

Occupational Safety and Health Issues of Work Organization Affecting Air Traffic Controllers in Kenya

Annastacia Waitima Maina, Charles Mburu, Joseph Ngugi Kamau

Institute of Energy and Environmental Technology, Jomo Kenyatta University of Agriculture and Technology,
Nairobi, Kenya
Email: annastaciam2000@gmail.com

How to cite this paper: Maina, A.W., Mburu, C. and Kamau, J.N. (2025) Occupational Safety and Health Issues of Work Organization Affecting Air Traffic Controllers in Kenya. *Open Journal of Safety Science and Technology*, 15, 119-136.
<https://doi.org/10.4236/ojsst.2025.152007>

Received: May 9, 2025

Accepted: June 7, 2025

Published: June 10, 2025

Copyright © 2025 by author(s) and Scientific Research Publishing Inc.
This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Air traffic management (ATM) is essential for a safe, efficient, and effective aviation system, involving air traffic controllers, equipment, and procedures. Air traffic controllers manage air traffic and ensure safety through split-second decisions under strict deadlines. Occupational safety health (OSH) risks in ATC stem from how controllers interact with various systems necessary for their roles, highlighting the need for a well-designed work organization to mitigate hazards. While OSH issues have been extensively studied in sectors like agriculture, medicine, and road transport, there is limited research on how work organization affects the safety and health of Air Traffic Controllers in Kenya. This study evaluated safety and health issues of work organization affecting air traffic controllers in Kenya, using a quantitative descriptive design with $n = 64$ controllers from a population of 172. Data was collected via checklists and questionnaires and analyzed with SPSS. The study revealed that shift work schedules were unfavorable for air traffic controllers (ATCOs) operating in a 24-hour cycle. Specifically, 43.8% reported that duty cycles negatively impacted their social lives, with the effect most pronounced among 90% of respondents from Jomo Kenyatta International Airport (JKIA) and Moi International Airport (MIA). Additionally, 77% experienced mild headaches after shifts, 48.4% had difficulty sleeping after night shifts, and 68.8% reported back pains, indicating substantial physical strain. A strong correlation ($r = 0.726$) was observed between sitting time and screen time, with average shift durations extending up to 18 hours. This reflects limited opportunities for rest or movement during work. Notably, 53.1% of respondents reported spending nearly the entire shift seated and using the screen without breaks. Alarming, 85% preferred self-medication over seeking professional medical care, highlighting potential issues with health-seeking behavior. Psychosocial stressors were also

significant. Key stressors included the fear of making an error (51.6%), handling emergencies (56.3%), and managing difficult pilots (65.6%). Additionally, 45.3% felt that institutional audits prioritized aviation safety over their personal health and safety. Motivational challenges were also evident: 84.4% felt unrecognized for their routine efforts, and 96.9% reported receiving no acknowledgment for effectively handling emergencies. The findings indicate that occupational safety and health issues among ATCOs in Kenya are heavily influenced by unfavorable work organization, particularly in relation to shift scheduling, prolonged sedentary time, and lack of adequate recognition. These outcomes align with the Circadian Rhythm Theory, which emphasizes the adverse effects of disrupting the body's natural sleep-wake cycle, and the Effort-Reward Imbalance (ERI) Model, which links high job demands and insufficient rewards to elevated stress levels. Addressing these challenges requires a multifaceted approach. Enhancing staffing levels and introducing more flexible shift rotations would help reduce fatigue and promote better work-life balance. Ergonomic improvements and scheduled breaks are essential to mitigate physical strain. Furthermore, establishing structured recognition and reward systems would boost motivation and reduce work-related stress. A shift in organizational culture is also needed to prioritize not just aviation safety, but the holistic well-being of the ATCOs themselves.

Keywords

Air Traffic Controllers, Safety, Health, Work Organization

1. Introduction

Air Traffic Controllers (ATCs) play a crucial role in maintaining aviation safety. Their work involves making rapid decisions under intense pressure to prevent aircraft collisions, ensure smooth traffic flow, and provide essential alerting and flight information services [1]. However, around-the-clock shift schedules have been linked to negative effects on health, family life, and organizational efficiency [2] [3]. These demanding conditions expose ATCs to continuous stress from time constraints, unpredictable events, and the fear of errors, often leading to symptoms such as headaches, fatigue, and insomnia [4].

ATCs must meet strict medical standards and are often reluctant to report minor health issues for fear of losing certification [4] [5]. These challenges underscore the complex interplay between shift work, stress, and health in this profession, particularly in Kenya, where 24-hour rotating shifts are common.

Kumar [6] compares the stress levels of ATCs to those in the medical field, identifying stress and fatigue as key contributors to burnout. Like medical professionals, ATCs bear responsibility for human lives, and mistakes can have irreversible consequences. Maintaining mental well-being is therefore critical yet difficult due to the high-pressure nature of their work. According to the American Foundation

for Stress Prevention, 70% of suicides among doctors are attributed to work-related stress, underscoring the need for better workload management and post-work recreational activities to prevent burnout [6].

The Occupational Safety and Health Act of 2007 mandates employers to assess and mitigate risks in the workplace, ensuring the safety and health of all workers. In line with this, the Kenya Civil Aviation Authority (KCAA) limits ATC working hours through the Personnel Licensing Regulations of 2013 and requires regular medical evaluations. Controllers are also prohibited from working while fatigued. ICAO guidelines further define the procedures necessary to perform ATC duties safely [1].

