International Journal of Public Health Science (IJPHS)
Vol. 14, No. 1, March 2025, pp. 200~210
ISSN: 2252-8806, DOI: 10.11591/ijphs.v14i1.24492

The effectiveness of progressive muscle relaxation for air traffic controller in Indonesia

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Article Info

Article history:

Received Jan 18, 2024
Revised May 10, 2024
Accepted May 18, 2024

Keywords:

Air traffic controllers
Anxiety
Progressive muscle relaxation
Psychological fatigue
Quality of life

ABSTRACT

Evaluation of progressive muscle relaxation (PMR) intervention testing is deemed necessary for air traffic controllers as their role in controlling aircraft airways requires high focus with stable physical and mental conditions. This study aimed to analyze the effectiveness of progressive muscle relaxation in improving health status, quality of life, and reducing psychological fatigue in air traffic controllers. A quasi-experimental pre-test post-test control group design was employed, involving 184 participants separated into intervention and control groups. The results showed that there was a significant difference in the pulse rate, oxygen level, specific diastolic blood pressure, depression, anxiety, quality of life domains 1 and 2, as well as feelings of fatigue before and after progressive muscle relaxation was implemented with $p<0.05$ but not in control group at the end of the observation. The Mann-Whitney U-Test results indicated that anxiety and pulse rate are variables reduced significantly in the two groups. It can be concluded that the implementation of PMR is effective to improve the health status, quality of life, and reduce psychological fatigue among controller in Indonesia.

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1. INTRODUCTION

Progressive muscle relaxation (PMR) has been demonstrated to be an efficacious technique in diminishing stress levels and enhancing mental well-being. This relaxation is very efficient because it positively affects physical and mental health [1]–[3] only with safe movements, short time, and no cost or just do short stretches between work activities without the need to purchase special equipment [4], [5]. Moreover, PMR has been discovered to notably diminish pain among the elderly [3]. Over eleven decades ago, pioneer physician, Edmund Jacobson discovered PMR and proved its effectiveness as a therapy in the medical sector, such as being beneficial in controlling blood pressure [6], negative emotional (stress, anxiety, and depression) [3], [7], [8], increase self-esteem and self-efficacy [4], reduce chemotherapy side effects [9], and as a measure of pain [5]. It was reported that it reduces anxiety, improves sleep quality, and enhances the quality of life among COVID-19 sufferers [10]–[12].

Considering the benefits of PMR in the medical field as a non-pharmacological therapy, the development of relaxation interventions to improve air traffic controller (ATC). Performance in Indonesia is considered highly important given the high scale of mental workload [13], [14]. In which air traffic controllers

are responsible for qualitative workload [15] of safely directing aircraft, ensuring sufficient separation between aircraft including by providing instructions to pilots, as well as managing emergency situations [14], [16]. This can cause morbidities such as depression, anxiety, stress, and others [17], [18]. Several studies also reported that the ATC workload was significantly heavy and affected them psychologically [13], [14], as well as had an impact on work performance [19].

Investigations in the last few years that review the effectiveness of PMR in active workers are very limited and are still in the medical scope, such as the effectiveness in nurses [20]. This empirical evidence of PMR efficacy can promote the implementation to improve the health status of workers both in government agencies and private institutions. The aviation industry's scope encompasses stringent regulations underscoring the significance of both physical and mental fitness. For instance, as outlined in regulation No. 69/2017 by the Minister of Transportation, Republic of Indonesia concerning Aviation Safety Regulations Subpart C Medical Requirements 67,203, a person must not suffer from diseases or disabilities that can interfere with the smooth work process. Additionally, the psychological disorder factor is one of the conditions for not being allowed to receive a personnel health license.

The concept of stress has evolved and is seen as an ongoing adaptive process [21]. Starting from stress can have a serious impact on a person's mental and physical health, to the body's response to stress by releasing chemicals in the blood which can cause chronic health conditions such as hypertension and coronary heart disease, requiring internal treatment [21]–[23]. This can be illustrated through the air traffic controller, where there are very high workload demands which result in conditions of fatigue and muscle tension as a reflex response to stress, which can develop into a serious illness. The International Civil Aviation Organization (ICAO) states that the absence of accidents is not a sign of quality neglect, it requires continuous improvement, especially in quality and safety-oriented human resources. In light of the foregoing, a renewed focus on continuous improvement within human resources, particularly with regard to quality and safety initiatives, is deemed essential.

