, and generally healthy" (AMAS, 2024, para. 5). Though AMAS encourages pilots and controllers to seek help, they acknowledge that certain conditions could result in suspension or revocation of FAA credentials. The main reason cited for avoiding mental health reporting or treatment is the fear of losing medical clearance. Although most mental health cases do not lead to credential loss, obtaining a special issuance medical clearance is challenging, and there is no guarantee the FAA will allow an individual to return to work after treatment. As a result, pilots and controllers are likely to avoid seeking help to prevent risking their credentials (AMAS, 2024).

In 2024, the Mental Health & Aviation Medical Clearances Aviation Rulemaking Committee (ARC) published a recommendation report, grounded in numerous empirical studies. The report's purpose was to identify barriers that impede pilots and controllers from seeking mental health support and to suggest methods to mitigate or eliminate them.

The report was informed by a panel of subject-matter experts, federal agencies, academics, industry professionals, and published research.

The ARC's (2024) report identified several barriers that may prevent pilots and controllers from seeking help for mental health concerns. These barriers include culture, trust, fear, stigma, financial impacts, processes, and knowledge gaps (ARC, 2024, pp. 18-29). The aviation culture is described as one that fears reporting medical issues, especially those related to mental health (ARC, 2024, p.19). Woven into the current culture is a lack of trust between pilots and controllers, which will be the most difficult challenge, as it is widespread across the industry and can contribute to a culture of non-reporting. The Committee further states that pilots and controllers do not trust the FAA, AMEs, the medical system, their employers, or the certification process. This distrust is paired with fear and a lack of understanding of the processes involved in medical clearances. Pilots and controllers often avoid reporting medical and mental health issues out of fear of losing their jobs (Hoffman et al., 2022). When they do report, the cost of regaining medical clearance is often prohibitive. In addition to losing income while awaiting clearance, pilots and controllers must also pay for additional medical tests and treatments required to regain their certification (ARC, 2024, pp. 26-29). Moreover, obtaining a special issuance can take years and involves complex paperwork. Lastly, the pilot and controller communities lack adequate knowledge and often rely on peers for guidance. Stories about the difficulties of the process are commonly shared among the pilot and controller communities and accepted as fact, fostering a culture of avoidance. Sadly, continuing to avoid seeking therapy perpetuates a culture that also avoids seeking help (ARC, 2024).

Controllers' avoidance of self-reporting is not limited to the United States. Under and Gerede (2020) conducted a quantitative study of 212 air traffic controllers in Turkey to examine why controllers voluntarily avoid reporting safety issues. Data were collected through a three-part survey with results indicating controllers avoid reporting because they accept the status quo and do not challenge it. The authors found no statistically significant association between demographics and non-reporting. Three key findings emerged from the data. First, controllers perceived that reports were being handled incorrectly and viewed the system as flawed. Second, they observed no change attributable to reporting. Third, they did not see the value in reporting. When controllers do not see positive results from reporting, they lose faith in its importance and perceive it as unnecessary. Additionally, controllers fear repercussions; they tend to remain silent to protect themselves. Furthermore, they fear being perceived as informants and aim to protect their colleagues (Under & Gerede, 2020).

The study by Under and Gerede (2020) is important because it demonstrates that every report must be addressed so controllers feel their reporting matters. Whether action is taken or not, feedback should be provided to ensure that reporters feel heard and that their reports are valued. Additionally, controllers need to understand that their reports are anonymous. Maintaining anonymity helps controllers feel safe when reporting and, hopefully, encourages them to report more proactively.

Theoretical Framework

This study is based on a burnout-inspired framework that places air traffic controllers' anxiety and depressive symptoms within the larger context of ongoing organizational stress. Burnout is considered a workplace issue resulting from prolonged exposure to unmanaged occupational stressors. According to the areas-of-work-life model, there are six areas of work life that can be out of balance: workload, control, reward, community, fairness, and values (Maslach & Leiter, 1997). An imbalance in any of the aforementioned areas between an employee and their job can result in burnout (Maslach & Leiter, 1997). Burnout is a workplace phenomenon resulting from prolonged exposure to workplace stressors, and it comprises three interrelated dimensions: emotional exhaustion, depersonalization or cynicism, and reduced personal accomplishment or inefficacy (Maslach et al., 2001; WHO, 2019).

According to Schaufeli (2006), systematic imbalances of demands and resources lead to burnout. Understaffing is one example of an imbalance between demands and resources that may be associated with multiple areas of work life. For example, as workload increases, the manageability of the work likely decreases. Control can also be negatively impacted as employees may not be able to influence their work or workplace as much as when they are fully staffed. Community could also be affected by staffing shortages, as workload increases and control decreases; social interactions may become infrequent or strained. Prior research suggests that ongoing workplace stressors are associated with an elevated risk of burnout (Maslach et al., 2001), which has been associated with increased employee turnover and turnover behavior (Leiter & Maslach, 2009), exacerbating the staffing issues facing air traffic controllers. It is important to note that burnout is not conceptualized as an individual employee's problem; rather, it is viewed as a problem of the workplace environment and, therefore, as the organization's responsibility to address (Maslach & Leiter, 2017). Maslach and Leiter's (1997) model shifts the focus from the individual controller to the organization, emphasizing the need for adequate staffing and recovery to reduce mental health risks for the controller population.