Risks in ATC stem from how, when, and how long controllers interact with critical systems. This study focuses on organizational factors such as equipment layout, screen display design, screen and sitting time, workspace configuration, shift schedules, workload, communication and training, recognition, and management support.

Occupational safety and health (OSH) issues have been studied across various sectors, including agriculture, medicine, transport, and engineering. In aviation, most research focuses on stress and fatigue among ATCs [7]-[12]. However, limited studies have examined work organization [13] in relation to ATC safety in Kenya. Notably, none have directly addressed the occupational safety and health challenges unique to Kenyan ATCs.

This study aims to explore these issues and provide insights for scholars and KCAA management to inform interventions that enhance the safety and well-being of air traffic controllers.

1.1. Statement of the Problem

Air Traffic Controller requires high levels of alertness, fast reaction time and a perfect memory to be able to perform their jobs perfectly. Shift work, sleep deprivation, circadian disruptions and extended duty time impair the level of safety, health and performance. Aircraft accidents could be the outcome of having an unhealthy workforce. Therefore, ATC work organization must be designed to mitigate work-related hazards. While Occupational Safety and Health (OSH) issues affecting employees have been researched in most industries, such as agriculture, medicine, road transport, and engineering, most of these studies have only concentrated on how the work environment causes stress and fatigue. Very few published research studies have touched on work organization and how they affect the safety and health of Air Traffic Controllers in Kenya. Therefore, the purpose of this study is to investigate the safety and health issues affecting Air Traffic Controllers in Kenya.

1.2. Objective

The main objective of this study is to assess the influence of work organization on Air Traffic Controllers in Kenya.

2. Literature Review

2.1. OSH Regulation

OSH Act 2007 applies to all workplaces where any person is at work, whether temporarily or permanently. This act seeks to secure the safety, health, and welfare of persons at work and protect them from risks to safety and health arising from their work activities [14].

Under general provisions, the duties of an occupier have been provided. They should ensure the safety, health, and welfare of all persons working in their workplace. This is achieved by providing and maintaining a safe plant, work systems, and procedures free from health risks. The occupier must also provide information, training, and supervision as required to ensure the safety and health of every person at work. They should also provide and maintain a safe and risk-free means of access to and exit from the workplace. Finally, the employer must provide and maintain an adequate workplace regarding facilities and arrangements for the employee's welfare. An employer should undertake a risk assessment concerning the safety and health of persons employed. The results of this assessment should then be used to develop preventive measures to ensure that all chemicals, machinery, equipment, tools, and processes at the workplace are safe and free of health risk under all conditions of their intended use.

2.2. ATC Concepts

According to International Civil Aviation Doc. 4444-2010, the functions of Air Traffic Controllers vary distinctively based on the operating positions [1]. The 3 central roles include aerodrome control, approach control, and area control.

An aerodrome controller maintains a continuous watch on all visible flight operations in the vicinity of the aerodrome. This controller is also responsible for the visual flight rules (VFR) flights within the control zone. They issue the VFR with clearance to ensure a safe and orderly flow of traffic in the vicinity of the aerodrome. Coordination is also crucial in this control position. Through this coordination, they can notify aircraft under its control of any failure or irregular operation of any device or apparatus used for guidance of aerodrome service. They also provide alerting service by coordinating with rescue and fire-fighting services and notifying them of an aircraft requiring any assistance during landing in case of an emergency. Finally, they provide meteorological information to aircraft on request to facilitate their safe landing or departure.

An approach Controller's primary responsibility is to provide standard separation between controlled flights within a terminal control area and control zone. They also notify aircraft under their control of any failure or irregular operation of aerodrome facilities used to guide aerodrome traffic. These controllers are also tasked to provide flight information service and alerting service to aircraft within their area of jurisdiction. They also initiate overdue action of any aircraft at the destination aerodrome. Where RADAR is in use and this controller is trained to

provide RADAR service, they provide radar monitoring of air traffic within the terminal control area. They also provide radar separation and radar vectoring to resolve conflicts and expeditions.

An Area Controller's primary responsibility is to provide standard separation between controlled flights outside the terminal control area but within the Kenyan Flight Information Region (FIR). They also facilitate seamless aircraft transfer from Kenyan FIR to another FIR, ensuring proper coordination between all the units concerned. When employing RADAR and these controllers have been trained to use it, they provide radar monitoring of air traffic within the FIR. They also provide radar separation and radar vectoring to resolve aircraft conflicts within their control area.

The workloads and stress levels experienced by Aerodrome, Approach, and Area Controllers vary significantly due to the nature and complexity of their responsibilities. Aerodrome Controllers often operate under high pressure due to the need for constant visual monitoring and rapid decision-making in a dynamic and confined environment, particularly during peak traffic periods or adverse weather. Approach Controllers typically face higher cognitive demands as they manage multiple aircraft converging towards busy terminal areas, requiring precise coordination, sequencing, and separation, often using radar. Area Controllers, while dealing with aircraft at higher altitudes and generally more stable flight paths, manage large volumes of en-route traffic over vast areas, necessitating long periods of sustained concentration and coordination across FIR boundaries. Consequently, while all three roles are critical, the stress intensity may fluctuate based on traffic density, time of day, and operational complexity, with Approach Controllers often experiencing the highest stress due to the intricacy and immediacy of their tasks Giovanni (2000) [5].

