



RESEARCH ARTICLE

The Effect of Workload, Work Life Balance on Quality of Life Through Job Stress and Work Fatigue Among Air Traffic Controllers (ATC) in Makassar City

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ARTICLE INFO	ABSTRACT
Received: Nov 12, 2024	<p>Indonesia is experiencing rapid development in aviation, leading to increased flight frequencies and heavier responsibilities for Air Traffic Controllers (ATCs). This situation can result in high workloads and disrupted work-life balance, negatively impacting ATC performance, work quality, productivity and overall quality of life. This study aims to analyze the effects of workload and work-life balance on the quality of ATC employees in Makassar City, focusing on work stress and fatigue. A cross-sectional quantitative descriptive research design was employed, using probability sampling with proportional random sampling, resulting in 125 samples. Data were collected through questionnaires and analyzed using the Amos application. The findings reveal a direct effect of work-life balance on fatigue ($p=0.000$) and quality of life ($p=0.000$), as well as a direct effect of fatigue on work stress ($p=0.000$) and quality of life ($p=0.029$). Indirect effects were also noted, with workload impacting quality of life through work stress ($p=0.457$) and fatigue ($p=0.927$), and work-life balance affecting quality of life through work stress ($p=0.589$) and fatigue ($p=0.045$). The study emphasizes the importance of maintaining physical and mental health through healthy living practices and progressive muscle relaxation techniques to alleviate psychological disturbances, ensuring optimal air navigation services. The findings offer recommendations for AirNav to enhance management and prioritize the safety and health of ATCs.</p>
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INTRODUCTION

Indonesia has experienced rapid growth in its aviation sector, with 285 airports from Sabang to Merauke and approximately 5,000 employees. AirNav Indonesia reports 1.5 million aircraft movements and over 75 million passengers annually, along with 60,000 international flights carrying 13.5 million passengers. This growth necessitates a focus on safety and security to sustainably enhance service quality (Saleh et al., 2020). However, the high demand for air transportation has also led to incidents of aircraft accidents, often caused by technical errors or chaotic air traffic management. A primary factor is frequently the lack of discipline and insufficient competency among aviation personnel and organizations. Thus, effective air transportation requires robust support in facilities and human resources, particularly air traffic controllers (Witjaksono & Novianti 2018).

This profession has a considerable workload due to the responsibility for flight safety. Various roles of air traffic controllers are essential to ensure smooth flights, including managing, monitoring, and providing information related to flight fluency (Galuh, 2019). Currently, the airspace in Indonesia is very congested with aircraft, which demands that air traffic controllers remain vigilant and focused on their work conditions. As the frequency of air traffic operations will become heavier, potentially leading to stress both during work and after completing their job activities (Susanto et al., 2021). Ideally, ATC workers should have low work-related stress, however the risks associated with the job are very high and involve the lives of many people, which creates a significant burden and responsibility for an ATC.

The primary cause of aircraft accidents in Indonesia is attributed to errors made by Air Traffic Controllers (ATC). Data from Garuda Indonesia indicates that from 2009 to 2012, 62% of ATC incidents were linked to domestic flight accidents, followed by runway issues at 28% and pilot errors at 10%. Notable incidents include 2016 collision between a Batik Air Boeing B-737-800NG and an ATR-72 Trans Nusa at Halim Perdanakusuma Airport, as well as a Batik Air Flight colliding with a commuter aircraft at the end of runway 24, both due to poor coordination between control towers (Chairunnisa, 2019). According to the National Transportation Safety Committee of Indonesia in 2020, human error, often due to fatigue and miscommunication between ATC and pilots, accounts for 51.4% of all flight accidents since 2016. The increasing number of flight contributes to ATC fatigue, as the rising workload and demands lead to psychological pressure, given that ATCs oversee hundreds or thousands of aircraft (Hamid et al., 2023).

