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Research Article

A Quasi-Experimental One Group Pre-Post Test Design in Air Traffic Controller in Indonesia: Progressive Muscle Relaxation

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ABSTRACT

Objectives: The effectiveness of progressive muscle relaxation (PMR) in assessing the general health of air traffic controllers (ATC) is still insufficient, specifically when examining the psychological conditions of workers who use questionnaire instruments. Therefore, this research aimed to evaluate the use of PMR program in ATC by developing a model using biomarkers (saliva) tested on the cocorometer stress diagnostic tool and validity, including observing related determinants in the work environment. **Methods:** A quasi-experimental method was used, focusing on one group pre-post-test design for 92 respondents across six research areas in Indonesia. All respondents had received training in PMR methods conducted by psychologists. Subsequently, ongoing assistance was provided in implementing relaxation by a trained reminder team for eight weeks to maintain the precision and effectiveness of the intervention. Further analysis was conducted using the Wilcoxon signed rank test to evaluate the success of the intervention. **Results:** The implementation of PMR program in ATC reduced the incidence of stress levels after the observation. Statistically, the feeling of fatigue was a significant variable that decreased in mean value after the implementation of the relaxation program on the data review. The main benefit of PMR program in improving psychological health conditions (stress) was found in Surabaya branch ATC. **Conclusions:** The relaxation program was proven to reduce stress levels in ATC, showing an improvement in conditions before and after the implementation of PMR.

Key words: Air traffic controller, Cocorometer, Flight navigation, Progressive muscle relaxation, Stress.

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INTRODUCTION

Airspace traffic in Indonesia is increasing along with the stability of the aviation industry system, specifically during the post-Covid-19. This significant growth is further accentuated by the reopening of new flight routes, both domestically and internationally[1,2]. The addition of new routes has implications for additional tasks of air traffic controllers (ATC) in analyzing aircraft movements for almost the same time interval to maintain the highest safety, namely avoiding accident crashes. Based on the data obtained before the COVID-19 pandemic, AirNav Indonesia manages approximately 7,539,693 Km2 of airspace, serving an average of 6,125 aircraft movements per day[1]. Referring to safety rules by observing the domino theory representing cause-effect in a chain reaction, the burden of high vigilance in navigation services by ATC is a basic factor in the occurrence of bodily responses. These responses are in the form of psychological health disorders capable of affecting controller performance in relation to fatigue feelings[3,4], and muscle tension as a reflex reaction to stress response[5].

According to the literature review, stressors experienced by ATC include workload (heavy level)[6,7,8], shift schedule[7,8], equipment or work facilities[9], the position of aircraft close to each other in airspace[10], family-work conflict[11]. The efforts to control psychological disorders in the form of implementing progressive muscle relaxation (PMR) have proven significant among workers, serving as a concern for occupational safety and health rules[12,13]. According to the theory by Joseph Wolpe, the routine application of PMR is an ideal response to a better body or counter-conditioning, where relaxation is capable of increasing β-Endorphin to form Immunity[14]. Several factors have been identified to improve the validity of the plan to implement a routine occupational health program in ATC workplace, as supported by the Directorate General of Air Transport. These include the use of PMR programs in ATC including developing a method for assessing occupational stress experienced using a cocorometer with saliva biomarkers as a barometer for determining stress indices. Furthermore, there is a need to observe the impact of PMR implementation on related determinants in the work environment.

The determination of saliva as a biomarker of stress levels in individuals has been showed by various previous research including the identification of recovery[15]. Consequently, this research aimed to detect ATC stress conditions in Indonesia using a diagnostic cocorometer tool by reviewing stress levels before and after the application of PMR. Based on the analysis, a significant correlation was found, where higher amylase levels in a person's saliva result in greater stress levels. The results emphasized the significance of counterconditioning through PMR to establish a model of harmony and balance at work.