2.3. Work Organization in ATC Context

This is considered a non-physical hazard that causes work-related stress. Giovanni (2000) [5] categorizes these hazards that directly affect air traffic controllers into: work demands, time pressure, reward and recognition, workloads, shift work schedules, hours of work, sitting time per shift, screen time per shift, support from supervisors, job clarity, job design and workspace, job training, and communication at the workplace.

Subotić and Mandarić (2014) [12] consider work organization essential in improving working conditions, increasing productivity, and enhancing the quality and performance of employees. In their study, they recommended that any workplace design should suit the work environment, needs, and characteristics of workers and processes. Such work organization by design removes any obstacles to the workers' ability to work effectively and efficiently. The overall outcome is a high-quality, human-oriented work organization and an ergonomically sound environment.

Giovanni (2000) [5] considers stress related to shift-oriented work to result from

poor roster design, the mental and physical demands of the job, family and social responsibilities, and disrupted circadian rhythms. In his study, he argues that most employees resort to alcohol and other substance abuse to cope with stress and fatigue. This can be hazardous to employees' safety and health, especially if the work involved is sensitive and requires high levels of attention. According to Giovanni (2000) [5], a rapidly rotating three-way shift developed for air traffic controllers' rosters should adopt a forward rotation of night, morning, and evening shifts. This allows the body to adjust with minimal disruptions to circadian rhythms. The rest time between shifts in this rotation is also adequate. The Circadian Rhythm Theory is based on the biological concept that the human body operates on a roughly 24-hour internal clock that regulates sleep-wake cycles, hormone release, body temperature, and other vital physiological functions. Disruption of this natural rhythm usually due to irregular or night shift work can lead to sleep disturbances, fatigue, cognitive impairments, and long-term health issues. In occupations like air traffic control, where shift work is common, misalignment with circadian rhythms compromises alertness and decision-making, thereby affecting both individual well-being and workplace safety [2].

In ATC, teamwork is essential during normal operations, periods of increased traffic, and abnormal situations such as aircraft accidents. Workspaces must always be designed and organized to support teamwork in ATC, as this facilitates easier and faster coordination between different ATC units. Tharikh and Hamzah (2020) [8] concluded that teamwork in ATC reduces a controller's workload to manageable levels.

Majumdar and Ochieng (2002) [15] highlighted the critical factors used to determine a controller's workload. These include the type of air traffic, the sector dynamics in the airspace, and the condition of the equipment used to provide air traffic control. This includes both the ATM equipment on the ground and the aircraft's onboard equipment. Lastly, age, experience, and health are also essential when evaluating a controller's workload.

The Effort-Reward Imbalance (ERI) Model, by Johannes Siegrist, suggests that work-related stress arises when the efforts an employee invests are not adequately matched by the rewards received (such as recognition, salary, career advancement, or job security). Prolonged exposure to this imbalance can lead to emotional exhaustion, demotivation, and even physical health problems. In high-stakes professions like air traffic control, where performance is critical and errors can be catastrophic, lack of recognition and support can severely impact both morale and job effectiveness [16].

2.4. Relevant Related Studies

Occupational safety and health have been widely studied across various professions in Kenya and globally. In civil engineering, the construction sector ranks as the second most hazardous industry after transport, according to statistics from the Directorate of Occupational Safety and Health (DOSHS). Similarly, extensive

research has been conducted on occupational issues in the medical field, where long hours and understaffing contribute significantly to burnout (Kumar, 2016) [6]. In agriculture, workers face numerous hazards including machinery accidents, chemical exposure, and livestock handling risks. Molina-Guzmán and Ríos-Osorio (2020) [7] emphasize the need for automation and ongoing risk assessment to manage these hazards effectively.

In air traffic control (ATC), recent studies have focused on ergonomic assessments, environmental factors, and work organization. Tharikh and Hamzah (2020) [8] applied the Wellbeing Theory to the ATC profession, emphasizing the importance of optimizing ergonomic conditions and shift management strategies. Saleree (2018) [9] investigated the effects of lighting and noise, finding that poor lighting and high noise levels impair situational awareness and communication, ultimately affecting ATC performance.

Claudine and Nadine (2018) [13] explored the impact of work schedules and traffic intensity on ATC fatigue and quality of life. Their findings revealed that lighter traffic loads improved alertness and sleep quality, while changes in work schedules primarily affected family life. In Brazil, Sonati *et al.* (2016) [11] identified physical inactivity, poor diet, and sleep deprivation as key contributors to chronic health issues among ATCOs. They recommended improvements to the working environment, including rest before night shifts and promotion of physical activity.

In Europe, Kumar (2016) [6] highlighted how stress-related burnout in the medical field can lead to premature retirement, suicide, or early death. The study recommends that health institutions improve work environments, invest in equipment, and promote time off to prevent burnout rather than merely treat it.