Air Traffic Controllers (ATC) have social roles beyond their work, including family interactions and community engagement. Conflicts can arise when these roles overlap, making it challenging for ATCs to balance work with family and social life. This relates to work-life balance theories, particularly the conflict theory by Greenhaus & Beutell (1985), which suggests that conflicting roles can lead to stress and fatigue. Research by Muharrani (2023) found that 69.44% of 72 ATCs struggled with emotional management, often feeling restless and anxious at work while thinking about unfinished roles outside their job. Additionally, a study by Urba & Soetjningsih (2022) revealed that 65.79% of BULOG employees experienced a moderated work-life balance, significantly impacting work-related stress. This highlights that a good work-life balance can reduce work stress.

Air Traffic Controllers play a crucial role in guiding air navigation to prevent collisions between aircraft both in the air and on the ground. Ensuring smooth flights is closely to flights 24 hours a day. This makes the ATC profession associated with a high level of stress and fatigue at work. Consequently, this impacts the performance of ATC personnel, which can affect work quality, lead to decreased productivity and influence the quality of life of ATCs. Therefore, it is important for both individuals and organizations to understand the impact of work related stress on quality of life in order to implement appropriate strategies to reduce work stress, promote a healthy work life balance, and provide support for the physical and mental well-being of employees. This way, individuals can experience an improvement in their quality of life that is better and more sustainable.

MATERIAL AND METHOD

This study used an observational method with a cross-sectional design, which is a type of observational research design used to determine the relationship between independent variables, intervening variables, and dependent variables that are conducted simultaneously. This study was conducted at Makassar Air Traffic Center (MATSC), Sultan Hasanuddin International Airport, In July-August 2024.

The study employs probability sampling, a technique that provides equal opportunities for each population element to be selected as a sample member. Specifically, it uses proportional random

sampling, where subjects are selected proportionally from each stratum or unit/department, in accordance with the number of subjects in each unit. To measure the sample size to be studied, the Slovin formula is used with a significance level 5% (0.05). the results obtained from each proportional random sampling are ADC (Aerodrome Control Tower) with 21 people, APP (Approach Control Tower) with 26 people, and ACC (Area Control Centre) with 78 people. Therefore, the total sample is 125 respondents.

The research instruments used include a consent form for willingness to participate as a respondent, respondent identification (name, unit, age, and gender), a workload questionnaire (NASA-TLX) with a validity value of (0.946) and reliability of (0.813), a work life balance questionnaire (Work Life Balance Scale) with a validity value of (0.789) and reliability of (0.976), a quality of life questionnaire (WRQOL Scale) with a validity value of (0.780) and reliability of (0.950), a work fatigue questionnaire (KAUPK2) with a validity value of (0.468) and reliability of (0.911), and a work stress questionnaire (Perceived Stress Scale) with a validity value of (0.413) and reliability of (0.797). The data processing procedures include editing, coding, data entry, cleaning, and scoring. The data in this study were analyzed using the AMOS application to see the relationship between independent variables and dependent variables through intervening variables.

RESULTS

Based on the characteristics of the respondents in Table 1, it can be observed that the percentage of the age group <35 years is the highest, with a total 87 (69.6%), while ≥ 35 years with total 38 (30.4%). The percentage of gender shows that there are 91 male (72.8%) and 34 female (27.2%). Furthermore, the percentage of work experience among respondents is predominantly over 5 years, with a total of 117 (93.6%), while those with 5 years or less amount to only 8 (6.4%). Lastly, the distribution of respondents by unit shows that the unit with the highest number of respondents is ACC, with 78 (62.4%), followed by APP with 26 (20.8%), and ADC with 21 (16.8%).