METHODS

Research Design

This research used a quasi-experimental one-group pre-post-test design, carried out for two months

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between late August and late October 2023. The subjects were selected from respondents who participated in research conducted in 2021-2022. Respondents who took time off work/mutation were excluded ensuring that new subjects were obtained based on willingness to partake in the intervention training at early stages with the support of shift coordinators at each AirNav branch.

Sample

The number of samples for each region was adjusted to the members of individual AirNav in the six research areas. This was carried out to ensure a total of 92 respondents participated based on eligibility, as shown in Figure 1. However, certain activities, including employee transfers, leave, and other conditions, reduced the number of samples to 71 respondents who met the criteria for participating in the relaxation program during the 2 months of observations.

Procedure

All respondents passed through the same series for the assessment of time points, namely the commencement and conclusion of observation. At the initial stage, all respondents filled out a questionnaire (pre-test) and checked health status such as oxygen saturation, pulse rate, and blood pressure, including stress levels using a diagnostic stress tool or cocorometer. This stress barometer used saliva biomarkers, where test strip from the cocorometer was inserted into the oral cavity precisely under the tongue ranging from 30 seconds to 1 minute for the absorption of saliva. Subsequently, saliva sample collected on the strip was inserted into the cocorometer for analysis. After a few moments, the results of the examination appeared on the monitor. Based on the standard cocorometer, stress levels ranged from a minimum of 10 to a maximum of 150, and the higher amylase level in salival corresponded to greater stress perceived.

Respondents were regularly assisted by trained enumerators in implementing PMR after the control or as a daily routine during the eight weeks of observation. After the observation, the same questionnaire format (post-test), assessment of health status, and reassessment of stress levels using a diagnostic tool were conducted. This research obtained ethical approval from Ethics Commission, Faculty of Public Health, Hasanuddin University, with protocol number 14723105016.

Instrument

Data collection was carried out by interviewing ATC respondents in the research area using a standardized questionnaire. Meanwhile, the details of the tools used were a cocorometer to detect stress levels made by Nipro Corporation Cocoro Meter, Osaka, Japan, and a feeling of fatigue instrument through the Setyawati questionnaire in 1994. Regarding health status, several health measurements were taken, including oxygen saturation, pulse rate, and blood pressure. Oxygen saturation and pulse rate were measured using an oximeter, while blood pressure was measured with a manual sphygmomanometer. Criteria for measuring blood pressure and pulse rate referred to the American Heart Association category, while oxygen assessment was based on the WHO category. For quality of life assessment, references were made to the Quality of Work Life (QoWL) questionnaire published by the Research and Consultancy Group at the Department of Psychology, University of Portsmouth.