Subotić and Mandarić (2014) [12] examined stressors associated with equipment failure in ATC systems. They emphasized the need for improved equipment design and operator training to support effective recovery during system malfunctions. Similarly, Giovanni (2000) [5] linked the demanding nature of ATC work to chronic health symptoms, such as fatigue, headaches, and gastrointestinal issues.

These studies collectively demonstrate that occupational stress and health risks in ATC are multifaceted and comparable to those in other high-stakes professions. They reinforce the need for comprehensive strategies to support ATCO well-being through improved work design, policy, and support systems

3. Materials and Methods

A cross-sectional descriptive survey was used to collect data. It involved the use of a questionnaire administered either manually or electronically to the sample at a definite time. The study area covered the 7 manned airports in Kenya, which is a combination of both international and domestic airports. The sample was obtained from the total population of 172 controllers working in selected airports in Kenya. Purposive sampling was used to select 7 airports from a population of 9. A

sample size of $n = 64$ was calculated using Yamane's formula of random sampling as shown in Equation (1) [17].

$$n = \frac{N}{1 + N(\alpha)^2} \quad (1)$$

where, N = target population (172), α = margin error (10%) and n = sample size.

Proportionate distribution was then used to obtain the sample size in each airport, as shown in **Table 1**. SPSS software was employed to analyze the quantitative data collected and was presented using tables and charts.

Table 1. Sample distribution.

S/No.	Station Name	Population (p)	$(p/TP) * n$	Sample size (n)
1	Moi International Airport	36	13.4	13
2	Malindi Airport	8	2.98	3
3	Diani Airport	6	2.23	2
4	Kisumu Airport	7	2.60	3
5	Eldoret International Airport	7	2.60	3
6	Jomo Kenyatta International Airport	86	32	32
7	Wilson Airport	22	8.19	8
Total Population (TP)		172		64

The sample size of 64 air traffic controllers (ATCOs) was deemed appropriate for the scope of this study, considering the practical and occupational constraints of the target population. Out of the total population of 172 ATCOs in Kenya, only those actively engaged in operational control duties were considered ideal for this research, as the study aimed to assess occupational safety and health issues specifically related to live air traffic control work. Approximately 43 individuals were excluded because they were involved in office-based management roles, which do not entail the same physiological and psychological demands as active control desk duties. Therefore, the accessible population was effectively reduced to 129. Of this number, 64 respondents were selected based on their availability and active engagement on the control desk during the data collection period. This approach ensured that the data collected was relevant, context-specific, and reflective of the real working conditions faced by operational ATCOs, thereby strengthening the validity of the study findings despite the focused sample.

4. Results and Discussion

4.1. Respondents Demographic Profile

The social demographic profile revealed that the respondent's gender distribution

was 65.6% male and 34.4%. 51.6% of the respondents were aged between 36 and 45 years, while 40.6% of the respondents were aged between 26 and 35 years. Only 7.8% of the respondents were aged above 45 years. Education level analysis of the respondents indicates that the majority were highly skilled. 48.4% had acquired an undergraduate degree, 28.1% master's degree, while those with a postgraduate diploma and postgraduate certificate were 9.4% for each category. Only 4.7% of the respondents had diplomas. 62.5% of the respondents were married across all airports used in this study, 32.8 % were single, and only 4.7% were separated. Most of the respondents (46.9%) had 10 to 20 years of job experience, 28.1% had 5 to 10 years of experience, and 15.6% had less than 5 years of experience. The remaining 9.4 % of the respondents had more than 20 years' experience.

A survey was carried out of all the 64 ATCO respondents as planned. All the questionnaires were filled out online, while the checklists were filled out at the respective workstations. The response rate was 100% from all the airports as planned.

To determine the influence of work organization on Air Traffic Controllers in Kenya. The respondents were required to choose one of the five options given (5—Strongly agree, 4—Agree, 3—neutral, 2—disagree & 1—strongly disagree) from a list of predetermined statements. The responses were analysed, discussed, and presented in **Table 2**.

Table 2. Responses on work organization factors affecting air traffic controllers.

Work Organization	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Std. Deviation	Decision
Airspace design enables reduction in workload	7.8%	29.7%	20.3%	40.6%	1.6%	2.9	1.0	Low perception
Consoles are designed to allow enough space while working	7.8%	28.1%	14.1%	45.3%	4.7%	3.1	1.1	Low perception
Overwhelmed by traffic as the traffic density increases	1.6%	26.6%	31.3%	28.1%	12.5%	3.2	1.0	Low perception
Few displays with multiple functions will improve work efficiency	-	3.1%	7.8%	59.4%	29.7%	4.2	0.7	High perception
Equipment arrangement suits your operation while working	6.3%	28.1%	21.9%	40.6%	3.1%	3.0	1.0	Low perception
Experience loss of sleep a night after doing a night shift	4.7%	9.4%	7.8%	48.4%	29.7%	3.9	1.1	High Perception

Continued

Sitting time almost equals shift time	-	1.6%	3.1%	53.1%	42.2%	4.4	0.6	High perception
Screen time almost equals shift time	-	3.1%	6.3%	53.1%	37.5%	4.3	0.7	High Perception

Note: Weighted Average = 3.63.