Table 1. Distribution of Respondents Based on Characteristics of Air Traffic Controller (ATC) Employees in Makassar City. (n = 125)

Characteristics of the respondents	Frequency (%)
Age	
<35 year	87 (69,6)
≥ 35 year	38 (30,4)
Gender	
Female	34 (27,2)
Male	91 (72,8)
Masa Kerja	
≤ 5 year	8 (6,4)
> 5 year	117 (93,6)
Unit	
ACC	78 (62,4)
ADC	21 (16,8)
APP	26 (20,8)

Based on the direct hypothesis results in Table 2, several findings emerge. First, workload does not significantly affect work stress, fatigue, or quality of life, as indicated by p-values greater than 0.05 for all three relationships. While the influence direction is positive for work stress and negative for fatigue and quality of life, workload is not a direct determining factor in this study. In contrast, work life balance significantly impacts fatigue (p-value = 0.000) with a negative relationship and improves quality of life (p-value= 0.000) with a positive relationship. However, it does not significantly affect work stress, despite a negative relationship. Additionally, fatigue significantly increases work stress

(p-value =0.000) and decreases quality of life (p-value= 0.029). Finally, the relationship between work stress and quality of life is found to be insignificant.

Table 2. Results of Direct Hypothesis Testing. (n=125)

Parameters		Estimate	S.E.	C.R.	p-value	
Workload	→	Work Stress	0,035	0,036	0,949	0,343
Workload	→	Fatigue	-0,043	0,059	-0,728	0,467
Workload	→	Quality of Life	-0,080	0,106	-0,759	0,448
Work Life Balance	→	Work Stress	-0,041	0,067	-0,609	0,543
Work Life Balance	→	Fatigue	-0,487	0,099	-4,942	0,000
Work Life Balance	→	Quality of Life	0,995	0,195	5,112	0,000
Fatigue	→	Work Stress	0,288	0,057	5,049	0,000
Fatigue	→	Quality of Life	-0,399	0,182	-2,189	0,029
Work Stress	→	Quality of Life	-0,309	0,267	1,157	0,247

*p-value <0.05 : there is a significant influence

In Table 3, it shows that the analysis indicate that work stress does not significantly mediate the relationship between workload and quality of life. This is evidenced by a t-statistics value of 0.744 with a p-value of 0.457, which is well above the significance threshold (0.05). therefore, workload does not have a significant impact on quality of life through work stress. The results also show that work stress is not a significant mediator in the relationship between work life balance and quality of life with a t-statistics value of -0.541 and p-value of 0.589, this path does not have a meaningful effect. This indicates that the management of work life balance does not directly affect quality of life through a reduction in work stress. Fatigue also does not mediate the relationship between workload and quality of life. This is shown by a t-statistics value of 0.092 and p value of 0.927, meaning that workload does not have a significant indirect effect on quality of life through fatigue. Conversely, the analysis results indicate that work fatigue is a significant mediator in the relationship between work life balance and quality of life with a t-statistic value of 2.002 and p-value of 0.045, this path is significant, indicating that better work life balance can improve quality of life indirectly through a reduction in fatigue.

Table 3. Results of Indirect Effect Hypothesis Testing with The Sobel Test

	t-statistics	Std. Error	p-value
Workload → Work Stress → Quality of Life	0,744	0,015	0,457
Work Life Balance → Work Stress → Quality of Life	-0,541	0,023	0,589
Workload → Fatigue → Quality of Life	0,092	0,187	0,927
Work Life Balance → Fatigue → Quality of Life	2,002	0,097	0,045

*p-value <0.05 : there is a significant influence

Path analysis is a multivariate statistical method used to test causal relationships among complex variables. Figure 1 shows the path analysis from this study. In this research, two path models were developed. The first model examines the effect of workload and work life balance on quality of life through fatigue, while the second model investigates the effect of workload and work life balance on quality of life through work stress. In this model, fatigue and work stress serve as intervening variables to determine the presence of direct or indirect effects.