Methodology

This quantitative study evaluated the mental health status of air traffic controllers. The researchers employed purposive and snowball sampling methods to recruit participants, utilizing private social media groups and personal contacts. Due to the sensitive nature of the topic under assessment, data were collected via an anonymous survey. An IRB-approved recruitment script, along with a link to the survey, was posted by the principal investigator (PI) in private social media groups comprised primarily of practicing and retired air traffic controllers. The social media groups included both U.S.-based and international controllers. Participant eligibility was verified through self-reporting as a certified controller aged 19 years or older during the informed consent process. In addition, the research team sent the survey link and recruitment script to individual controllers known to the team members, requesting that they take the survey and share it with other controllers they knew. Recruitment occurred between May and August 2024.

Research Questions

Based on the literature demonstrating relationships among staffing shortages, fatigue, recovery, and psychological well-being in safety-critical occupations, this study examined the following research questions:

RQ1: To what extent do staffing levels, traffic volume, and sleep duration predict anxiety symptoms among air traffic controllers as measured by the GAD-7?

RQ2: To what extent do staffing levels, traffic volume, and sleep duration predict depressive symptoms among air traffic controllers as measured by the PHQ-9?

Measures

Demographic Questionnaire

The survey began with an informed consent statement assuring participants that their responses would remain anonymous and providing the principal investigator's contact information for any questions. Participants were informed: *By clicking "Yes" below, you indicate that you are an air traffic controller who is 19 years of age or older and that you voluntarily consent to participate in this study.* Those who selected "No" were exited from the survey, whereas those who selected "Yes" proceeded to the demographic section.

The demographic section included nine items designed to capture participant characteristics and employment details. Participants could skip any item, and all but one included a "Prefer not to say" option. Gender identity was assessed first (e.g., female, male, transgender, nonbinary), with an "Other" option and a text box for specification. Age was collected as a continuous variable. Marital status was assessed using categorical options (e.g., married, widowed, divorced, separated, single, other). Participants then selected their country of employment from a dropdown list of 196 countries.

Four subsequent items addressed employment characteristics. Employment status options included full-time, part-time, contract/temporary, retired, unemployed, and unable to work. Participants indicated their primary work setting (e.g., ATCT/Tower Control, TRACON/Approach Control/Terminal Control, ARTCC/ACC), using terminology consistent with both FAA and international standards; an "Other (please specify)" option was provided for additional detail. Staffing levels were reported as ranges (0–25%, 26–50%, 51–75%, 76–100%), and average annual traffic counts were categorized as (under 25,000; 25,000–100,000; 100,000–200,000; 200,000–1 million; more than 1 million). The final demographic item assessed sleep duration as a continuous variable.

Depression Assessment

The nine-item Patient Health Questionnaire-9 (PHQ-9) is a self-report Likert-type screening tool used to assess symptoms of major depressive disorder over the previous two weeks (Kroenke et al., 2001). Participants are asked to indicate how frequently they have been bothered by each symptom. Response options range from 0 (*not at all*) to 3 (*nearly every day*) for each item (e.g., little interest or pleasure in doing things; feeling down, depressed, or hopeless), producing a total scoring range of 0-27. Finally, if participants endorsed any items, they were to indicate how difficult the symptoms make daily life on a 4-point Likert scale ranging from "*not difficult at all"* to "*extremely difficult*." PHQ-9 scores of 5, 10, 15, and 20 represent thresholds for mild, moderate, moderately severe, and severe depressive symptom severity, respectively. Kroenke et al. (2002) reported internal consistency coefficients of Cronbach's $\alpha = .89$ in primary care and .86 in obstetrics and gynecology (OB-GYN) settings. PHQ-9 scores were highly correlated with mental health professional diagnoses of major depressive disorder (.84).

Anxiety Assessment

The Generalized Anxiety Disorder-7 (GAD-7) is a seven-item self-report measure used to assess symptoms of generalized anxiety disorder (Spitzer et al., 2006). This measure asks participants to endorse symptom frequency on a Likert-type scale from 0 (*not at all*) to 3 (*nearly every day*). Symptoms include "feeling nervous, anxious, or on edge" and "not being able to stop or control worrying." If participants indicated experiencing any symptoms, they are asked to rate the difficulty the symptoms cause in daily life on a 4-point Likert scale from "not difficult at all" to "extremely difficult." Scores of 0-4 indicate minimal anxiety, 5-9 indicate mild anxiety, 10-14 indicate moderate anxiety, and 15-21 indicate severe anxiety. Spitzer and colleagues (2006) reported an internal consistency of $\alpha =.92$.

Both the PHQ-9 and the GAD-7 have strong reliability and validity, take approximately five minutes to complete, and can be completed anonymously by controllers (Kalkbrenner et al., 2023). These attributes made the assessments ideal for this study.

Missing Data and Sample Preparation

A total of 92 participants completed both the GAD-7 and PHQ-9 instruments and were initially eligible for inclusion in the analyses. The initial 92 responses were used to calculate the distribution of anxiety and depression severity categories among participants. Prior to conducting regression analyses, four cases were excluded due to substantial missing data on key demographic and employment variables required as control variables, resulting in an analytic dataset of 88 respondents. The remaining data were then reviewed and recoded to address small cell sizes within several categorical variables. For example, staffing categories representing facilities staffed at 25% or less and 26%-50% were combined into a single reference category due to limited observations. Dummy variables were created for categorical predictors, and control variables were included in the regression models.

For the primary regression models examining staffing level, traffic volume, and sleep duration as predictors of anxiety and depressive symptoms, listwise deletion yielded a final sample of 80 participants because 8 respondents had missing data on one or more variables included in those analyses. Subsequent sequential regression models focusing on staffing and demographic control variables were estimated using data from 84 participants, as only 4 respondents had missing data for the variables included in those models. All exclusions were attributable to missing data; no cases were removed as outliers or for any other reason.

