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# Effects of Breathing Exercises Applied to Intensive Care Nurses on Fatigue and Perceived Stress: A Randomized Controlled Trial

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**Keywords:** Fatigue; Perceived Stress; Breathing Exercise; Intensive Care; Nurse

**Abstract**

**Background:** *Fatigue and stress are common challenges for intensive care nurses. Reducing stress and fatigue among nurses is important for improving nurse and patient safety. Breathing exercises are a nonpharmacological approach that effectively reduces fatigue and stress. This study aimed to evaluate the effects of breathing exercises on fatigue and stress among intensive care nurses.* **Methods:** *The research was conducted as a randomized controlled trial between October and December 2024. The study included 66 nurses, 33 in the control group and 33 in the intervention group. Nurses in the intervention group performed breathing exercises lasting approximately 20 minutes for 30 days. No intervention was performed in the control group. Data were collected using the Piper Fatigue Scale and Perceived Stress Scale at the beginning of the study, on the 15$^{th}$ day, and on the 30$^{th}$ day.* **Results:** *A statistically significant difference was identified in the group effect, time effect, and group-time interaction for the mean scores on the Piper Fatigue Scale and the Perceived Stress Scale ($p<0.01$). The fatigue and stress scores of nurses in the intervention group decreased on the 15$^{th}$ and 30$^{th}$ days.* **Conclusions:** *This study shows that breathing exercises positively affect fatigue and stress among intensive care nurses. The breathing exercise protocol can be applied to intensive care nurses, and these exercises can be taught to nurses through in-service training.*

## 1. Introduction

Intensive care units (ICUs) are specialized units where patients with organ dysfunction or at risk of developing organ dysfunction are hospitalized, where complex technologies are used, and where patients are continuously monitored and followed up [1]. A multidisciplinary team approach is required to monitor and follow up patients in ICUs. Nurses, an indispensable part of this team, have essential roles and responsibilities [1, 2], such as diagnosing patients, providing advanced, high-quality care, continuously monitoring vital functions, administering treatments, and establishing therapeutic relationships with patients and their relatives [3].

ICU nurses may experience fatigue due to an intense workload, shift work, insomnia, environmental factors, prolonged standing, and physically demanding tasks (such as patient transfers and positioning) [4, 5]. Fatigue has adverse effects on cognition, psychology, and biology. Individuals may experience irritability, difficulty concentrating, reduced physical

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capacity, communication difficulties, and decreased perception and reaction time due to fatigue, a health problem [6]. Fatigue adversely impacts nurses' well-being, patient safety, and care. It creates serious problems for patient and employee safety, including an increased likelihood of errors and an increased risk of injury [7].

Fatigue and its adverse effects constitute a major source of stress for nurses. The literature reports a positive relationship between stress and fatigue [8]. Because of the nature of intensive care, ICU nurses follow critically ill patients and witness longer hospitalizations and higher mortality rates more frequently than nurses in other units. Numerous factors, such as sudden deterioration of patient condition, rapid decision-making, an intense workload, and the use of complex technological equipment, are also sources of stress for nurses [2]. Increased fatigue and stress lead to adverse effects such as joint and muscle pain, insomnia, anxiety, depression, burnout, and communication problems among nurses [8-12].

Non-pharmacological interventions have recently gained importance for reducing stress and fatigue among nurses. Many alternative medical treatments, such as massage, progressive relaxation exercises, acupressure, and music therapy, have been reported to reduce stress and fatigue in nurses [2, 13-15]. Breathing exercises are also among the non-pharmacological methods that effectively reduce fatigue and stress [16, 17]. Deep, controlled breathing exercises activate the parasympathetic nervous system, thereby lowering stress hormone levels, such as cortisol [18]. Breathing exercises are easy to apply, cost-free, and effective methods that promote relaxation of the mind and body [19]. In this respect, three-step breathing and 4-7-8 breathing techniques are among those that effectively reduce fatigue and stress [17, 20]. The three-step breathing exercise is also known as full yogic breathing (Dirgha). The aim of this breathing technique is to take deep breaths. The steps of deep breathing are performed to the abdomen, chest, and collarbone, respectively [21, 22]. In the 4-7-8 breathing technique, an individual inhales through the nose by counting to 4, holds breath by counting to 7, and exhales through the mouth by counting to 8. It is an easy-to-apply and simple breathing technique that quite effectively reduces stress, fatigue, and restlessness [17].