2. METHOD

This study utilized a quasi-experimental pre-test post-test control group design, respondents were allocated to intervention and control groups based on their willingness to participate in intervention training at the outset of the study, facilitated by the support of shift coordinators in each AirNav branch. Structured questionnaire interviews were carried out to assess intervention outcomes at the commencement and conclusion of the intervention period. The interventions were evaluated at two junctures: at the outset and following the intervention. Ethical clearance was secured from the Ethics Commission of the Faculty of Public Health, Hasanuddin University, under protocol number: 14222105002.

The sample sizes in each subgroup, encompassing both intervention and control groups, were adjusted to match the count of AirNav members in the six chosen research areas. This agreement was reached through a focus group discussion involving the research team, AirNav Indonesia Personnel Control and Evaluation Manager, several AirNav general managers, and International Air Traffic Controller Association (IATCA) chair and members. A sample stratification method was applied across the six selected AirNav strata, beginning with the main, intermediate, and primary branches, ensuring a balanced representation for analysis. Limited sample sizes in some research areas were due to resource constraints and the busy schedules of ATCs, impacting control and other work-related activities. Despite efforts to optimize available samples, this limitation persisted, discussions with controller coordinators were held to adapt to these conditions and work activities.

The sample size employed in this research adhered to the standards outlined in Krejcie and Morgan's 1970 seminal article on determining sample size for research activities [24], although Krejcie and Morgan's reference is dated, it provides a robust foundation, methodological credibility, and enables better comparability and reproducibility within the research community when determining sample size for studies. The study population initially comprised 340 individuals, with 181 responses obtained. Following adjustments for the number of respondents from selected research areas, the final participant count was based on eligibility criteria. This resulted in a total of 184 respondents, with a 1:1 ratio maintained between the intervention and control groups as shown in Figure 1. All respondents underwent the same initial stages, which involved completing a pre-test questionnaire. Additionally, the intervention group received specific training on the implementation techniques of PMR. This training was facilitated by the research team, comprised of clinical psychologists. The relaxation training was conducted for the intervention group respondents, who were gathered in a single meeting room and instructed on the appropriate PMR stages. Subsequently, the intervention group implemented the results of the relaxation training before and after their aircraft control duties, with the aim of promoting relaxation or reducing muscle tension.

This activity was conducted over an eight-week observation period without specific time limits for observation, encompassing morning, afternoon, and evening sessions to align with the fluctuating shift schedules of respondents who are ATC. Each relaxation session was directly supervised by the enumerator

team to ensure precision in relaxation movements and to verify that all necessary steps were executed correctly and not overlooked. Enumerators underwent training on progressive muscle relaxation techniques, the 14 core stages, performed twice during each session, along with two special opening steps (praying and concluding with thanksgiving), were meticulously detailed as:

- Before relaxing, ATC prays first according to their respective beliefs.
- Wrinkle your forehead and eyebrows until they wrinkle, then relax them again slowly for 10 seconds. The movement in the facial area aims to relax the facial muscles.
- Close your eyes as hard as possible until the muscles in the eye area feel tense for 10 seconds.
- Close your mouth while pressing your teeth as hard as possible for 10 seconds, to relax muscle tension in the jaw.
- Make the letter O on the lips, then pull as hard as possible forward for 10 seconds, aiming to relax the muscles in the mouth area.
- Press your head towards your back until you feel tension in your neck muscles for 10 seconds. The movement in this area is intended to relax the neck muscles to release tension.
- Bend and lower your chin until it touches your chest for 10 seconds.
- Grasp your hands while making a fist for 10 seconds, aimed at training your hand muscles.
- Bend both wrists back slowly for 10 seconds.
- Grasp both hands and bring the fists to the shoulders for 10 seconds, aiming to train the hand muscles at the back.
- Raise both shoulders towards your ears as high as possible for 10 seconds. This movement is intended to relax the shoulder muscles.
- Lift your body from the back of the chair, then stick out your chest for 10 seconds, aiming to train your back muscles.
- Pull in your stomach as hard as you can until it feels tense for 10 seconds, to relax your chest muscles.
- Pull in your stomach as hard as possible for 10 seconds, to train your stomach muscles.
- Straighten the soles of your feet for 10 seconds, to relax the leg muscles.
- After relaxing, say gratitude.