Analysis

All statistical analyses were conducted using R and Microsoft Excel. Prior to analysis, data were screened for missing values, outliers, and violations of multiple regression assumptions, including linearity, homoscedasticity, independence of errors, and multicollinearity. Breusch-Pagan tests indicated no significant heteroscedasticity (all $p > .05$), and variance inflation factors ranged from 1.05 to 2.44, suggesting that multicollinearity was not a concern. Inspection of Cook's distance values revealed no highly influential observations (all Cook's $D < .20$). Although residuals demonstrated some departures from normality, the violations were not considered severe enough to warrant modification of the analyses. Therefore, the regression models were retained. Descriptive statistics and bivariate correlations were computed to examine initial relationships among variables.

To address the research questions, a series of multiple regression analyses was performed to identify predictors of anxiety and depressive symptoms. The dependent variables (DVs) were generalized anxiety symptoms (GAD-7 scores) and depressive symptoms (PHQ-9 scores). Each DV was regressed on three independent variables (IVs): [staff, traffic, and sleep]. Sequential models were then used to evaluate whether staffing effects remained stable after demographic and employment-related controls were introduced.

Following this, control variables (e.g., age, gender, marital status) were entered sequentially to evaluate their incremental contribution and to determine whether the primary IVs remained significant after adjustment. This hierarchical approach enabled assessment of the robustness of the IVs as predictors of anxiety and depressive symptoms. Model fit was evaluated using R^2, adjusted R^2, and F-tests.

Staffing level was originally collected using four categories (0-25%, 26-50%, 51-75%, and 76-100%). Due to small cell sizes within the two lowest staffing categories, values were combined to create a reference category representing facilities staffed at 50% or below. Dummy variables were then constructed for the 51-75% and 76-100% staffing categories. Similar dummy coding procedures were used for traffic volume, sleep duration, facility type, and other categorical variables prior to regression analyses.

Because participants were permitted to skip survey items, missing data were present for several variables. Analyses were conducted using listwise deletion, so only cases with complete data on variables included in a given model were analyzed. Consequently, sample sizes varied slightly across models.

Results

A total of 168 respondents began the survey, but only 92 (55%) completed both the GAD-7 and PHQ-9 instruments. Of the 92 respondents, 47 (51%) were from the United States, and 45 (49%) were from international locations. In the current sample, the GAD-7 demonstrated excellent internal consistency in the sample ($\alpha = .91$, n = 92, k = 7), as did the PHQ-9 ($\alpha = .91$, n = 92, k = 9).

According to Spitzer et al. (2006), approximately 5% of the general global population presents with generalized anxiety disorder (GAD). On the GAD-7, individuals who demonstrate moderate to severe anxiety would typically be referred for further assessment and treatment (Sapra et al., 2020). That being said, nine (19%) of the U.S. participants and six (13%) of the international participants presented with moderate to severe anxiety (Table 1), significantly higher than the general population. However, it is important to note that the current sample is not generalizable due to the low response rate.

Table 1

Distribution of GAD-7 Anxiety Severity Categories Among U.S. and International Air Traffic Controllers

Anxiety Scale	*United States*		*International*	
	n	*%*	*n*	*%*
Minimal Anxiety	25	53.19%	24	53.33%
Mild Anxiety	13	27.66%	15	33.33%
Moderate Anxiety	3	6.38%	3	6.67%
Severe Anxiety	6	12.77%	3	6.67%
Total	47		45	

In addition, depression affects approximately 7% of the U.S. adult population and 5% of the global adult population (Chand & Arif, 2024; World Health Organization, 2023). Individuals scoring within the moderately severe to severe range on the PHQ-9 generally present with major depressive disorders (Kroenke et al., 2001). A total of six (12.77%) U.S. participants and five (11.11%) international participants presented with moderate-severe to severe depression (Table 2), both higher than the global average. Again, the results are not generalizable due to the small sample size.

Table 2
Distribution of PHQ-9 Depression Severity Categories Among U.S. and International Air Traffic Controllers

Depression Severity	*United States*		*International*	
	n	*%*	*n*	*%*
Non-minimal	23	48.94%	23	51.11%
Mild	10	21.28%	11	24.44%
Moderate	8	17.02%	6	13.33%
Moderately Severe	3	6.38%	1	2.22%
Severe	3	6.38%	4	8.89%
Total	47		45	

Regression Results

A multiple regression analysis was conducted on 80 completed cases (8 observations were excluded due to missingness) to determine whether staffing levels, traffic volume, and sleep duration predicted GAD-7 scores (Table 3). The model was statistically significant, $F(10, 69) = 2.79$, $p = .006$, explaining 29% of the variance ($R^2 = .29$, Adjusted $R^2 = .18$). Staffing was the only predictor that reached significance: compared to the reference staffing category (0–50%)(n=7), 51–75% staffing was linked to lower GAD-7 scores ($n=32$, $B = -8.36$, $SE = 2.18$, $t = -3.84$, $p < .001$), as was 76–100% staffing ($n=41$, $B = -5.99$, $SE = 2.14$, $t = -2.80$, $p = .007$). Traffic volume categories were not significant (ps = .59–.90). Sleep duration categories were also not significant (ps = .14–.91), although sleeping 8 hours showed a nonsignificant trend toward lower GAD-7 scores ($B = -3.97$, $SE = 2.63$, $t = -1.51$, $p = .14$).