No study in the literature has examined the effects of breathing exercises on fatigue and stress among ICU nurses. Research indicates that breathing exercises are most often used in conjunction with other nonpharmacological interventions, suggesting that they reduce stress and fatigue among ICU nurses [13, 15]. The literature reports that the breathing techniques used in this study have been applied to adults and patients [16, 20-21, 23]; however, no studies have investigated their application to nurses or the working population. ICU nurses experience high levels of stress and fatigue, which have significant effects on both patients and nurses. In light of this information, the current study was conducted to assess the effects of breathing exercises on fatigue and stress among ICU nurses.

The research hypotheses propose that implementing breathing exercises for nurses will lead to measurable improvements in well-being: specifically, it is expected that nurses who participate in the breathing-exercise protocol will report lower levels of fatigue compared with those in the control group, and, concurrently, will exhibit reduced perceived stress relative to their untreated colleagues.

## 2. Methods

### 2.1. Design

The current research was conducted as a randomized controlled experimental trial in the intensive care units of a state hospital in the Mediterranean region of Türkiye between October and December 2024. The CONSORT checklist [24] was followed when reporting the study. The study was registered on Clinicaltrials.gov (NCT06642376).

### 2.2. Inclusion and Exclusion Criteria

The study included nurses with at least 6 months of experience in intensive care units who volunteered to participate in the research and did not use complementary therapies, such as breathing exercises, acupuncture, massage therapy, relaxation techniques, and yoga, that could affect perceived stress

and fatigue during the study. Nurses who had a condition that prevented nasal breathing and the use of breathing exercises, were receiving psychotherapy, had a mean PFS total score of 3 or lower, were pregnant, or had physical or mental health problems that impaired communication were not included in the study. Figure 1 displays the CONSORT flow chart for the nurses included in the study.

### 2.3. Setting and Sample

The hospital where the research was conducted has 6 ICUs (internal medicine, neurology, coronary, anesthesia and reanimation, surgery, and cardiovascular surgery) that provide care and treatment to adult patients. One hundred and fifty nurses work in the intensive care units. Similar studies have shown that the effect size of breathing exercises across different groups is large [16, 25]. The program G*Power 3.1.9.7 was used to calculate the sample size. With an effect size of 0.80, the sample size was 26 per group, with 80% power and a 5% margin of error. No sample selection was performed in our study, and we attempted to reach the entire population. The research was completed with 66 nurses who met the inclusion criteria (control group: 33; intervention group: 33) (Figure 1).

### 2.4. Randomization and Blinding

A simple randomization method was used to ensure an equal and random distribution of nurses between the two groups. Nurses who met the inclusion criteria were listed in numerical order and numbered from 1 to 66. The numbers to be selected before randomization were determined by a lottery method to form the intervention group. Subsequently, 33 numbers were selected from the 66 using the website https://www.randomizer.org/. The remaining 33 nurses formed the control group. An independent statistician analyzed the research data, and the groups were anonymized by referring to them only by numbers.