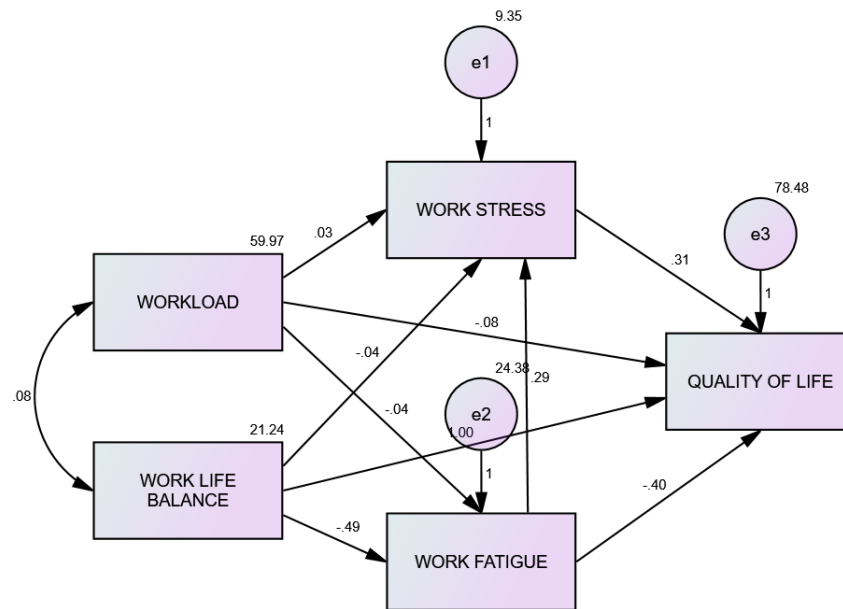


Figure 1: Path Analysis Model Construction

DISCUSSION

The Effect Workload on Fatigue

Based on the research results, it shows an insignificant effect. Although ATC have a high workload, this does not lead to excessive fatigue among ATC personnel. Fatigue before and after work does increase significantly, but it remains within reasonable limits. This means that the ATC personnel are still able to manage their workload and do not experience fatigue. This phenomenon can be explained by the psychological adaptation mechanisms possessed by ATC, in which ATC create conditions that make them feel more energetic and engaged in their work, thereby reducing their perception of work related fatigue. Additionally, other factors include high motivation and a strong sense of responsibility for flight safety. This is in line with the research by Triyanti et al. (2020), which explains that mental workload is not related to fatigue in ATC. This condition indicates that the maximum work time regulation of 2 hours implemented by ATC is already quite effective in preventing excessive fatigue.

The Effect Workload on Work stress

Based on the research results, it shows a positive but not significant effect. Based on the results of the correlational hypothesis test and frequency analysis conducted, it can be interpreted that the higher the workload experienced, the level of work-related stress can be either high or low. Therefore, workload does not automatically affect the work stress experienced by ATC personnel. This is in line with the research conducted by Ahmad & Wiwik (2019), which shows that there is no effect of workload on work stress among ATC at Ahmad Yani Airport in Semarang.

The Effect Workload on Quality of Life

Based on the research results, it shows that the effect is not strong enough to state that mental workload significantly affects the quality of life of ATC. One explanation for this phenomenon is that

ATC may have strong coping mechanisms, allowing them to maintain a positive perception of their quality of life. Their adaptability, social support, work experience, and other psychological factors may influence their perception of workload. This aligns with research by Kristanto et al. (2022), which found no relationship between workload and quality of life among ambulance personnel in Semarang city. Despite the heavy workload leading to fatigue and stress, high compassion satisfaction can help mitigate these negative effects, as ATC demonstrate good resilience in their work.

The Effect Work Life Balance on Fatigue

Based on the research results, it shows that an increase in work life balance is associated with a decrease in levels of fatigue. From the questionnaire research data, 91.2% of ATC have a balanced work life balance. ATC believe that a good balance between work and personal life can provide many benefits, such as reducing stress and fatigue, increasing productivity, and creating a healthy balance in life. This is line with the research by Lestari & Purba (2019), which explains that there is a relationship between work life balance and fatigue among hospital nurses, with a negative correlation indicating that the higher the work life balance, the lower fatigue, the results of this study show that the balance between work and personal life plays a significant role in reducing emotional fatigue, depression, and personal achievement.