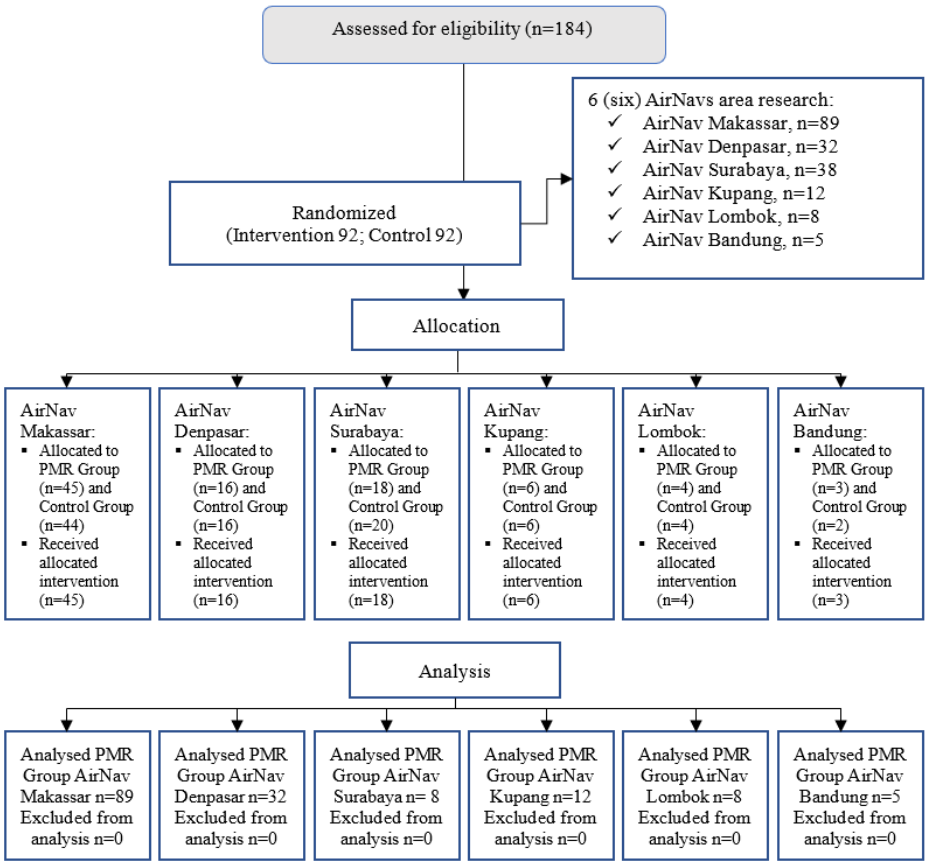

Figure 1. Flowchart of study participants

Data were gathered via interviews with ATC in different regions employing standardized questionnaires. Despite utilizing a standardized questionnaire, as elaborated below, the questionnaire's validity and reliability were still assessed on ATCs not involved in this study to ascertain its appropriateness for this study's context, and all questionnaire items were deemed valid and reliable. The depression, anxiety, and stress (DASS) questionnaire, designed by Lovibond in 1995 [25] we utilize this reference because the DASS questionnaire provides detailed measurements of depression, anxiety, and stress levels, allowing researchers and practitioners to gain a comprehensive understanding of an individual's psychological condition. The Setyawati questionnaire was designed in 1994 [26] were used to measure feelings of work fatigue, the Setyawati questionnaire remains important for use today due to its validity, focus on work fatigue, relevance to contemporary workplace demands, and its ability to provide consistency and continuity in research on the phenomenon of work fatigue.