Table 3
Predictors of GAD-7 Anxiety Scores: Staffing, Traffic Volume, and Sleep Duration

Predictor	B	SE	95% CI	t	p
(Intercept)	12.10	3.38	[5.48, 18.72]	3.58	0.001
Staff 51-75%	-8.36	2.18	[-12.63, -4.09]	-3.84	0.000
Staff 76-100%	-5.99	2.14	[-10.18, -1.80]	-2.80	0.007
Traffic 25K-100k	-1.06	1.94	[-4.86, 2.74]	-0.55	0.587
Traffic 100k-200k	0.72	2.10	[-3.40, 4.84]	0.34	0.734
Traffic 200k-1m	-0.25	1.92	[-4.01, 3.51]	-0.13	0.898
Traffic >1m	-0.90	2.02	[-4.86, 3.06]	-0.45	0.656
Sleep 5 Hours	1.17	2.52	[-3.77, 6.11]	0.47	0.643

Sleep 6 Hours	1.40	2.06	[-2.64, 5.44]	0.68	0.498
Sleep 7 Hours	-0.41	2.12	[-4.57, 3.75]	-0.19	0.847
Sleep 8 Hours	-3.97	2.63	[-9.12, 1.18]	-1.51	0.135

Note. N = 80, $R^2 = .29$, Adjusted $R^2 = .18$, $F(10, 69) = 2.79$, $p = .006$

The analysis shows that staffing levels is significant for anxiety. Controllers in facilities that are staffed above 51% score 8.36 points lower on the anxiety scale than those at facilities staffed at 50% or less. Those controllers at facilities staffed above 76% score almost 6 points lower. A decrease of 6-8 points on the GAD7 scale is the difference between moderate or severe anxiety and no or mild anxiety. Higher staffing levels were associated with lower anxiety scores.

Including age as a control variable resulted in a significant model (Table 4), $F(3, 80) = 6.84$, $p < .001$, $R^2 = .20$. Staffing remained significant (51–75%: n=32, $B = -8.42$, 95% CI [−12.59, −4.25], $p < .001$; 76–100%: n=41, $B = -6.26$, 95% CI [−10.34, −2.18], $p = .004$). Age was not significant ($p = .11$).

Table 4
Predictors of PHQ-9 Depression Scores: Staffing, Traffic Volume, and Sleep Duration

Predictor	B	SE	95% CI	t	p
(Intercept)	8.10	3.79	[0.67, 15.53]	2.14	0.036
Staff 51-75%	-7.12	2.44	[-11.90, -2.34]	-2.92	0.005
Staff 76-100%	-6.28	2.40	[-10.98, -1.58]	-2.62	0.011
Traffic 25K-100k	-0.13	2.17	[-4.38, 4.12]	-0.06	0.954
Traffic 100k-200k	3.90	2.36	[-0.73, 8.53]	1.66	0.102
Traffic 200k-1m	2.65	2.15	[-1.56, 6.86]	1.23	0.222
Traffic >1m	0.42	2.26	[-4.01, 4.85]	0.18	0.855
Sleep 5 Hours	6.76	2.82	[1.23, 12.29]	2.39	0.019
Sleep 6 Hours	4.56	2.30	[0.05, 9.07]	1.98	0.052
Sleep 7 Hours	3.18	2.37	[-1.47, 7.83]	1.34	0.184
Sleep 8 Hours	-0.35	2.94	[-6.11, 5.41]	-0.12	0.906

Note. N =80, $R^2 = .32$, Adjusted $R^2 = .22$, $F(10, 69) = 3.26$, $p = .002$

As was done with the GAD-7 analyses, the first PHQ-9 analysis evaluated staffing, traffic count, and sleep as factors. Just as with the GAD-7 analyses, staffing was significant. The analysis also had the same interesting outcome that controllers from facilities with moderate staffing (51-75%) had lower depression scores than those who reported full staffing. Again, numerous confounding factors that could explain this were not captured in this study.

A series of sequential regression models was conducted to evaluate the stability of the staffing effects after controlling for demographic and employment-related variables. Across all models, higher staffing levels consistently predicted lower anxiety and depression scores. Older age was associated with lower anxiety and depression scores. Marital status was also associated with lower anxiety scores but not depression scores. Sleep duration was uniquely associated with depressive symptoms, with shorter sleep linked to higher PHQ-9 scores. Other variables, including traffic volume, gender, and facility type, were not significant predictors.

Additional variables were added to the analysis one at a time, namely marital status, domestic or international location, full-time or part-time employment status, and type of ATC facility. None of these additional variables showed statistical significance. For controller depression scores, staffing, sleep, and age were the only significant factors identified in the data.

Staffing was a statistically significant factor for both anxiety and depression scores, as controllers at moderately staffed facilities (51-75% staffing) reported lower scores for both anxiety and depression than their counterparts at fully staffed (76-100%) facilities. Age also showed a minor mitigating effect on both anxiety and depression that was statistically significant. Married controllers had statistically significantly lower anxiety scores, but marital status was not statistically significant for depression. Complete regression results are reported in Appendix A.

Of the statistically significant factors, only sleep duration showed an increased effect, specifically increasing with 6 hours or less of sleep, and that was only on depression. While the anxiety data were not statistically significant, the model intercepts suggest a similar pattern may exist, although it was not statistically significant in the present study. Further research with a larger response rate may help clarify these relationships. Together, these findings suggest that anxiety and depressive symptoms in air traffic controllers are best understood not as independent outcomes, but may reflect interconnected responses to chronic work overload caused by continued understaffing and inadequate recovery.