The Effect Work Life Balance on Work Stress

Based on the research results, it shows that an indication work life balance can reduce work stress, however this relationship is not strong enough to be considered significant. Although WLB has an influence, its effect may be overshadowed by other more dominant variables. This is often the case in high pressure work contexts, where factors directly related to the job can be the primary causes of stress. Meanwhile, WLB functions more as a supportive factor. Another study by Ramdhan & Fajrianti (2021) explains that one dimension of work life balance, namely personal life interference with work (PLIW), has a significant value of 0.793 regarding work stress. This means that this aspect does not have a significant influence on work stress. However, in the results of this study, ATC employees tend to avoid bringing personal issues to the workplace. Given the heavy responsibilities of their duties, ATC strive not to carry their personal problems to work, as it can be dangerous if they do so.

The Effect Work Life Balance on Quality of Life

Based on the research results, it shows that significant positive relationship, where an increase in work life balance contributes to an improvement in the quality of life ATC. A good WLB not only enhances job satisfaction but also boosts work productivity, reduces stress, and promotes overall happiness, thereby improving quality of life (Chaeria, 2024). Another study by Lusiana et al. (2024) explains that the implementation of work life balance has the potential to enhance employee well-being. Employees who are able to manage their time and energy, whether for work or personal life, will become more productive. On the other hand, an organization that prioritizes WLB will experience employee retention, employee satisfaction, and overall performance.

The Effect Fatigue on Quality of Life

Based on the research results, it shows that the results are negative and indicated that the lower fatigue, the higher quality of life tends to be. Other studies by Zhou et al, have proven that work fatigue can affect quality of life. This research developed a mediation model by analyzing the relationship between fatigue and quality of life, with findings suggesting that psychological resilience and self efficacy can mediate the relationship between fatigue and quality of life (Peng et al., 2021). This is in line with the research by Rachmadina & Puspitadewi (2019), which shows a significant relationship between work fatigue and safety performance among ATC workers at a public company in Indonesia. If work fatigue can affect the decline in safety performance among ATC, it will also

impact their performance and quality of life. Unlike the study conducted by Saleh et al. (2022), which explains that work fatigue does not have a direct impact on the quality of life of 185 ATC.

The Effect Work Stress on Quality of Life

Based on the research results, it shows that although the relationship is negative, the effect is not statistically significant. This means there is an indication that an increase in work stress lowers quality of life, but in the context of this study, the relationship is not strong enough to be recognized as significant. When regression results shows a negative but insignificant relationship, it may be due to other variables that have a stronger influence on quality of life. Research by Akinwale et al. (2024) explains that there is no effect of work stress on quality of life among nurses in Osogbo. This is evidenced by the correlations results, which yielded a p-value of 0.059. In reality, work stress can have certain positive impacts, such as fostering strong motivation in the workplace. As a result, workers may achieve high performance, be more productive, and provide inspiration to contribute to improving quality of life (Konitasari et al., 2023).

The Effect Fatigue on Work Stress

Based on the research results, it shows that fatigue significantly contributes to the increase in work stress among ATC. The higher the level of fatigue experienced by ATC, the higher the level of stress they feel. Fatigue acts as a protective mechanism for the body to prevent damage. However, if prolonged fatigue occurs, it can lead to stress, tension, and disruptions in daily life stability (Yulenda, 2021). Another study by Asya & Hodi (2023) analyzes the factors causing work stress among ATC at Airnav Adi Soemarmo International airport. The research findings indicate, both physically and mentally. There is data showing that 70% of aviation accidents related to human factors are caused by fatigue, lack of sleep, and circadian disruptions, as flight operations can affect performance and flight safety. In Indonesia, incidents involving aircraft due to alleged errors by ATC still occur. One example is the near-miss incident involving Garuda Indonesia and Lion Air in 2015 at Sultan Hasanuddin airport. A similar incident occurred in the United States in 2011, where an ATC officer allegedly fell asleep due to fatigue, causing both aircraft to land without guidance from the controller (Susanti, 2016).