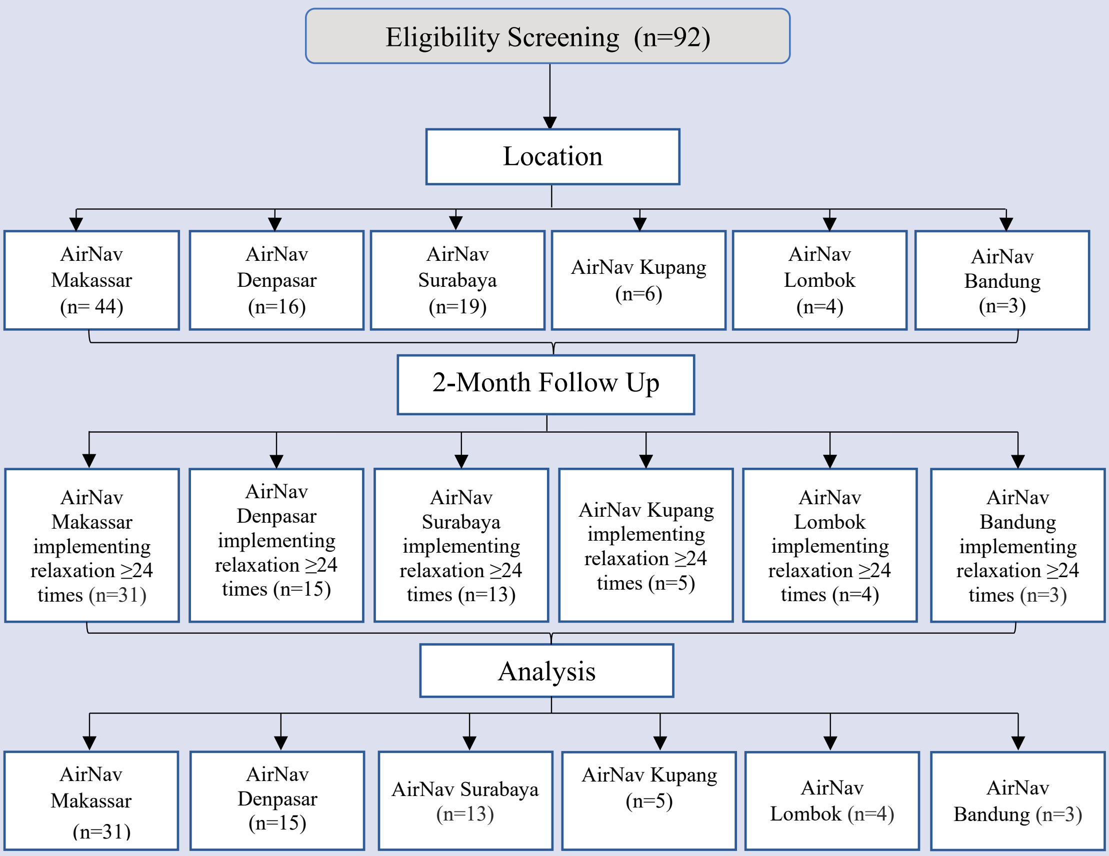

Figure 1. Flowchart of Study Participants.

Statistical Analysis

The analysis was carried out through several stages starting from editing, coding, entry, cleaning, to tabulation, to compare the average score of success indicators before and after the intervention. Subsequently, Wilcoxon was used to review the effectiveness after the observation. The analytical tools used were SPSS 23 software and Microsoft Office Excel 2016 during the entry process.

RESULTS

Table 1 shows that respondents are predominantly male with a percentage of 77.5%, where most have completed diploma/S1 level education (95.8%). Furthermore, the age category shows a slightly higher representation in the <36 years compared to the age ≥ 36 years. Regarding marital status, 80.3% are married, and 87.3% have a working period of >5 years.

Based on the results of stress conditions in Figure 2, there were eight occurrences of stress with various levels and 63 respondents in non-stress conditions for the initial observation of the entire research area (ALL). After the implementation of PMR for 2 months, there was an improvement in stress levels across several research areas.

Based on the review in Table 2 regarding the condition of the fatigue perceived at the beginning of the observation, there was no severity identified. Related conditions were found only in the categories of moderate and mild fatigue. After the observation or the implementation of PMR, respondents experiencing fatigue decreased, increasing the number of those who were not tired. At the commencement of the observation, 4 respondents (5.6%) experienced low oxygen levels. However, after the post-test observation, the condition of low oxygen levels became normal.

The high category pulse rate variable in the initial observation was found in one respondent, precisely in the Surabaya City research area. After the observation, these conditions had improved to normal. The results of identifying normal blood pressure conditions increased at the end of the observation. Moreover, the review of hypertension after the implementation of PMR caused a significant reduction. This included grade 2 hypertension from 12.7% to 4.2%, while normal conditions increased from 54.9% to 71.8%. The results of workers' quality of life presented in Table 2 showed a significant increase after the implementation of PMR from 70.4% to 84.5%, as observed

Table 1. Frequency and Distribution of Characteristics among ATC.