The data analysis detailed in **Table 2** shows that most of the respondents highly perceived that work organization affected air traffic controllers. In particular, the respondents perceived that few displays with multiple functions would help to improve their work efficiency. It was observed that controllers used so many displays at the same time to perform different functions entailing their work. This is consistent with a study by Subotic *et al.* (2014) [12], which concluded that handling multiple equipment simultaneously can increase the complexity and cognitive load on air traffic controllers. The need to process information from multiple sources, coordinate tasks, and prioritize tasks can increase mental fatigue. Training and coordinated effort from several controllers would help them reduce the effects of using multiple equipment.

Similarly, the respondents experienced loss of sleep a night after doing a night shift and highly perceived that shift time & screen time were almost equal to screen time. Claudine and Nadine's (2018) [13] study agrees with this research in which an experiment was done that proved that reduced workload (aircraft traffic level) resulted in better sleep and increased alertness.

Conversely, the majority of the respondents had a low perception that different aspects of work organization had an impact on air traffic controllers. For instance, airspace design enabled a reduction in workload, consoles were well designed to allow for enough work and leg space while working, equipment arrangement was ergonomically suitable for working, and respondents felt overwhelmed by traffic as the traffic density increased.

Table 3. Relationship between sitting time and Screen time.

	Sitting time per shift (hours)	Screen time per shift(hours)
Mean	18.25	18.39
Median	18.00	18.00
Mode	24	24
Range	16	17
Minimum	9	8
Maximum	25	25

The analysis shown in **Table 3** shows the relationship between sitting time per shift and screen time per shift. A schedule comprised three shift cycles in a rota-

tion that had a total of 26 hours. The mean sitting time and screen time was approximately 18 hours. This means that on average, controllers spend approximately 18 hours sitting and consequently on the screen out of the 26 hours they spend at work. The minimum sitting hour recorded was 9 hours, while the maximum was 25 hours; on the other hand, the minimum screen time was 8 hours, and the maximum was 25 hours. The median and the mode were recorded as 18 hours and 24 hours respectively. This shows that majority of the controllers stay on the screen working while sitting with minimal or no breaks in between.

Table 4. Correlation between sitting time and screen time.

	Sitting time per shift	Screen time per shift
Sitting time per shift	1	
Screen time per Shift	0.726**	1

Note: **Correlation is significant at the 0.01 level (2-tailed).

The Pearson correlation was conducted, as presented in **Table 4**, to examine the relationship between sitting time and screen time in a sample of 64 respondents. The correlation between the variables was statistically significant = 0.726, $p < 0.01$. This indicates a strong positive relationship between sitting time and screen time. An increase in screen time per shift is associated with an increase in sitting time per shift. **Table 1** also shows that the majority (53.1%) of the controllers agreed that screen time and sitting time were almost equal in a shift. This is mainly due to the nature of work that air traffic controllers do. The contributing factor is the need to always maintain situational awareness while working. Increasing the number of employees and introducing breaks between shifts could help alleviate this problem.

Therefore, ATCOs in Kenya are exposed to continuous high-stakes decision-making in environments with limited human resources and rigid schedules. The lack of adequate breaks (reported by 53.1%) and dissatisfaction with work-life balance illustrates classic high-strain conditions predicted by the Job Demand-Control model [4]. To reduce occupational stress, there is a clear need for organizational interventions focused on task autonomy, increased staffing, and rest scheduling.

4.1.1. Effect of Shift Work

Table 5. Responses on shift work.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Std. Deviation
Shift work schedules allow for enough rest after a rotation	18.8%	34.4%	14.1%	21.9%	10.9%	2.7	1.3
Shift work schedules affect social life outside of work	4.7%	3.1%	6.3%	43.8%	42.2%	4.16	1.0

The analysis shown in **Table 5** shows that 34.4% of the respondents disagreed that the available work schedules allow for enough rest after a rotation. The majority of the respondents (43.8%) agreed that shift work affected their social life outside work. This confirms the research by George (2016) [10], which indicates that it is challenging for shift workers to maintain a healthy work-life balance due to their irregular work hours.

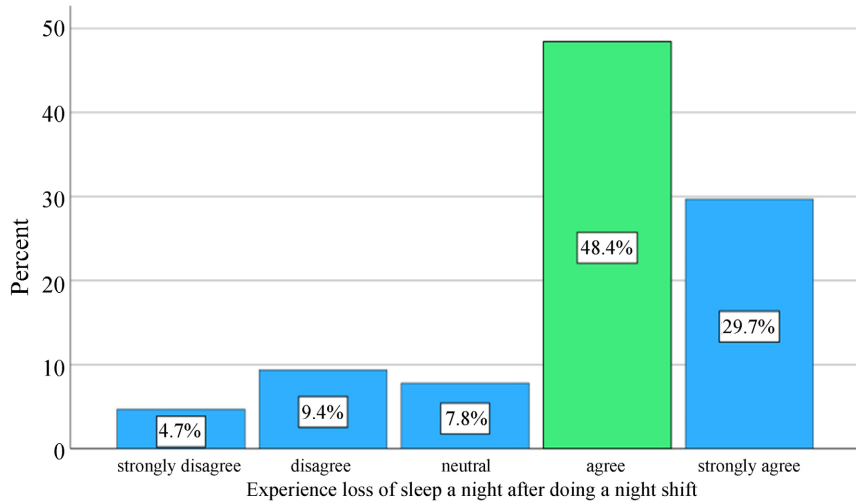


Figure 1. Effects of night shifts.