Discussion

Air traffic control is a challenging career characterized by complex environments, high workloads, long hours, and inadequate recovery time (Imroz et al., 2022; Maxwell, 1986; Raduntz et al., 2021; Hembree, 2023; Ericsson et al., 2021). Based on existing literature, individuals exposed to high stress, shift work, long working hours, and poor social environments can experience symptoms of anxiety and depression; thus, the focus of this study is on evaluating the mental health of air traffic controllers. (Maxwell, 1986; Skypalova et al., 2022; Lee & Park, 2022; Repetti, 1993).

Anxiety

The results of the GAD-7 indicate that nearly 20% of U.S. controller participants and 13% of international controller participants were working with moderate to severe anxiety at the time of data collection. Individuals scoring that high on the GAD-7 in a medical office would be recommended for further evaluation and possible prescriptive treatment (Sapra et al., 2020), indicating that a substantial portion of controllers may be working while experiencing significant anxiety. However, the results of this study are not generalizable due to the low response rate. Regardless, considering the safety-critical nature of air traffic control, these findings raise concerns about the well-being of the controller population and systemic safety risks.

Importantly, staffing levels emerged as the most robust statistical predictor of anxiety across all regression models, remaining significant even after controlling for demographic and employment-related variables. Controllers working in facilities with staffing levels above 50% scored 6–8 points lower on the GAD-7 than those reporting staffing levels of 50% or less, a difference that represents a shift from moderate or severe anxiety to mild or minimal symptoms. Interestingly, controllers at moderately staffed facilities (51–75%) reported lower anxiety scores than those at fully staffed facilities. While the reasons for this finding are unclear, it may reflect unmeasured factors such as facility complexity, traffic characteristics, organizational culture, or differences in workload expectations. Regardless, staffing remained consistently associated with anxiety outcomes across all models, suggesting that staffing may represent more than a logistical concern. The findings further underscore the need for qualitative data to better understand these relationships.

From a theoretical perspective, these results align closely with Maslach and Leiter's (1997) areas-of-work-life model of burnout. Chronic understaffing creates a systemic imbalance between job demands and available resources, particularly in workload and control. As staffing levels drop, controllers may face increased cognitive and emotional demands, fewer opportunities for recovery, and less control over their work schedules. These conditions are known to increase emotional exhaustion and anxiety, particularly in jobs where the cost of errors is high (Maslach et al., 2001; Schaufeli, 2006). In the air traffic control environment, anxiety may reflect a prolonged state of hypervigilance due to workload rather than individual weakness.

Together, the findings support the idea that air traffic controllers may experience anxiety as a result of organizational gaps and not due to individual weakness. When systemic imbalances in workload, control, and recovery continue, anxiety may become more prevalent (Maslach & Leiter, 2017). Therefore, addressing anxiety among air traffic controllers requires organizational change in addition to coping strategies or clinical treatment. Specifically, facilities should focus on obtaining and maintaining adequate staffing levels to potentially support controller well-being.

Depression

According to Kroenke et al. (2001), individuals with PHQ-9 scores that are moderately severe to severe tend to present with major depression. Based on the results of this study, over 10% of the participants scored moderately severe to severe on the PHQ-9, indicating a potential of one in ten controllers working while meeting criteria for major depressive disorder at the time of data collection. The percentage of controllers reporting depressive symptoms indicates a potential impact on safety, performance, and long-term workforce sustainability.

Similar to the anxiety findings, staffing levels were a strong statistical predictor of depressive symptoms across all regression models. Controllers working in facilities with staffing above 50% reported significantly lower PHQ-9 scores than those in understaffed facilities, scoring 6-8 points lower. The difference in scores represents a difference between clinically significant symptoms and mild depression. The results support the need for adequate staffing at control facilities, as lower staffing levels were consistently associated with poorer mental health outcomes in this sample.

In contrast to anxiety, depression symptoms were also significantly associated with sleep, as controllers who reported getting five or fewer hours of sleep scored substantially higher on the PHQ-9. As sleeping too much or too little is one symptom of major depressive disorder, this finding is consistent with the diagnostic criteria and literature, which supports that insufficient sleep and inadequate recovery are strongly associated with individuals experiencing depression (Chang et al., 2019; Nealley & Gawron, 2015; Skypalova et al., 2022). The ongoing staffing shortage in air traffic control may contribute to fatigue-related conditions, including overtime requirements and reduced recovery opportunities.

According to the statistical analysis, age appeared as a protective factor for depression symptoms, with older controllers reporting slightly lower PHQ-9 scores. Although the results were statistically significant, the magnitude of the effect was small. One possible explanation is that controllers who remain in the profession longer may differ from those who leave in ways not captured by the current study. The resulting older workforce may develop coping mechanisms that enable them to continue despite the fatigue and stress associated with the job. Although causal conclusions cannot be drawn from the current study, the results suggest that efforts to improve staffing levels and to provide controllers with adequate recovery time between shifts warrant further consideration as potential strategies to support controller well-being.

It should be noted that although staffing levels were consistently associated with anxiety and depressive symptoms, these findings should not be interpreted as evidence of causation. The observed relationships may also reflect unmeasured variables such as facility complexity, organizational culture, workload distribution, subjective perceptions of staffing adequacy, or individual differences in coping. Future longitudinal and mixed-methods studies are needed to better understand these relationships.

Limitations

The current study is limited by the response rate. Air traffic controllers tend to avoid discussions related to mental health, making it challenging to obtain data (*Counseling, Depression and Psychological Support*, 2024). Of the 168 responses, only 92 were completed to a usable level. The Federal Aviation Administration (2024) employed over 14,000 air traffic controllers, with about 3,400 in training at the time of this study. This means that this sample represents only 0.3% of the total U.S. air traffic controller workforce and 0.4% of the certified professional controller workforce. Additionally, nearly half of participants were located outside the United States, and important differences in organizational structures, regulatory environments, and staffing practices across countries were not examined. Furthermore, recruitment relied on purposive and snowball sampling, which created the potential for self-selection bias. Individuals experiencing greater distress may have been more or less likely to participate. The sample size and low response rate limit generalizability to the broader air traffic controller population. Therefore, these findings should be viewed as exploratory and not definitive.