Respondent Characteristics	n	%
Gender		
Female	16	22.5
Male	55	77.5
Education		
S2	2	2.8
Diploma/S1	69	97.2
Age		
≥ 36 years old	25	35.2
< 36 years	46	64.8
Marital Status		
Not married	14	19.7
Married	57	80.3
Period of Employment		
> 5 years	62	87.3
≤ 5 years	9	12.7

Source: Primary Data, 2023

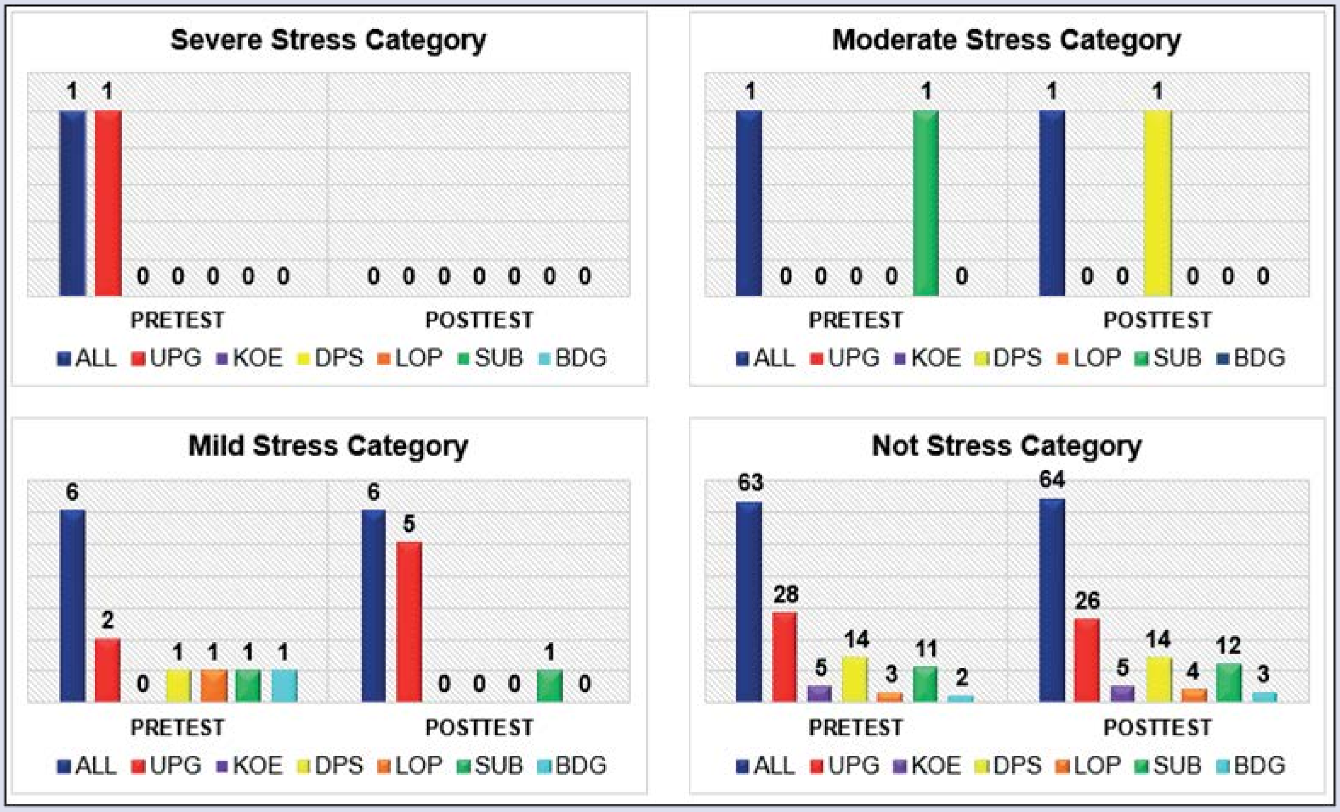

Figure 2. Graph of Pretest and Posttest of Psychological Condition (Stress).