Following the health measurements were taken: oxygen saturation, pulse rate, and blood pressure. Oxygen saturation and pulse rate were measured using an oximeter, and blood pressure was measured with a manual sphygmomanometer. Blood pressure and pulse rate measurements were categorized according to the American Heart Association guidelines, and oxygen saturation was assessed in accordance with standards set by the World Health Organization (WHO). Quality of life data was assessed based on the evaluation of the World Health Organization's quality of life assessment [27] we refer to the World Health Organization quality of life questionnaire to evaluate the quality of life of ATCs because this questionnaire ensures alignment with international standards, high validity and reliability, and its ability to provide a comprehensive overview and useful comparative data for research and clinical practice.

We recognized that the primary confounding factor in this study was the participants' level of motivation and adherence to progressive muscle relaxation instructions. However, due to the extensive licensing process undertaken for our research, we secured support from Airnav Indonesia at the central level, various general managers in the research area, the IATCA as a professional organization, and local shift coordinators. This support facilitated our control over the research implementers.

To ensure data validity, rigorous quality control measures were implemented throughout the research process, including data re-verification, validation of measurement instruments, and the utilization of appropriate statistical techniques for analyzing the findings. The analysis proceeded through several stages, including editing, coding, data entry, cleaning, and tabulation. To compare the mean scores of success indicators pre- and post-intervention, Wilcoxon and Mann-Whitney U-Tests were utilized to evaluate the effectiveness at the end of the observation period between the two groups. The analytical tools used during the data entry process were SPSS 23 software and Microsoft Office Excel 2016.

3. RESULTS AND DISCUSSION

Table 1 indicates that the majority of respondents are male, comprising 67.4%, with 96.7% falling into the diploma/bachelor category. Additionally, 63.0% are aged below 34 years, the highest years of service being over five years at 76.1%, and the majority are married, accounting for 78.8%. On the other hand, Table 2 illustrates an improvement in conditions both before and after the intervention, alongside a decrease in the control group. Based on the results, requirements with standard categories of depression, anxiety, and stress initially covered 98.9%, 93.5%, and 98.8% in the intervention group, respectively. The value increased to 100% on depression and stress variables as well as 97.8% for anxiety. Furthermore, the feeling of fatigue experienced by the intervention group also gradually improved from 78.3% to 93.5%.

The results were slightly different before and after the oxygen saturation category intervention. At the beginning, 98.9% of the respondents had normal oxygen levels, then after the intervention, the value decreased to 97.8%. Regarding the standard pulse rate, the value increased from 83.7% to 94.6%. The decrease in hypertension conditions also experienced changes at the end of the intervention in each category. The body mass index (BMI) variable in the heavy class decreased from 33.7% to 30.4%, but there was a slight increase in obesity from 21.7% to 23.9%. At the end of the observation, the quality of life for each domain of the intervention group also experienced a better improvement except for domain 4.

As indicated in Table 3, there were disparities in levels of depression and anxiety before and after the intervention ($p<0.05$), unlike the control group ($p>0.05$). However, for the intervention group, the stress variable did not show significance. Additionally, variations were observed in feeling tired, oxygen levels, and pulse rate variables in the intervention group compared to the control.

The control group exhibited a significant decrease in systolic blood pressure compared to the intervention group. Nonetheless, there were no statistically significant disparities in diastolic blood pressure between both groups, with a p-value of <0.05 throughout the observation period. As for BMI, there were no discrepancies between the two groups before and after the intervention.