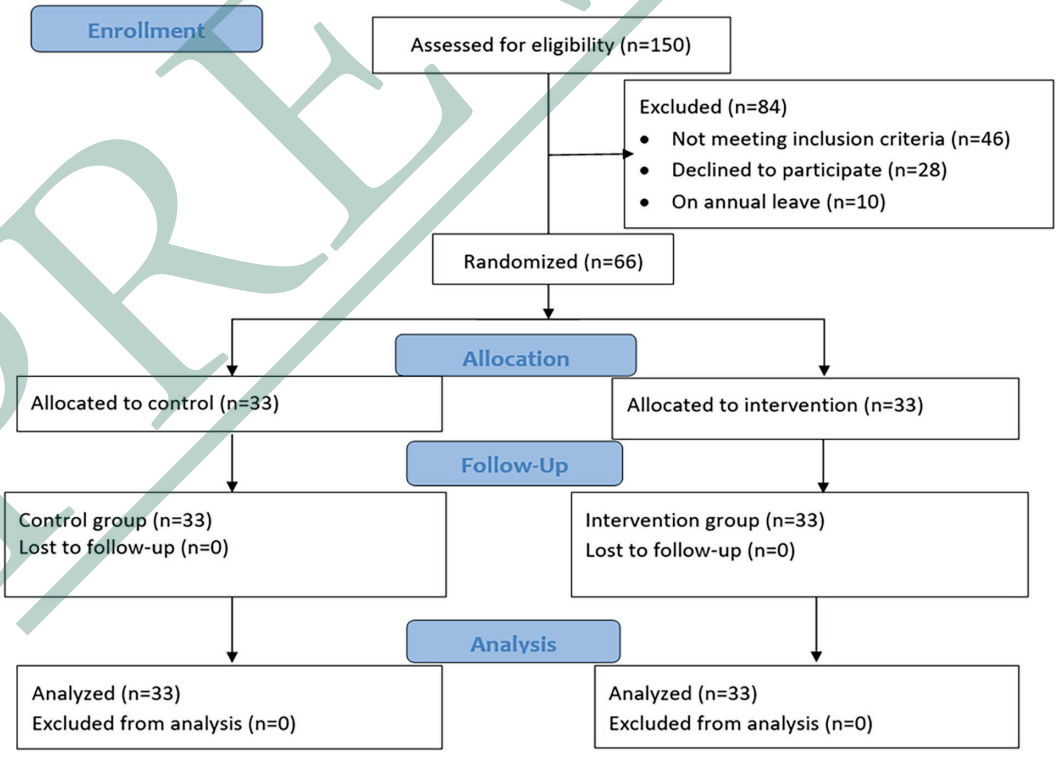


**Figure 1.** CONSORT flow diagram of the study.

## 2.5. Data Vollection Tools

### *2.5.1 Nurse Demographic Information Form*

It is a questionnaire consisting of 16 questions (age, sex, education level, marital status, unit of employment, and duration) prepared by the researchers based on the literature [2, 10, 26].

### *2.5.2 Piper Fatigue Scale*

The scale, developed in 1987 by Piper et al., assesses subjective fatigue using the "integrated fatigue model" [27]. Can et al. conducted a validity and reliability study of this scale in Türkiye in 2004. The scale comprises 22 items, each rated on a 0-10-point Visual Analog Scale. It also includes five items that allow expression of thoughts about fatigue not included in the scoring. The scale consists of four subscales: behavior, affect, sensory, and cognitive/psychological. The behavior subscale assesses the impact of fatigue on daily life and its severity. The affect subscale evaluates the emotional meaning attributed to fatigue. The sensory subscale assesses the mental, physical, and emotional symptoms of fatigue. The cognitive/psychological subscale evaluates the extent to which fatigue affects cognitive functions and mental state. The total score and the subscale scores range from 0 to 10. A high score on the scale indicates increased fatigue [27, 28]. On the scale, a score of 0 indicates "no fatigue", a score of 1-3 indicates "mild fatigue", a score of 4-6 indicates "moderate fatigue", and a score of 7-10 indicates "severe fatigue". The scale is used in studies assessing fatigue among ICU healthcare professionals [29, 30]. In the validity and reliability study for the scale, Cronbac's alpha reliability coefficient was found to be between 0.92 and 0.96 for the subscales and 0.97 for the overall scale [28]. In the present study, the scale's Cronbach's alpha reliability coefficient was lowest (0.86) for the pre-test, mid-test, and post-test.

### *2.5.3 Perceived Stress Scale*

Cohen et al. developed the scale in question in 1983 [31]. Eskin et al. performed their validity and reliability study in Türkiye. The scale comprises 14 items. Additionally, there are 10-item and 4-item short versions of the scale, along with a 14-item version. The current study employed the 14-item version. The possible score on the scale ranges from 14 to 56. A high score indicates that perceived stress increases. Cronbach's alpha reliability coefficient was 0.84 in the scale's validity and reliability study [32]. The scale is used to assess perceived stress among ICU nurses [15, 26]. In this study, Cronbach's alpha reliability coefficient was 0.86 for the pre-test, 0.85 for the mid-test, and 0.94 for the post-test.

## 2.6. Breathing Exercises Applied

The first researcher holds an internationally valid and university-approved certificate in breathing techniques. The three-step and 4-7-8 breathing techniques were applied to nurses in our study. Expert opinions were obtained from a breathing techniques trainer of trainers and a faculty member with a certificate in breathing techniques regarding the applicability of the breathing exercise protocol. The application protocol for the breathing techniques was finalized in line with the expert opinions received. The application steps of the breathing techniques are presented in the breathing techniques application protocol (Supplemental Material S1).