Table 2. Frequency and Distribution of Pretest and Posttest Feelings of Fatigue, Oxygen Level, Pulse Rate, Blood Pressure, and Quality of Life.

Variable	Research Area													
	ALL		Makassar (UPG)		Kupang (KOE)		Denpasar (DPS)		Lombok (LOP)		Surabaya (SUB)		Bandung (BDG)	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Feeling of Fatigue														
Heavy	**0 (0.0%)**	**0 (0.0%)**	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Moderate	**4 (5.6%)**	**2 (2.8%)**	1 (3.2%)	2 (6.5%)	1 (20.0%)	0 (0.0%)	1 (6.7%)	0 (0.0%)	1 (25.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Light	**10 (14.1%)**	**7 (9.9%)**	9 (29.0%)	4 (12.9%)	1 (20.0%)	2 (40.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (25.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Heavy	**57 (80.3%)**	**62 (87.3%)**	21 (67.7%)	25 (80.6%)	3 (60.0%)	3 (60.0%)	14 (93.3%)	15 (100%)	3 (75.0)	3 (75.0)	13 (100%)	13 (100%)	3 (100%)	3 (100%)
Oxygen Content														
High	**0 (0.0%)**	**0 (0.0%)**	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Low	**4 (5.6%)**	**0 (0.0%)**	1 (3.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (6.7%)	0 (0.0%)	1 (25.0%)	0 (0.0%)	1 (25.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Normal	**67 (94.4%)**	**71 (100%)**	30 (96.8%)	31 (100%)	5 (100%)	5 (100%)	14 (93.3%)	15 (100%)	3 (75.0)	4 (100%)	12 (92.3%)	13 (100%)	3 (100%)	3 (100%)
Pulsa Rate														
High	**1 (1.4%)**	**1 (1.4%)**	0 (0.0%)	1 (3.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (7.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Low	**7 (9.9%)**	**6 (8.5%)**	1 (3.2%)	2 (6.5%)	0 (0.0%)	1 (20.0%)	2 (13.3)	3 (20.0)	2 (50.0%)	0 (0.0%)	2 (15.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Normal	**63 (88.7%)**	**64 (90.1%)**	30 (96.8%)	28 (90.3%)	5 (100%)	4 (80.0%)	13 (86.7)	12 (80.0)	2 (50.0%)	4 (100%)	10 (76.9%)	13 (100%)	3 (100%)	3 (100%)
Blood Pressure														
Hypertension Crisis	**0 (0.0%)**	**0 (0.0%)**	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Grade 2 Hypertension	**9 (12.7%)**	**3 (4.2%)**	5 (16.1%)	3 (9.7%)	1 (20.0%)	0 (0.0%)	1 (6.7%)	0 (0.0%)	1 (25.0%)	0 (0.0%)	1 (7.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Grade 1 Hypertension	**15 (21.1%)**	**8 (11.3%)**	7 (22.6%)	6 (19.4%)	0 (0.0%)	0 (0.0%)	3 (20.0)	0 (0.0%)	2 (50.0%)	1 (25.0%)	2 (15.4%)	1 (7.7%)	1 (33.3%)	0 (0.0%)
Hypertension	**8 (11.3%)**	**9 (12.7%)**	1 (3.2%)	2 (6.5%)	0 (0.0%)	0 (0.0%)	1 (6.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (46.2%)	6 (46.2%)	0 (0.0%)	1 (33.3%)
Normal	**39 (54.9%)**	**51 (71.8%)**	18 (58.1%)	20 (64.5%)	4 (80.0%)	5 (100%)	10 (66.7%)	15 (100%)	1 (25.0%)	3 (75.0)	4 (30.8%)	6 (46.2%)	2 (66.7%)	2 (66.7%)
Quality of Work Life														
Low	**4 (5.6%)**	**1 (1.4%)**	1 (3.2%)	1 (3.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (15.4%)	0 (0.0%)	1 (33.3%)	0 (0.0%)
High	**50 (70.4%)**	**60 (84.5%)**	20 (64.5%)	23 (74.2%)	2 (40.0%)	4 (80.0%)	15 (100%)	15 (100%)	1 (25.0%)	3 (75.0)	11 (84.6%)	13 (100%)	1 (33.3%)	2 (66.7%)
Normal	**17 (23.9%)**	**10 (14.1%)**	10 (32.3%)	7 (22.6%)	3 (60.0%)	1 (20.0%)	0 (0.0%)	0 (0.0%)	3 (75.0)	1 (25.0%)	0 (0.0%)	0 (0.0%)	1 (33.3%)	1 (33.3%)