Table 1. Characteristic of respondents

Characteristics	Frequency	%
Gender		
Female	60	32.6
Male	124	67.4
Education		
Magister degree	6	3.3
Diploma/bachelor's degree	178	96.7
Age		
<34 years	116	63.0
≥34 years	68	37.0
Years of service		
≤5 years	44	23.9
>5 years	140	76.1
Marital status		
Single	35	19.0
Widower/widow	4	2.2
Married	145	78.8

Table 2. Distribution of respondents before and after progressive muscle relaxation

Variables	Pre-test n (%)		Post-test n (%)	
	Intervention	Control	Intervention	Control
Depression				
Normal	91 (98.9)	91 (98.9)	92 (100)	89 (96.7)
Mild	1 (1.1)	1 (1.1)	0 (0.0)	3 (3.3)
Anxiety				
Normal	86 (93.5)	89 (96.7)	90 (97.8)	89 (96.7)
Mild	5 (5.4)	2 (2.2)	1 (1.1)	1 (1.1)
Moderate	0 (0.0)	1 (1.1)	1 (1.1)	2 (2.2)
Extremely severe	1 (1.1)	0 (0.0)	0 (0.0)	0 (0.0)
Stress				
Normal	91 (98.9)	92 (100)	92 (100)	92 (100)
Mild	1 (1.1)	0 (0.0)	0 (0.0)	0 (0.0)
Feelings of fatigue				
Not tired	72 (78.3)	83 (90.2)	86 (93.5)	76 (82.6)
Mild	15 (16.3)	9 (9.8)	6 (6.5)	15 (16.3)
Moderate	3 (3.3)	0 (0.0)	0 (0.0)	0 (0.0)
Severe	2 (2.2)	0 (0.0)	0 (0.0)	1 (1.1)
Blood oxygen level				
Low (< 95%)	1 (1.1)	4 (4.3)	2 (2.2)	5 (5.4)
Normal (95–100%)	91 (98.9)	87 (94.6)	90 (97.8)	86 (93.5)
Hypoxia (=>120%)	0 (0.0)	1 (1.1)	0 (0.0)	1 (1.1)
Pulse (per minute)				
Low (<60 PRbpm)	2 (2.2)	1 (1.1)	3 (3.3)	1 (1.1)
Normal (60-100 PRbpm)	77 (83.7)	90 (97.8)	87 (94.6)	91 (98.9)
High (>100 PRbpm)	13 (14.1)	1 (1.1)	2 (2.2)	0 (0.0)
Blood pressure				
Normal (≤120/≤80 mmHg)	66 (71.7)	56 (60.9)	64 (69.6)	58 (63.0)
Hypertension (120-129/≤80 mmHg)	8 (8.7)	10 (10.9)	10 (10.9)	11 (12.0)
Hypertension Grade I (130-139/80-89 mmHg)	9 (9.8)	9 (9.8)	13 (14.1)	14 (15.2)
Hypertension Grade II (≥140/ ≥90 mmHg)	9 (9.8)	16 (17.4)	5 (5.4)	9 (9.8)
Hypertensive Crisis (≥80/ ≥120 mmHg)	0 (0.0)	1 (1.1)	0 (0.0)	0 (0.0)
Quality of life				
Domain 1-physical				
High	41 (44.6)	37 (40.2)	51 (55.4)	38 (41.3)
Medium	24 (26.1)	34 (37.0)	19 (20.7)	29 (31.5)
Low	27 (29.3)	21 (22.8)	22 (23.9)	25 (27.2)
Domain 2-psychological				
High	31 (33.7)	49 (53.3)	40 (43.5)	42 (45.7)
Medium	34 (37.0)	18 (19.6)	25 (27.2)	23 (25.0)
Low	27 (29.3)	25 (27.2)	27 (29.3)	27 (29.3)
Domain 3-social				
High	22 (23.9)	17 (18.5)	23 (25.0)	12 (13.0)
Medium	29 (31.5)	39 (42.4)	34 (37.0)	42 (45.7)
Low	41 (44.6)	36 (39.1)	35 (38.0)	38 (41.3)
Domain 4-environmental				
High	41 (44.6)	42 (45.7)	40 (43.5)	42 (45.7)
Medium	11 (12.0)	18 (19.6)	19 (20.7)	18 (19.6)
Low	40 (43.5)	32 (34.8)	33 (35.9)	32 (34.8)

Table 3. Changes in health indicators before and after the progressive muscle relaxation