## 2.7. Intervention and Data Collection

Nurses in the intervention and control groups were informed about the study's purpose and implementation. Written and verbal consent was obtained from the nurses who confirmed their willingness to participate in the study. Pre-test data for the intervention and control groups were collected in person from nurses using data collection forms (Nurse Demographic Information Form, PFS, and PSS). It took 10-15 minutes to complete the data collection forms. On the 15$^{th}$ day of the intervention, face-to-face interviews were conducted with nurses, and mid-test forms were completed using the PFS and PSS. Post-test data were collected by conducting face-to-face interviews with nurses on the 30$^{th}$ day of the study.

The primary researcher showed nurses in the intervention group how to perform the breathing exercises face-to-face at the beginning of the study. Nurses were taught the correct techniques by practicing breathing exercises through demonstrations. Then, to implement the breathing exercises technique, a WhatsApp group was created for nurses in the intervention group and the researchers. A video recording of the researcher's breathing techniques was sent to this group. Since the video duration is limited via WhatsApp, this video includes the correct implementation techniques of the breathing exercises. The researcher created an audio recording of the breathing exercises (20 minutes), including a full session. This audio recording was shared in the group. Breathing exercises were performed once a day for 30 days. Breathing exercises were performed face-to-face with nurses three days a week. Days for face-to-face application were arranged according to nurses' shift days. On other days, feedback was received from nurses who used WhatsApp to apply the breathing exercises and ensure they exercised regularly. Nurses in the intervention group were told not to share the breathing exercises to avoid affecting nurses in the control group.

Nurses in the control group were placed on a waiting list and received no intervention during the research process. After the study was completed and the final data were collected, the breathing exercise protocol was taught to the control group through in-person demonstrations. Video and audio recordings demonstrating the breathing exercises were shared with the control group.

### 2.8. Data Analysis

IBM SPSS 27 was used to analyze the data. Individuals' descriptive characteristics were presented as numbers, percentages, means, and standard deviations. To compare the study groups with categorical variables, Fisher's exact test was used in 2x2 and rxc tables [33]. The Shapiro-Wilk test and Q-Q plots were used to assess whether the data were normally distributed. The data were found to be normally distributed. The two-way mixed-design ANOVA evaluated the effects of time, group, and their interaction on the repeated measurements. Before the two-way mixed design ANOVA test, the homogeneity of variances was assessed using Levene's test, and it was found that the assumption of homogeneity of variances was met (p values range from 0.149 to 0.951). The homogeneity of the covariance matrices was examined using Box's M test, and it was found that the assumption was met (p values range from 0.167 to 0.851). The sphericity assumption for the repeated-measures factor was tested using Mauchly's test, and it was met (p values range from 0.081 to 0.343). The Bonferroni test was used to determine in which group and at which time the group-time interaction differed. Partial eta squared ($\eta^2$) was used to assess the effect size [34].

### 2.9. Ethical Considerations

Approval was obtained from the university's non-interventional research ethics committee (decision number 2024/11-02, dated July 22, 2024) and from the institution where the research would be conducted. Nurses were informed about the study, and their written and verbal consent was obtained. The current study was conducted in accordance with the principles of the Declaration of Helsinki and publication ethics. No adverse events related to the research were observed.

## 3. Results

There were no differences between the control and intervention groups, which were initially homogeneous. Furthermore, 45.5% of nurses in the control group and 51.5% of those in the intervention group reported experiencing fatigue for a year or more (Table 1).

A statistically significant difference was observed between the group effect, time effect, and group-time interaction on the PFS mean scores and the PSS total mean scores ($p < 0.001$; Table 2).