Quality of Work Life

Table 3. Changes in Health Indicators Before and After PMR.

Variable		Research Area													
		ALL		Makassar (UPG)		Kupang (KOE)		Denpasar (DPS)		Lombok (LOP)		Surabaya (SUB)		Bandung (BDG)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Work Stress	Pretest	12.73	13.759	11.06	15.340	9.40	8.414	13.87	10.895	15.25	16.338	15.46	15.131	14.67	14.224
	Posttest	11.79	12.117	14.06	12.884	10.20	8.075	10.20	15.044	14.50	7.895	7.69	8.741	13.00	12.288
	p-value	***0.699***		***0.063***		***0.715***		***0.102***		***0.715***		***0.049***		***0.18***	
Feelings of fatigue	Pretest	2.45	2.787	3.19	2.833	3.40	4.450	1.87	2.503	2.75	4.193	.92	1.188	2.33	2.082
	Posttest	1.82	2.486	2.65	2.927	2.80	3.421	.87	.990	2.50	3.697	.54	.776	1.00	1.000
	p-value	***0.016***		***0.341***		***0.655***		***0.054***		***0.317***		***0.163***		***0.157***	
Oxygen saturation	Pretest	97.42	2.719	97.52	1.338	97.00	1.225	97.13	4.809	96.75	3.304	97.69	2.750	98.33	1.155
	Posttest	97.96	1.281	97.74	1.460	97.80	1.643	98.20	.941	97.75	1.893	98.08	.954	99.00	0.000
	p-value	***0.228***		***0.328***		***0.336***		***0.774***		***0.715***		***0.751***		***0.317***	
Pulse (Per minute)	Pretest	77.7	11.999	77.74	9.356	82.20	11.476	77.93	13.014	68.50	16.703	78.85	16.426	76.00	2.646
	Posttest	77.63	11.207	76.58	11.983	74.80	13.442	72.13	9.219	91.00	4.546	83.85	7.679	76.00	5.000
	p-value	***0.515***		***0.509***		***0.138***		***0.069***		***0.109***		***0.221***		***1.000***	
Blood pressure (Systole)	Pretest	121.59	14.564	120.65	15.478	118.00	17.889	118.67	9.904	140.00	27.080	124.08	7.135	116.67	15.275
	Posttest	118.86	11.763	121.45	14.387	108.00	13.038	116.67	6.172	120.00	8.165	120.92	5.469	110.67	16.921
	p-value	***0.096***		***0.756***		***0.102***		***0.366***		***0.18***		***0.092***		***0.102***	
Blood pressure (Diastole)	Pretest	77.9	10.142	78.10	12.421	68.00	8.367	78.00	9.411	81.25	2.500	79.62	4.519	80.00	10.000
	Posttest	78.37	9.436	79.35	12.893	74.00	8.944	76.00	5.071	76.25	4.787	80.15	3.313	82.33	4.933
	p-value	***0.603***		***0.505***		***0.18***		***0.426***		***0.157***		***0.812***		***1.000***	
Quality of Work Life	Pretest	87.46	11.725	86.35	9.779	81.20	6.723	94.53	7.927	81.00	7.257	88.08	18.136	80.00	11.533
	Posttest	89.87	8.814	87.45	8.648	89.00	12.145	93.47	7.900	93.00	12.987	92.38	6.239	83.33	8.021
	p-value	***0.101***		***0.359***		***0.176***		***0.46***		***0.068***		***0.972***		***0.18***	