Variables		Grup									
		Intervention					Control				
		Mean	Difference	SD	Min-Max	p-value	Mean	Difference	SD	Min-Max	p-value
Depression	Pretest	2.12	0.91	2.080	0-11	**0.000**	2.10	0.18	2.386	0-16	0.075
	Posttest	1.21		1.634	0-7		1.91		2.663	0-13	
Anxiety	Pretest	3.35	1.32	2.876	0-20	**0.000**	2.76	0.07	2.294	0-11	0.320
	Posttest	2.03		2.270	0-11		2.70		2.502	0-14	
Stress	Pretest	3.80	1.84	3.262	0-17	**0.000**	3.01	0.83	2.869	0-14	**0.000**
	Posttest	1.97		2.313	0-9		2.18		2.086	0-9	
Feelings of fatigue	Pretest	2.61	1.23	2.972	0-17	**0.000**	1.73	-0.24	1.978	0-8	0.435
	Posttest	1.38		1.772	0-8		1.97		2.723	0-16	
Oxygen saturation	Pretest	98.23	0.63	1.250	93-99	**0.012**	98.17	0.53	2.728	89-117	0.053
	Posttest	97.60		2.902	74-100		97.64		2.716	87-110	
Pulse (per minute)	Pretest	87.72	9.70	20.738	48-190	**0.000**	80.47	0.03	9.045	55-101	0.972
	Posttest	78.02		11.725	52-127		80.43		9.251	57-100	
Blood pressure (Systole)	Pretest	119.26	-0.64	14.102	90-170	0.556	123.00	3.55	16.351	90-198	**0.004**
	Posttest	119.90		13.311	100-180		119.45		14.024	90-156	
Blood pressure (Diastole)	Pretest	78.96	1.91	12.363	40-120	0.088	80.01	0.36	11.308	50-114	0.632
	Posttest	77.04		8.399	60-100		79.65		10.363	60-120	
Quality of life											
Domain 1-physical	Pretest	14.80	-0.63	2.190	10-20	**0.002**	15.07	0.17	1.862	12-20	0.126
	Posttest	15.43		2.345	11-20		14.89		1.924	10-20	
Domain 2-psychological	Pretest	12.03	-0.20	1.627	7-15	0.078	12.43	0.21	1.585	7-15	0.085
	Posttest	12.23		1.723	6-15		12.23		1.453	9-15	
Domain 3-social	Pretest	11.48	-0.30	1.661	8-15	0.057	11.51	0.17	1.544	7-15	0.162
	Posttest	11.78		1.721	8-15		11.34		1.564	8-15	
Domain 4-environmental	Pretest	15.04	-0.24	2.153	10-20	0.297	15.38	0.21	2.111	9-20	0.171
	Posttest	15.28		2.428	7-20		15.17		2.063	10-20	

A significant distinction in the quality of life was evident in domain 1 among participants in the intervention group, whereas no such variance was noted in the control group. This suggests an enhancement in the quality of life concerning physical health among controllers following relaxation techniques in the intervention group. However, for domains 2, 3, and 4, there were no statistically significant differences ($p>0.05$) observed between the two groups. The distribution of Figure 2 shows that the intervention group practicing PMR experienced a 17-point decrease in fatigue levels at the final assessment (post-test). Conversely, the control group showed minimal improvement, with nearly all indicators of fatigue remaining unchanged at the end of the observation period. However, two exceptions emerged: one respondent reported reduced back pain after work, and five respondents noted a decrease in throat thirst.

The outcomes of the Mann-Whitney U-Test depicted in Table 4 indicate that intervention was very effective in controlling anxiety levels ($p=0.017$) and pulse rate compared to the control. The other variables used as indicators of relaxation effectiveness testing were insignificant as demonstrated by Asymp. Sig. (2-tailed)>0.05.

3.1. Discussion

This study was conducted to review the effectiveness of providing PMR intervention to air traffic controller employees to improve health and quality of life as well as reduce psychological fatigue. The results indicate that ATCs who implemented PMR therapy had more favorable outcomes than those who did not. Respondents in the treatment group exhibited a decrease in the sensation of fatigue following the relaxation period, which was notably lower compared to the control group.