A barrier to participation in a study like this is the fear of disclosing a condition that could lead to termination. In the process of collecting data for this study via social media outlets, controllers pushed back against the data collection, citing concerns about the FAA's ability to use the data to harm their employment status. Several controllers made comments such as "Not today, FAA" and "Circle the wagons, boys! This 'academic' can promote controller health over our dead bodies!" The overt distrust of the FAA regarding mental health played a critical role in controllers' refusing to participate in the anonymous survey.

There is a stigma in the aviation industry surrounding mental health. While the FAA has recently changed its stance on mental health treatment and reinstatement of medical privileges following treatment (ARC, 2024), the consensus among the workforce in the aviation industry is that the FAA will punish those who admit to or seek help for mental health issues, whether that is true of the FAA or not. As one commenter stated, "we know the FAA will never act in our benefit nor understand how to, but only act to save face publicly." The hesitancy to participate in the study reinforces that fear and lack of trust act as barriers to both research and mental health interventions (ARC, 2024). This avoidance may indicate grossly underreported anxiety and depressive symptoms among controllers.

The study used the PHQ-9 and GAD-7, both self-report measures, which made the data subjective. While these measures are well-validated and reliable, they do not provide a clinical diagnosis. Nevertheless, both are widely used in research and clinical settings. The study's anonymous design, necessary due to the sensitive topic and the culture surrounding mental health in air traffic control, may have allowed some participants to falsely identify as controllers. The cross-sectional design impedes drawing conclusions about causality or the sequence of variables. Consequently, the findings should be viewed as exploratory rather than representative of the broader controller population. Additionally, the regression analyses describe relationships observed within the current sample and should not be generalized beyond the study participants without additional research.

Recommendations

According to the findings, increasing staffing at control facilities may be a promising intervention for controller mental health, based on the associations observed in this study. Across all regression models, staffing consistently predicted lower anxiety and depression scores. The score differences were significant, moving participants from levels requiring clinical intervention to much less severe levels. Therefore, staffing should not be seen as merely an organizational need but as a critical component of the mental health of the air traffic controller workforce and the safety of the National Airspace System.

According to Chang et al. (2019), the scheduling of controllers' shifts is directly related to the levels of fatigue they experience. Although our study focused on the presence of anxiety and depressive symptoms among air traffic controllers, prior research has associated fatigue with the development of mental health disorders (Bongo & Seva, 2021; Chang et al., 2019; Hembree, 2023; Nealley & Gawron, 2015; Skypalova et al., 2022). The shortage of qualified air traffic controllers makes it difficult to provide adequate time off, as many controllers are working 10-hour days, six days a week (NATCA, 2025). Even small improvements in recovery opportunities may reduce fatigue associated with depression.

When considering air traffic control, microbreaks may be a viable solution to help with controller mental health. Research shows that short, intentional breaks can promote cognitive recovery, helping to mitigate fatigue (Bennett et al., 2020). However, this type of intervention should not be used as a substitute for adequate recovery time and staffing, and it needs to be evaluated in an ATC environment.

Additionally, it is interesting that the amount of sleep and traffic levels were not significant in this analysis, as one might expect that less sleep and higher traffic levels would correlate with higher anxiety among controllers. The lack of significance may be due to a small sample size or to other confounding variables not identified in this study. Future studies with a generalizable sample size may better demonstrate associations between sleep and traffic levels with anxiety symptoms.

Finally, the FAA should continue to seek ways to increase access to mental health care for controllers. The current efforts, such as the proposed bill H.R. 2591, demonstrate that the government recognizes the importance of controllers having access to treatment, yet the widespread fear among controllers of medical disqualification persists. The FAA should work to create protected pathways for mental health evaluation and treatment that do not threaten immediate loss of employment due to loss of medical clearance to control. If the FAA cannot build trust among the controller population, controllers may remain reluctant to disclose symptoms or seek treatment.

Conclusion

Air traffic control is a safety-critical profession characterized by high cognitive demands, operational complexity, and limited tolerance for error. The current study aimed to explore the mental health status of air traffic controllers with regard to the presence of anxiety and depression. The findings indicate that a percentage of the population of controllers may be working while experiencing levels of anxiety and depression that would warrant clinical intervention. The fact that controllers continue to work while avoiding seeking care may pose a threat to the safety of the National Airspace System and, more importantly, to the health and well-being of the air traffic control workforce. The findings align with burnout theory (Maslach & Leiter, 1997) demonstrated by staffing being a consistent predictor of anxiety and depression across all regression models. The apparent imbalance between workload and recovery due to inadequate staffing is associated with psychological outcomes not attributable to individual controllers' weaknesses but to organizational issues beyond their control. The study’s findings suggest that organizational and policy-level changes warrant further consideration.

Although the cross-sectional design prevents definitive causal conclusions, the findings suggest significant associations between staffing levels, recovery opportunities, and anxiety and depressive symptoms among air traffic controllers. These associations were consistent across multiple regression models and align with prior research (Chen et al., 2019; Imroz et al., 2022; Maslach & Leiter, 1997; Maslach et al., 2001). Future research should build on the current study by using a generalizable sample size to better understand burnout levels and the mental health status of air traffic controllers. In addition, longitudinal studies are needed to examine how prolonged exposure to workplace stressors and a lack of recovery affect both burnout and controllers' mental health. Furthermore, qualitative data may provide rich insight into the lived experience of controllers and their existing coping strategies.