The comparison test found no statistically significant differences between the groups in the PFS total score ($p = 0.671$), PFS subscales behavioral fatigue ($p = 0.197$), affective fatigue ($p = 0.760$), sensory fatigue ($p = 0.235$), and cognitive fatigue ($p = 0.155$) mean scores before the intervention. On the 15$^{th}$ and 30$^{th}$ days, the PFS total score ($p < 0.001$ for both) and subscale behavioral fatigue ($p = 0.022$

**Table 1.** Comparison of nurses' descriptive characteristics (N=66).

| | Control Group (n=33) | Intervention Group (n=33) | | |
|---|---|---|---|---|
| **Variables** | **Mean ± SD** | **Mean ± SD** | **t** | **p** |
| Age Years (min.-max.) | 32.15 ± 4.84 (25.00-48.00) | 31.76 ± 5.32 (24.00-47.00) | 0.315 | 0.754 |
| Years as a Nurse-years (min.-max.) | 9.67 ± 3.92 (1.00-19.00) | 9.18 ± 4.89 (1.00-20.00) | 0.445 | 0.658 |
| Years in the ICU-years (min.-max.) | 4.76 ± 3.08 (1.00-12.00) | 4.55 ± 3.43 (1.00-14.00) | 0.399 | 0.792 |
| **Variables** | **n (%)** | **n (%)** | | **p** |
| **Gender** | | | | |
| Female | 21 (63.6) | 19 (57.6) | | 0.801 |
| Male | 12 (36.4) | 14 (42.4) | | |
| **Marital status** | | | | |
| Married | 20 (60.6) | 19 (57.6) | | 1.000 |
| Single | 13 (39.4) | 14 (42.4) | | |
| **Education Level** | | | | |
| High School | 2 (6.1) | 1 (3.0) | | 0.750 |
| Bachelor's Degree | 28 (84.8) | 30 (90.9) | | |
| Postgraduate | 3 (9.1) | 2 (6.1) | | |
| **ICU Worked In** | | | | |
| Internal Medicine | 13 (39.4) | 14 (42.4) | | 0.767 |
| Anesthesiology and Reanimation | 10 (30.3) | 7 (21.2) | | |
| Neurosurgery | 4 (12.1) | 2 (6.1) | | |
| Coronary | 2 (6.1) | 5 (15.2) | | |
| Cardiovascular Surgery | 2 (6.1) | 2 (6.1) | | |
| Surgical | 2 (6.1) | 3 (9.1) | | |
| **Work Shift** | | | | |
| Day Shift | 3 (9.1) | 6 (18.2) | | 0.596 |
| Night Shift | 22 (66.7) | 20 (60.6) | | |
| Rotating Day and Night Shifts | 8 (24.2) | 7 (21.2) | | |
| **Presence of a Chronic Disease** | | | | |
| Yes | 1 (3.0) | 2 (6.1) | | 1.000 |
| No | 32 (97.0) | 31 (93.9) | | |
| **Smoking Status** | | | | |
| Current Smoker | 11 (33.3) | 9 (27.3) | | 0.917 |
| Quit Smoking | 2 (6.1) | 2 (6.1) | | |
| Never Smoked | 20 (60.6) | 22 (66.7) | | |
| **Alcohol Consumption** | | | | |
| Drinking Alcohol | 5 (15.2) | 3 (9.1) | | 0.479 |
| Quit | 0 (0.0) | 2 (6.1) | | |
| Never Drunk Alcohol | 28 (84.8) | 28 (84.8) | | |
| **Duration of Fatigue** | | | | |
| 0-6 Months | 17 (51.5) | 13 (39.4) | | 0.422 |
| 7-12 Months | 1 (3.0) | 3 (9.1) | | |
| 1 Year Over | 15 (45.5) | 17 (51.5) | | |

**Table 2.** Comparison of the change in mean scores on the Piper Fatigue Scale and Perceived Stress Scale between the intervention and control groups.