Further analysis in **Figure 1.** shows that 48.4% of the respondents agree that they experience loss of sleep a night after doing a night shift. This is consistent with research by Sonati *et al.* (2016) [11], which indicates that shift work is associated with irregular working hours, which causes sleep disturbances. Chronic sleep deprivation in ATC could cause fatigue-related errors.

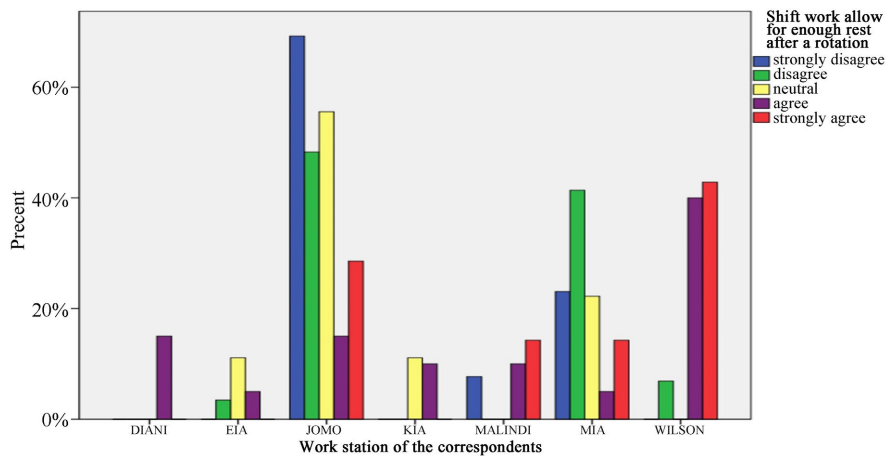


Figure 2. Effects of shift work on rest periods.

Further analysis was done to determine how shift work affected controllers working in different airports, as shown in **Figure 2.** It was determined that con-

trollers who worked in stations with night shifts (Jomo Kenyatta International Airport or Mombasa International Airport) felt that the rest periods after a shift rotation were inadequate. Wilson Airport had embraced a 3-way day shift, which seemed to be working for the controllers. Most controllers working there agreed that the rest periods provided were adequate. It was noted that only one day off was provided after a night shift for both Mombasa airport and Jomo Kenyatta airports. The management should come up with workable models to solve the fatigue issue for stations with night shifts. Increasing the rest period after a shift cycle could be one of the effective ways to deal with fatigue in such stations.

Shift work emerged as one of the key factors influencing fatigue, health, and performance. Approximately 63.2% of ATCOs (mainly from JKIA and MIA) experienced difficulty adjusting to irregular work schedules. This aligns with the Circadian Rhythm Theory, which highlights how disruption to natural biological rhythms caused by night or rotating shifts can impair sleep, cognition, and overall well-being [2]. Shift work in the 24-hrs stations continues to pose a systemic occupational health challenge, especially given the critical nature of sustained alertness in air traffic control operations.

4.1.2. Health Conditions of Respondents

Respondents were asked questions related to their health conditions, and the analysis was done and presented in **Table 6**. It was noted that 77 % of the respondents reported suffering from mild headaches after a shift, while 68.8% experienced back pains that they didn't experience prior to employment at KCAA. Most of the controllers reported using self-medication as an intervention in all cases. According to ICAO Annex 1—Personnel Licensing (2018), a valid Class 3 medical certificate is required to practice as an air traffic controller. This certificate must be issued by an Aviation Medical Examiner (AME) annually for individuals over 40 years of age, and every two years for those aged 40 or below. This requires the officers to be examined medically and pass all the tests performed by the AME. Reduction in the workload, provision of ergonomic chairs for all ATCOs, proper posture, and frequent breaks between shifts are recommended to help alleviate these health problems.

Table 6 shows that 47.6% of the respondents reported to suffer from stress related to the work they do. **Figure 3** shows that out of 52.4% of the controllers who suffered from stress either from work or home-related activities, only 15% considered it necessary to seek medical help. Controllers should be sensitized to the need to seek medical help to reduce risks related to stress.

31.1% of the respondents reported suffering from stress-related illnesses such as depression & High blood pressure, while 38.1 % reported having eye problems as identified by AME. Although these percentages were below 50%, it is important to note that most of the controllers (over 90%) were aged between 26 and 45 years of age if the exposure to stress and other risks in the work environment is not reduced to tolerable levels, there exists a possibility that these percentages may increase with time. It was also evident that most controllers feared losing their

medical certificate due to health issues and hence opted for self-medication over seeking medical assistance from an AME.

9.7% of the respondents reported experiencing hearing problems as identified by AME. These respondents were distributed in all airports; hence, they might not be related to the work they do but rather could be from other hazards outside their workplace.

Table 6. Responses on health conditions of air traffic controllers.