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Appendix A

Table A1

Multiple Regression Analysis Predicting GAD-7 Anxiety Scores With Age and Marital Status as Control Variables

Predictor	B	SE	95% CI	t	p
(Intercept)	16.63	2.55	[11.63, 21.63]	6.52	0.000
Staff 51-75%	-8.17	2.08	[-12.25, -4.09]	-3.93	0.000
Staff 76-100%	-5.91	2.04	[-9.91, -1.91]	-2.90	0.005
Age	-0.09	0.04	[-0.17, -0.01]	-2.12	0.037
Married Unmarried	-2.33	1.06	[-4.41, -0.25]	-2.19	0.031

Note. N = 84, $R^2 = .25$, Adjusted $R^2 = .21$, $F(4, 79) = 6.57$, $p < .001$

Table A2
Predictors of GAD-7 Anxiety Scores: Staffing Levels With Controls for Age, Marital Status, and Gender

Predictor	B	SE	95% CI	t	p
(Intercept)	15.54	2.92	[9.82, 21.26]	5.33	0.000
Staff 51-75%	-8.31	2.09	[-12.41, -4.21]	-3.97	0.000
Staff 76-100%	-5.99	2.05	[-10.01, -1.97]	-2.93	0.004
Age	-0.10	0.04	[-0.18, -0.02]	-2.16	0.034
Married Unmarried	-2.23	1.07	[-4.33, -0.13]	-2.08	0.041
Gender Male	1.37	1.77	[-2.10, 4.84]	0.77	0.441

Note. N = 84, $R^2 = .26$, Adjusted $R^2 = .21$, $F(5, 78) = 5.35$, $p < .001$

Table A3
Predictors of GAD-7 Anxiety Scores: Staffing Levels With Controls for Age, Marital Status, Gender, and Domestic vs. International

Predictor	B	SE	95% CI	t	p
(Intercept)	15.50	2.97	[9.68, 21.32]	5.23	0.000
Staff 51-75%	-8.31	2.11	[-12.45, -4.17]	-3.94	0.000
Staff 76-100%	-5.99	2.06	[-10.03, -1.95]	-2.91	0.005
Age	-0.10	0.05	[-0.20, -0.00]	-2.13	0.036
Married Unmarried	-2.23	1.08	[-4.35, -0.11]	-2.06	0.043
Gender Male	1.38	1.79	[-2.13, 4.89]	0.77	0.441
Domestic International	0.09	1.05	[-1.97, 2.15]	0.09	0.930

Note. N = 84, $R^2 = .26$, Adjusted $R^2 = .20$, $F(6, 77) = 4.40$, $p < .001$

Table A4

Predictors of GAD-7 Anxiety Scores: Staffing Levels With Controls for Age, Marital Status, Gender, Domestic vs International, Employment Status

Predictor	B	SE	95% CI	t	p
(Intercept)	15.71	3.03	[9.77, 21.65]	5.18	0.000
Staff 51-75%	-8.32	2.12	[-12.48, -4.16]	-3.92	0.000
Staff 76-100%	-5.99	2.07	[-10.05, -1.93]	-2.89	0.005
Age	-0.10	0.05	[-0.20, -0.00]	-2.14	0.035
Married Unmarried	-2.27	1.09	[-4.41, -0.13]	-2.07	0.042
Gender Male	1.36	1.80	[-2.17, 4.89]	0.76	0.450
Domestic International	0.11	1.06	[-1.97, 2.19]	0.10	0.918
Employ Status Other	1.35	3.54	[-5.59, 8.29]	0.38	0.704

Note. N = 84, R^2 = .26, Adjusted R^2 = .19, F(7, 76) = 3.75, p = .002

Table A5

Predictors of GAD-7 Anxiety Scores: Staffing Levels With Controls for Age, Marital Status, Gender, Domestic vs International, Employment Status, Facility Type

Predictor	B	SE	95% CI	t	p
(Intercept)	12.61	6.02	[0.81, 24.41]	2.09	0.040
Staff 51-75%	-8.03	2.18	[-12.30, -3.76]	-3.68	0.000
Staff 76-100%	-5.75	2.14	[-9.94, -1.56]	-2.69	0.009
Age	-0.12	0.05	[-0.22, -0.02]	-2.46	0.016
Married Unmarried	-2.31	1.14	[-4.54, -0.08]	-2.02	0.047
Gender Male	0.83	1.92	[-2.93, 4.59]	0.43	0.669
Domestic International	0.14	1.11	[-2.04, 2.32]	0.12	0.903
Employ Status Other	2.68	3.73	[-4.63, 9.99]	0.72	0.475
ARTCC / ACC	4.25	5.03	[-5.61, 14.11]	0.84	0.401

ATCT / Tower control	4.84	5.01	[-4.98, 14.66]	0.96	0.338
ATCT/TRACON	1.81	5.29	[-8.56, 12.18]	0.34	0.733
Employment place: Prefer not to say	8.17	7.09	[-5.73, 22.07]	1.15	0.253
TRACON / Approach Control / Terminal Control	3.96	5.17	[-6.17, 14.09]	0.77	0.446

Note. N = 84, R^2 = .30, Adjusted R^2 = .18, F(12, 71) = 2.49, p = .009

Table A6
Predictors of PHQ-9 Depression Scores: Staffing Levels With Control for Age