in almost all research areas. Furthermore, the Wilcoxon Signed Test analysis presented in Table 3 showed that after the implementation, the feeling of fatigue became a significant variable (p=0.016). This showed that there was a significant influence on the occurrence of positive effects in the routine implementation of PMR performed by AirNav employees after control. Based on the analysis per research area for other significant variables, namely on the variable of work stress in the Surabaya research area, there were positive effects of PMR during the 2 months of observation. These effects were observed in terms of reducing the average value of stress levels in employees who routinely or at least carry out PMR ≥24 times, with a significance test value of p=0.049. Although only one research area was found to be statistically significant in reducing stress conditions, further review in Table.3 per region showed a decrease in average stress levels for DPS, LOP, SUB, and BDG. Among these areas, UPG had the lowest health degree improvement conditions in terms of mean value analysis.

DISCUSSION

The results showed that there was improvement in health conditions in ATC with the implementation of PMR. This was evident based on changes in the data profile at the commencement of the observation, specifically concerning the results of stressful events. Although the intervention outcomes were small, further analysis of the data review showed significant benefits of PMR in reducing feelings of fatigue in ATC.

Fatigue serves as a marker of a prolonged state of stress[16]. Additionally, engaging in activities that stimulate the brain can induce a state of mental fatigue comparable to physical fatigue, manifesting in work performance[17,18]. These results have practical implications regarding the importance of implementing PMR as stress management effort, according to protracted stress conditions in ATC that are unavoidable[6,7,8,19]. Implementing PMR serves as support for enforcing occupational health and safety rules, where fatigue has contributed to the onset of cardiovascular disease and cancer[16].

PMR can be applied in the work environment by the formation of a natural and healthy behavior modification or counterconditioning among ATC. The application of PMR enables ATC to manage excessive work pressure and release stress without disruption. The meta-analysis research of M. Zhang et al (2021) concluded that by implementing relaxation, individual stress conditions would decrease, including a reduction in feelings of fatigue, as reported by Semerci et al (2021); Asokawati & Hastuti (2023)[12,20,21].

The work profession in the aviation sector has a busy schedule, emphasizing the importance of considering rest and work time patterns, particularly for ATC officers. This is an important point for future research to consider each observation using a fast instrument in the assessment process, specifically standardized electronic instruments, to determine the value of test parameters.

CONCLUSION

This research showed that stressful conditions were persistent among ATC professionals due to the task responsibilities of controlling air traffic. However, the incorporation of emotional coping mechanisms was recommended as a countermeasure because unaddressed psychological conditions could have short-term and long-term effects on health, decreasing individual performance, and resulting in poor credibility. Therefore, the benefits of PMR in the scope of ATC work in reducing feelings of fatigue and stress levels served as a to strengthen or support capacity in resources.

DECLARATION OF CONFLICTING INTEREST

The authors declare that there are no significant competing financial, professional, or personal interests that might have affected the performance.

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AUTHORS CONTRIBUTIONS

L.M.S the main person in charge who substantial contributions to study design until involved in drafting article, S.S.R, who substantial contributions to critical review with important intellectual contributions especially in the study of medicine, I.T who substantial contributions to critical review with important intellectual contributions especially in the study of physcology, I.H.Y and Y.R, who substantial contributions to conception and design of work, analysis and interpretation of data. N.M.S and M.Y who substantial contributions to accountable for all aspects of the work in ensuring that questions related to accuracy or integrity of any part of work are appropriately investigated and resolved.

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