Health-related problems	YES	NO
Do you experience hearing problems as identified by AME?	9.7%	90.3%
Do you experience mild headaches after a shift?	77.0%	23.0%
Stress-related illnesses such as depression & High blood pressure have been identified by AME?	31.1%	68.9%
Are you suffering from stress related to the work you do?	47.6%	52.4%
Have you had any back pains that you did not experience before being employed as an ATCO?	68.8%	31.3%
Do you have eye problems as identified by AME that you didn't have before Joining ATC?	38.1%	61.9%

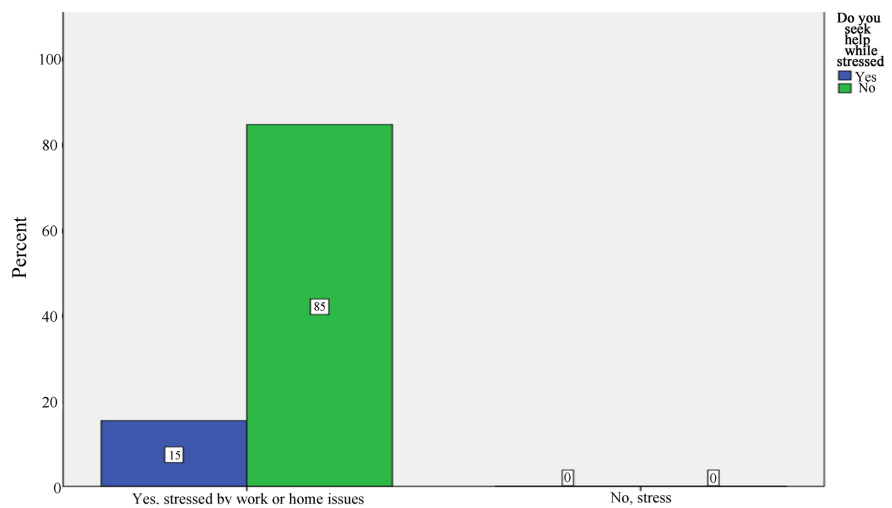


Figure 3. Stress from home or work versus seeking help.

4.2. Training and Management Support

The analysis done in **Table 7** shows that the majority of the respondents had a high perception of training and management support offered to air traffic controllers. For instance, they had a high perception that communication channels were available and effective for handling air traffic controllers' issues and concerns, management of weather in control rooms through air conditioning was prompted, and the management supported & listened to ATC through the available professional bodies and management considered needs & responsibilities during postings and transfers.

Table 7. Responses on training and management support.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Std. Deviation	Decision
Training is promptly done when there is a change	18.8%	46.9%	15.6%	14.1%	4.7%	2.4	1.1	Low perception
Training gaps are prioritised when training ATCOS	26.6%	56.3%	17.2%	-	-	1.9	0.7	Low perception
Training on stress, mental, health & safety and health is prioritized on all ATCOs	37.5%	45.3%	10.9%	4.7%	1.6%	1.9	0.9	Low perception
ATCOs have been well trained in sitting posture at work	34.4%	51.6%	10.9%	1.6%	1.6%	1.8	0.8	Low perception
Communication channels are available and working	18.8%	32.8%	29.7%	18.8%	-	2.5	1.0	High Perception
KCAA has an appraisal tool that works for controllers	51.6%	26.6%	17.2%	4.7%	-	1.8	0.9	Low perception
Reward & recognition is provided for in the appraisal tool	45.3%	39.1%	12.5%	3.1%	-	1.7	0.8	Low perception
Reward is provided for handling emergencies impeccably	54.7%	42.2%	3.1%	-	-	1.5	0.6	Low perception
Management prioritizes equipment serviceability	15.6%	46.9%	26.6%	10.9%	-	2.3	0.9	Low perception
Management of weather through air conditioning	1.6%	15.6%	17.2%	60.9%	4.7%	3.5	0.9	High Perception
Management supports & listens to ATC through available professional bodies.	6.3%	25.0%	34.4%	31.3%	3.1%	3.0	1.0	High Perception
Management considers needs & responsibilities during postings and transfers	14.1%	23.4%	32.8%	28.1%	1.6%	2.8	1.1	High Perception

Note: Weighted Average = 2.26.

On the other hand, the majority of the respondents had a low perception of the training and management support offered to air traffic controllers. For example, they had a low perception that training was promptly done when there was change, training gaps were prioritized when training ATCOS, training on stress, mental, health & safety and health was prioritized on all ATCOs, ATCOs had been well trained on sitting posture at work, KCAA had an appraisal tool that worked for controllers, reward & recognition was provided for in the appraisal tool, reward was provided for handling emergencies impeccably and management prioritized equipment serviceability. ICAO Annex 1—Personnel licensing (2022) [18] indicates that training and management support are crucial in the field of air traffic control due to the critical nature of their work and the potential consequences of errors. It facilitates safety, health, competence, stress management, effective communication, adaptability, resilience, and a supportive work environment. Overall, training and management support plays a key role in how the work organization affects air traffic controllers.

Another key factor identified in this study was motivation. About 84.4% of respondents felt their work efforts were not adequately recognized, and 96.9% cited that no recognition was done for handling emergencies impeccably. These perceptions align with the Effort-Reward Imbalance Model [16], which suggests that psychological distress arises when high job effort is not met with proportional rewards such as compensation, status, or career opportunities. This imbalance not only affects employee morale but also increases the risk of chronic stress and disengagement [16]. In Kenya's aviation sector, these motivational deficiencies highlight the importance of revising reward systems and ensuring career development frameworks are transparent and functional.