Predictor	B	SE	95% CI	t	p
(Intercept)	18.78	2.90	[13.10, 24.46]	6.47	0.000
Staff 51-75%	-8.03	2.47	[-12.87, -3.19]	-3.26	0.002
Staff 76-100%	-7.17	2.41	[-11.89, -2.45]	-2.97	0.004
Age	-0.12	0.05	[-0.22, -0.02]	-2.35	0.021

Note. N = 84, R^2 = .18, Adjusted R^2 = .15, F(3, 80) = 5.98, p < .001

Table A7
Predictors of PHQ-9 Depression Scores: Staffing Levels With Controls for Age, Marital Status

Predictor	B	SE	95% CI	t	p
(Intercept)	19.10	3.04	[13.14, 25.06]	6.28	0.000
Staff 51-75%	-7.98	2.48	[-12.84, -3.12]	-3.21	0.002
Staff 76-100%	-7.10	2.43	[-11.86, -2.34]	-2.92	0.005
Age	-0.13	0.05	[-0.23, -0.03]	-2.36	0.021
Married Unmarried	-0.47	1.27	[-2.96, 2.02]	-0.37	0.712

Note. N = 84, R^2 = .18, Adjusted R^2 = .14, F(4, 79) = 4.47, p = .003

Table A8

Predictors of PHQ-9 Depression Scores: Staffing Levels With Controls for Age, Marital Status, Gender

Predictor	B	SE	95% CI	t	p
(Intercept)	17.48	3.47	[10.68, 24.28]	5.03	0.000
Staff 51-75%	-8.19	2.49	[-13.07, -3.31]	-3.28	0.002
Staff 76-100%	-7.22	2.44	[-12.00, -2.44]	-2.96	0.004
Age	-0.13	0.05	[-0.23, -0.03]	-2.42	0.018
Married Unmarried	-0.32	1.28	[-2.83, 2.19]	-0.25	0.801
Gender Male	2.04	2.10	[-2.08, 6.16]	0.97	0.335

Note. N = 84, R^2 = .19, Adjusted R^2 = .14, F(5, 78) = 3.76, p = .004

Table A9

Predictors of PHQ-9 Depression Scores: Staffing Levels With Controls for Age, Marital Status, Gender, Domestic vs International

Predictor	B	SE	95% CI	t	p
(Intercept)	17.21	3.52	[10.31, 24.11]	4.88	0.000
Staff 51-75%	-8.15	2.51	[-13.07, -3.23]	-3.25	0.002
Staff 76-100%	-7.23	2.45	[-12.03, -2.43]	-2.95	0.004
Age	-0.13	0.05	[-0.23, -0.03]	-2.46	0.016
Married Unmarried	-0.29	1.29	[-2.82, 2.24]	-0.23	0.822
Gender Male	2.16	2.12	[-2.00, 6.32]	1.01	0.313
Domestic International	0.68	1.25	[-1.77, 3.13]	0.55	0.586

Note. N = 84, R^2 = .20, Adjusted R^2 = .13, F(6, 77) = 3.16, p = .008

Table A10
Predictors of PHQ-9 Depression Scores: Staffing Levels With Controls for Age, Marital Status, Gender, Domestic vs International, Employment Status

Predictor	B	SE	95% CI	t	p
(Intercept)	16.73	3.59	[9.69, 23.77]	4.66	0.000
Staff 51-75%	-8.13	2.51	[-13.05, -3.21]	-3.23	0.002
Staff 76-100%	-7.22	2.45	[-12.02, -2.42]	-2.94	0.004
Age	-0.12	0.06	[-0.24, -0.00]	-2.14	0.036
Married Unmarried	-0.20	1.30	[-2.75, 2.35]	-0.15	0.880
Gender Male	2.20	2.13	[-1.97, 6.37]	1.03	0.305
Domestic International	0.64	1.25	[-1.81, 3.09]	0.51	0.610
Employ Status Other	-3.14	4.20	[-11.37, 5.09]	-0.75	0.456

Note. N = 84, $R^2 = .20$, Adjusted $R^2 = .13$, $F(7, 76) = 2.77$, $p = .013$

Table A11
Predictors of PHQ-9 Depression Scores: Staffing Levels With Controls for Age, Marital Status, Gender, Domestic vs International, Employment Status, Facility Type

Predictor	B	SE	95% CI	t	p
(Intercept)	11.25	7.18	[-2.82, 25.32]	1.57	0.122
Staff 51-75%	-8.02	2.60	[-13.12, -2.92]	-3.08	0.003
Staff 76-100%	-7.36	2.55	[-12.36, -2.36]	-2.89	0.005
Age	-0.14	0.06	[-0.26, -0.02]	-2.28	0.026
Married Unmarried	-0.15	1.36	[-2.82, 2.52]	-0.11	0.913
Gender Male	1.70	2.29	[-2.79, 6.19]	0.74	0.462
Domestic International	0.81	1.32	[-1.78, 3.40]	0.61	0.542
Employ Status Other	-2.49	4.45	[-11.21, 6.23]	-0.56	0.578
ARTCC / ACC	6.65	6.00	[-5.11, 18.41]	1.11	0.272

ATCT / Tower control	7.09	5.98	[-4.63, 18.81]	1.19	0.240
ATCT/TRACON	5.24	6.31	[-7.13, 17.61]	0.83	0.409
Employment place: Prefer not to say	11.78	8.46	[-4.80, 28.36]	1.39	0.168
TRACON / Approach Control / Terminal Control	5.75	6.17	[-6.34, 17.84]	0.93	0.354

Note. N = 84, R^2 = .24, Adjusted R^2 = .11, F(12, 71) = 1.84, p = .059