The Effect Workload on Quality of Life through Fatigue

Based on the research results, it shows that the effect of workload on quality of life through fatigue has a t value of 0.092 and p value of 0.927. The results indicate that fatigue does not mediate the effect of workload on quality of life among Air Traffic Controllers (ATC) for several reasons, including the presence of compensation through other mechanisms. This means that ATCs use alternative strategies to cope with their workload, such as social support, good time management, or effective coping techniques. These strategies can reduce the direct impact of fatigue on quality of life, even when workload increases. Additionally, quality of life may be influenced by other variables, such as stress management, work hour arrangements, or other psychological factors, which may be more dominant than fatigue (Babapour et al., 2022). Another factor is tolerance to workload; ATCs who are accustomed to high workloads have a higher tolerance for fatigue. The research explains that longer work experience or continuous exposure to high stress can increase the threshold for fatigue, so that fatigue does not significantly affect quality of life (Saleem & Malik, 2023).

Other studies explain that factors beyond work fatigue, such as social support from colleagues and supervisors, can help individuals manage stress and fatigue. Their study shows that individuals with strong social support are better able to cope with the challenges of high workloads, so their quality of life is not negatively affected by fatigue (Zhou et al., 2024). Furthermore, a study aligned with this research explains that there is not significant effect of fatigue as an intervening variable between workload and employee performance at Bank Nagari, Pasar Raya Branch, Padang. This study shows t-statistic value of 0.380 and p-value of 0.704, indicating that work fatigue does not function as a

mediating variable in the effect of workload on employee performance (Abel & Mariyanti, 2024). Additionally, research explains that the indirect effect of workload on mental health through fatigue among healthcare workers during the Covid-19 pandemic shows p-value of 0.126, meaning that fatigue is not significant as an intervening variable in the effect of workload on mental health (Peng et al., 2021).

The Effect Workload on Quality of Life through Work Stress

Based on the research results regarding the effect of workload on quality of life through work stress, it shows a t-statistic value of 0.744 and p value of 0.457. this indicates that the effect is not statistically significant. Furthermore, a study aligned with this research by Sari et al. (2022) explains that work stress is not significant as an intervening variable in the effect of workload on employee performance. Additionally, another study by (Annisa et al., 2024) shows that work stress among ATC employees does not relate to the impact of mental workload on work productivity, with p-value of 0.046. Another study by Babapour et al. (2022) found that work stress has a direct and significant effect on quality of life, however work stress does not always mediate specific outcomes. This is supported by research, which explains that the social support received by ATCs in Riyadh, Saudi Arabia, plays a significant role in reducing the detrimental effects of workload on ATC performance. This means that the higher the social support provided, the lower the work stress experienced (Alaydi & Ng, 2024).

Other factors, such as management style, also contribute at the management system in the ATC work environment is well implemented. One aspect is the attention given to employee career development through promotions or the provision of facilities, which motivates ATCs to improve their performance and quality of life. Moreover, the factor of job experience can influence the relationship between stress and performance, lower work experience can trigger work stress. However, the average respondents have good job experience, so ATCs do not face difficulties as they are accustomed to and experienced in their jobs. This is supported by research from Galuh et al, which explains that ATCs at the Airnav office in Surabaya have good job experience, thus not diminishing their performance and quality of life (Galuh & Tjahjoanggoro, 2019).