The research provides empirical evidence endorsing the effectiveness of implementing PMR for workers in the aviation sector, particularly air traffic controllers so that this relaxation practice can serve as a valuable reference in occupational health programs. While no similar studies were found conducted by other researchers, exploration into the effects of PMR with health worker subjects has demonstrated it is efficacy in reducing work-related stress and anxiety levels [1], [19], [24], [25]. Furthermore, a series of observations in adults have indicated that PMR techniques effectively reduce stress, anxiety, and depression [3], [8]. Similarly, PMR was more effective than music therapy in reducing stress and depression in nurses [28]–[30]. In adolescents, PMR was highly effective in treating anxiety and moderately effective in reducing distress [31].

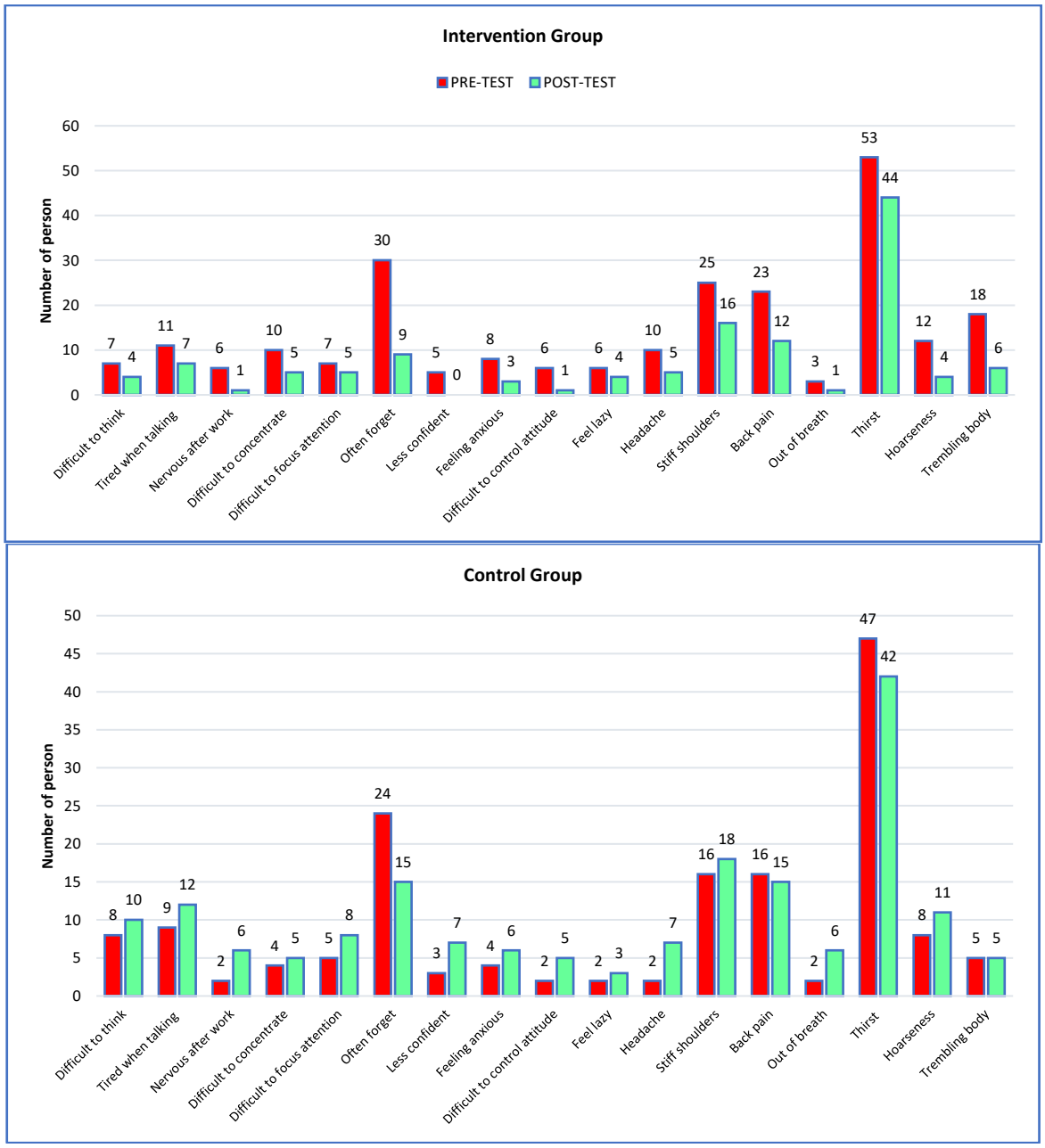

Figure 2. Feelings of fatigue in the intervention and control group

Although calm and tired are two different things, a better reduction in feelings of tiredness in the intervention group may help the role of ATC feel calmer, and being calm can help feel more energized. As previous research has shown, this relaxation technique in particular has shown the potential to increase feelings of calm, counteract negative effects on mental activity, and improve performance in a variety of different groups of individuals and in a variety of contexts or situations [32]–[34]. These findings underscore the potential of PMR techniques to aid individuals, including workers, in managing stress, anxiety, and enhancing physical flexibility.

These findings highlight the potential of PMR techniques to assist individuals, particularly employees like ATCs, in managing psychological fatigue and improving mental health. The practical implications suggest the importance of prioritizing ATCs' psychological well-being when designing workplace stress management strategies. These strategies could incorporate counterconditioning techniques, such as PMR. Future, broader, and in-depth studies are warranted to gain a deeper understanding of PMR's role in enhancing psychological well-

being and mental health within the working population. This is particularly relevant considering the high-pressure environment and elevated risk of psychological disorders faced by ATC.