5. Conclusions

This research aimed to determine the occupational safety and health issues affecting air traffic controllers (ATCOs) in Kenya, with a focus on work organization. Shift work schedules were found to be unfavourable, especially for ATCOs working in stations with a 24-hour operational cycle. A total of 43.8% of respondents reported that the existing duty cycles negatively affected their social life, while 48.4% experienced loss of sleep following night shifts.

Most workspaces were observed to be generally well designed; however, the chairs provided were not suitable for the console height and legroom, leading to ergonomic concerns. Sitting time and screen time were found to be largely dependent on the length of the shift. A strong positive correlation ($r = 0.726$) between sitting time and shift duration indicates that many controllers seldom took breaks from the screen or their seats. In fact, 53.1% of the ATCOs reported sitting and using the screen for almost the entire shift without any breaks.

To address these issues, increasing staffing levels and implementing more flexible work schedules would help ensure more frequent breaks from sitting and screen use. This, in turn, would improve the overall health of ATCOs and enhance

their operational efficiency.

The study also revealed a significant lack of motivation among ATCOs: 84.4% of respondents felt that their work efforts were not adequately recognized, and 96.9% stated that no recognition was given for handling emergencies effectively.

These findings strongly align with the Circadian Rhythm Theory and the Effort-Reward Imbalance (ERI) Model, demonstrating how fatigue associated with shift work and a lack of recognition and reward contribute to occupational stress. These theories offer a multidimensional framework for understanding and addressing occupational safety and health challenges within the air traffic control profession in Kenya.

6. Recommendations

Implement flexible work schedules and breaks to reduce sitting and screen time.

Introduce wellness programs that support mental health, including stress management workshops, counselling services, and fatigue management training tailored for shift workers.

Develop structured systems for acknowledging and rewarding outstanding performance, especially in critical situations such as emergency handling.

Continuously evaluate work organization practices using staff feedback and performance data to ensure they are aligned with best practices and occupational safety and health standards.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] ICAO (2010) Procedures for Air Navigation Services-Air Traffic Management (Doc 4444). International Civil Aviation Organization.
- [2] Caruso, C.C. (2014) Negative Impacts of Shiftwork and Long Work Hours. *Rehabilitation Nursing*, **39**, 16-25. <https://doi.org/10.1002/rnj.107>
- [3] Folkard, S. (2003) Shift Work, Safety and Productivity. *Occupational Medicine*, **53**, 95-101. <https://doi.org/10.1093/occmed/kqg047>
- [4] Cox, T. and Griffiths, A. (2005) The Nature and Measurement of Work-Related Stress. In: Wilson, J.R. and Corlett, N., Eds., *Evaluation of Human Work, 3rd Edition*, CRC Press, 553-571. <https://doi.org/10.1201/9781420055948.ch19>
- [5] Giovanni, A. (2000) Mental Load in ATC Operations. *Human Factors*, **42**, 221-230.
- [6] Kumar, S. (2016) Burnout in the Medical Profession: Causes, Prevention, and Treatment. *Indian Journal of Occupational and Environmental Medicine*, **20**, 4-10.
- [7] Molina-Guzmán, L.P. and Ríos-Osorio, L. A. (2020) Occupational Health and Safety in Agriculture: A Systematic Review. *Revista de la Facultad de Medicina*, **68**, 625-638. <https://doi.org/10.15446/revfacmed.v68n4.76519>
- [8] Tharikh, S.M. and Hamzah, N. (2020) Work Stress and Mental Health in ATCs. *International Journal of Human and Technology Interaction*, **4**, 45-53.
- [9] Saleree, A. (2018) Ergonomics and Stress Management in Air Traffic Control. *Journal*

- of Aviation Psychology*, **12**, 22-30.
- [10] George, A. (2016) Workplace Pressure in Aviation Services. *International Journal of Aviation Studies*, **8930**, 15-21.
 - [11] Sonati, J.G., et al. (2016) Occupational Stress in Aviation Workers. *Work*, **55**, 305-312.
 - [12] Subotić, T. and Mandarić, M. (2014) Stressors in the Air Traffic Control Profession. *Journal of Aviation Psychology*, **24**, 85-92.
 - [13] Claudine, M. and Nadine, R. (2018) Work Organization and ATC Efficiency. *International Journal of Aviation Management*, **5**, 12-25.
 - [14] Government of Kenya (2007) Occupational Safety and Health Act, 2007. National Council for Law Reporting. <https://www.osha.go.ke>
 - [15] Majumdar, A. and Ochieng, W.Y. (2002) Factors Affecting Air Traffic Controller Workload: Multivariate Analysis Based on Simulation Modeling of Controller Workload. *Transportation Research Record: Journal of the Transportation Research Board*, **1788**, 58-69. <https://doi.org/10.3141/1788-08>
 - [16] Siegrist, J. (1996) Adverse Health Effects of High-Effort/Low-Reward Conditions. *Journal of Occupational Health Psychology*, **1**, 27-41. <https://doi.org/10.1037/1076-8998.1.1.27>
 - [17] Taro, Y. (1967) *Statistics an Introductory Analysis*. 2nd Edition, Harper and Row.
 - [18] International Civil Aviation Organization (2018) Annex 1 to the Convention on International Civil Aviation: Personnel Licensing. 11th Edition, ICAO.