The Effect Work Life Balance on Quality of Life through Fatigue

Based on the research results regarding the indirect effect of work life balance on quality of life through fatigue among Air Traffic Controllers, it shows t-statistic value of 2.002 and p-value of 0.045. this indicates that the indirect effect of WLB on quality of life through fatigue is significant, as the p-value is less than 0.05. this is in line the research by Handawani et al. (2024), which shows that Perumda Tirta Jaya Mandisi has successfully built work quality of life, emotional fatigue, and good work performance among its employees. Work quality of life significantly affect emotional fatigue, and emotional fatigue significantly affects employee performance. Emotional fatigue can also serve as an affective mediator in the relationship between work quality of life and employee performance. A balanced work-life balance is a concept that integrates. The implementation of work life balance programs within a company can enhance employee satisfaction, leading to increased productivity in carrying out tasks and responsibilities (Dhaniswari & Sudarnice, 2024).

Research indicates that a good work-life balance improves the quality of life for ATC by reducing fatigue. Understanding this relationship allows company management to develop programs and policies that support employee well-being, such as adequate break times, mental health initiatives, and recreational activities. Investing in work-life balance benefits individuals and enhances productivity and performance within the company.

The Effect Work Life Balance on Quality of Life through Work Stress

Based on the research results regarding the indirect effect of work life balance on quality of life through work stress among ATCs, it shows a statistical value of -0.541 and p-value of 0.589. this high

p-value indicates that the indirect effect between WLB and quality of life through work stress is not statistically significant. As a profession, WLB should ideally help reduce work stress, however it seems that other factors may be more dominant in determining stress levels and quality of life. For instance, high work pressure and significant responsibilities can lead to stress regardless of efforts to maintain a balance between work and personal life.

A study by Aviola et al. (2022) found that work stress does not mediate the relationship between work-life balance and job satisfaction among employees at the immigration office in Padang. Employees with a balanced work-life experience high job satisfaction, as they can set aside work pressures, resulting in lower stress level. Similarly, research by Harvey et al. (2022) indicate that work stress is not a significant intervening variable in the effect of work-life balance on job satisfaction among couriers at PT. JNE Express Ambon, with a p-value of 0.657. These findings suggest that a balanced work-life enhances job satisfaction and quality of life for employees, indicating that work stress does not negatively impact their quality of life.

CONCLUSION & RECOMMENDATIONS

Based on results of the study conducted on Air Traffic Controller (ATC) employees and referring to the problem formulation, it was found that workload does not have a direct or indirect effect on quality of life of ATC employees. However, work life balance can influence the quality of life of ATC employees, both directly and indirectly (through work-related fatigue). It is recommended that ATC employees maintain their physical and mental health, get adequate rest, and continue to uphold a work life balance. For companies, it is recommended that management consider implementing progressive muscle relaxation techniques during each work shift to reduce or alleviate psychological disturbances, thereby optimizing air navigation services. Additionally, they should manage employee workload and provide annual exemplary awards to motivate and encourage ATC in their work. For future researchers, it is suggested to enrich theoretical concepts by considering other variables that have not been previously studied, which may have an impact on quality of life. For subsequent research, it is advisable to use qualitative research methodologies to delve deeper, resulting in findings that better support the phenomena occurring among ATC.

LIMITATIONS

This research was conducted over a limited period, which restricts the researcher's ability to observe the long-term effects of the variables studied. With the limited time frame, changes in dynamics in the field, both in terms of working conditions and ATC responses to workload, work stress, and fatigue may not be fully measurable.

Authors Contribution : ZAF conceptualized idea, drafted the manuscript, conducted the research, and analyzed the data. LM assisted in developing the idea, and conceptual framework. SSR provided guidance on research methodology. YT supervised the manuscript writing. AW contributed to the development of the discussion section. AM provided guidance on field research methodology and contributed to the development of the research background.

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Ethical approval by the Public Health Faculty Hasanuddin University, Makassar. (Ref no: 1255/UN4.14.1/TP.01.02/2024 dated 21/05/2024). Before data collection and interviews, the researcher explained the research objectives, methods and written consent.

Availability of Data and Material: The data that support the findings of this study are available from the corresponding author on request.

Competing interest: The authors declare that there are no conflicts of interest.

Consent for publication: The article has not been published in any other journal and is not currently under consideration by another journal.

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