The study encountered implementation limitations, particularly during the height of the COVID-19 pandemic with the Delta variant's high morbidity rate. This restricted daily visits to the research site. While the study benefits from a sample drawn across six AirNav regions (main, middle, and Pratama Branches), potential limitations exist due to uneven respondent distribution across some branches. Allocation of participants into intervention and control groups was determined by availability ratios. Furthermore, the assessment solely focused on the short-term impact of the intervention. Consequently, these results can act as a catalyst for future investigations.

Table 4. Differences in health indicators before and after PMR

Group		Mean-rank	p-value
Depression	Control	98.32	0.114
	Intervention	86.68	
Anxiety	Control	100.90	**0.030**
	Intervention	84.10	
Stress	Control	96.72	0.270
	Intervention	88.28	
Feelings of fatigue	Control	95.68	0.399
	Intervention	89.32	
Oxygen saturation	Control	94.16	0.656
	Intervention	90.84	
Pulse (per minute)	Control	100.22	**0.049**
	Intervention	84.78	
Blood pressure (Systole)	Control	92.24	0.948
	Intervention	92.76	
Blood pressure (Diastole)	Control	97.84	0.166
	Intervention	87.16	
Quality of life			
Domain 1-physical	Control	86.47	0.118
	Intervention	98.53	
Domain 2-psychological	Control	91.74	0.844
	Intervention	93.26	
Domain 3-social	Control	86.78	0.129
	Intervention	98.22	
Domain 4-environmental	Control	92.01	0.899
	Intervention	92.99	

4. CONCLUSION

According to the findings, health status and quality of life, as assessed by various indicators, exhibited greater improvement in the intervention group compared to the control. This suggests that integrating PMR into routine practices can effectively alleviate muscle tension. It is recommended that future researchers conduct experiments, especially in the field of pharmacology, to improve the health status of ATCs so that they can compare the effectiveness of pharmacological and non-pharmacological studies. This study further highlights the value of establishing a stress management team within an industry. This team would be responsible for identifying sources of stress and designing intervention strategies to assist employees in managing their well-being.

ACKNOWLEDGEMENTS

The authors are grateful to the Indonesia Endowment Fund for Education (LPDP) for sponsoring this research, Hasanuddin University, Research institutions and community service (LPPM), and our Faculty of Public Health, Occupational Health and Safety Department for contributing to the success of this study. The authors also acknowledge International Air Traffic Controller Association (IATCA) and AirNav for their supports. Indonesia Endowment Fund for Education (LPDP), number PRJ.47/LPDP/2019

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