| Scales and Measurements | Control Group (n=33) Mean ± SD | Intervention Group (n=33) Mean ± SD | Between-Group Mean Difference (95% CI) | | Group | Time | Group*Time Interaction |
|---|---|---|---|---|---|---|---|
| **Piper Fatigue Scale** | | | | | | | |
| *Behavioral Fatigue* | | | | | | | |
| Baseline | 5.36 ± 1.81$^{A, a}$ | 5.89 ± 1.51$^{A, a}$ | -0.54 (-1.36, 0.28) | F | 9.374 | 21.951 | 29.198 |
| 15$^{th}$ day | 5.41 ± 1.71$^{A, a}$ | 4.45 ± 1.61$^{B, b}$ | 0.96 (0.14, 1.77) | p | **0.003** | **<0.001** | **<0.001** |
| 30$^{th}$ day | 5.57 ± 1.83$^{A, a}$ | 2.90 ± 1.63$^{B, c}$ | 2.67 (1.82, 3.52) | $\eta^2$ | 0.128 | 0.255 | 0.313 |
| *Affective Fatigue* | | | | | | | |
| Baseline | 6.58 ± 1.74$^{A, a}$ | 6.42 ± 1.63$^{A, a}$ | 0.16 (-0.67, 0.99) | F | 32.534 | 34.150 | 45.633 |
| 15$^{th}$ day | 6.42 ± 1.70$^{A, a}$ | 4.43 ± 1.97$^{B, b}$ | 1.99 (1.08, 2.89) | p | **<0.001** | **<0.001** | **<0.001** |
| 30$^{th}$ day | 6.86 ± 1.65$^{A, a}$ | 2.84 ± 1.76$^{B, c}$ | 4.02 (3.18, 4.86) | $\eta^2$ | 0.337 | 0.348 | 0.416 |
| *SensoryFatigue* | | | | | | | |
| Baseline | 6.47 ± 1.79$^{A, a}$ | 5.93 ± 1.82$^{A, a}$ | 0.53 (-0.36, 1.42) | F | 28.515 | 18.538 | 28.417 |
| 15$^{th}$ day | 6.27 ± 1.68$^{A, a}$ | 4.69 ± 1.57$^{B, b}$ | 1.58 (0.78, 2.37) | p | **<0.001** | **<0.001** | **<0.001** |
| 30$^{th}$ day | 6.74 ± 1.55$^{A, a}$ | 3.34 ± 1.54$^{B, c}$ | 3.40 (2.64, 4.16) | $\eta^2$ | 0.308 | 0.225 | 0.307 |
| *Cognitive Fatigue* | | | | | | | |
| Baseline | 5.25 ± 1.71$^{A, a}$ | 5.84 ± 1.60$^{A, a}$ | -0.59 (-1.40, 0.23) | F | 13.465 | 16.282 | 24.156 |
| 15$^{th}$ day | 4.90 ± 1.80$^{A, a}$ | 4.22 ± 1.45$^{A, b}$ | 0.69 (-0.12, 1.49) | p | **0.005** | **<0.001** | **<0.001** |
| 30$^{th}$ day | 5.60 ± 2.00$^{A, a}$ | 2.99 ± 1.40$^{B, c}$ | 2.61 (1.75, 3.46) | $\eta^2$ | 0.115 | 0.203 | 0.274 |
| *Total Fatigue Score* | | | | | | | |
| Baseline | 5.86 ± 1.44$^{A, a}$ | 6.01 ± 1.39$^{A, a}$ | -0.15 (-0.84, 0.55) | F | 20.904 | 38.549 | 54.930 |
| 15$^{th}$ day | 5.70 ± 1.52$^{A, a}$ | 4.44 ± 1.42$^{B, b}$ | 1.26 (0.54, 1.98) | p | **<0.001** | **<0.001** | **<0.001** |
| 30$^{th}$ day | 6.14 ± 1.52$^{A, a}$ | 3.01 ± 1.43$^{B, c}$ | 3.13 (2.40, 3.85) | $\eta^2$ | 0.246 | 0.376 | 0.462 |
| **Perceived Stress Scale** | | | | | | | |
| *Total Score* | | | | | | | |
| Baseline | 28.76±6.42$^{A, a}$ | 29.30±7.68$^{A, a}$ | -0.55 (-4.02, 2.93) | F | 15.376 | 8.601 | 9.420 |
| 15$^{th}$ day | 28.88±6.08$^{A, a}$ | 26.06±5.51$^{A, a}$ | 2.82 (-0.04, 5.67) | p | **<0.001** | **<0.001** | **<0.001** |
| 30$^{th}$ day | 29.00±9.23$^{A, a}$ | 19.09±7.29$^{B, b}$ | 9.91 (5.82, 13.40) | $\eta^2$ | 0.194 | 0.118 | 0.128 |

*F= Two-way mixed design ANOVA, SD: Standard Deviation, values of p<0.05 are shown in bold.*
*$\eta^2$= Partial eta squared (small effect=0.01, medium effect=0.06, large effect=0.14)*
*A, B: Different capital letters in the same row indicate the difference between the intervention and control groups.*
*a, b, c: Different lowercase letters in the same column indicate the difference between measurement times.*

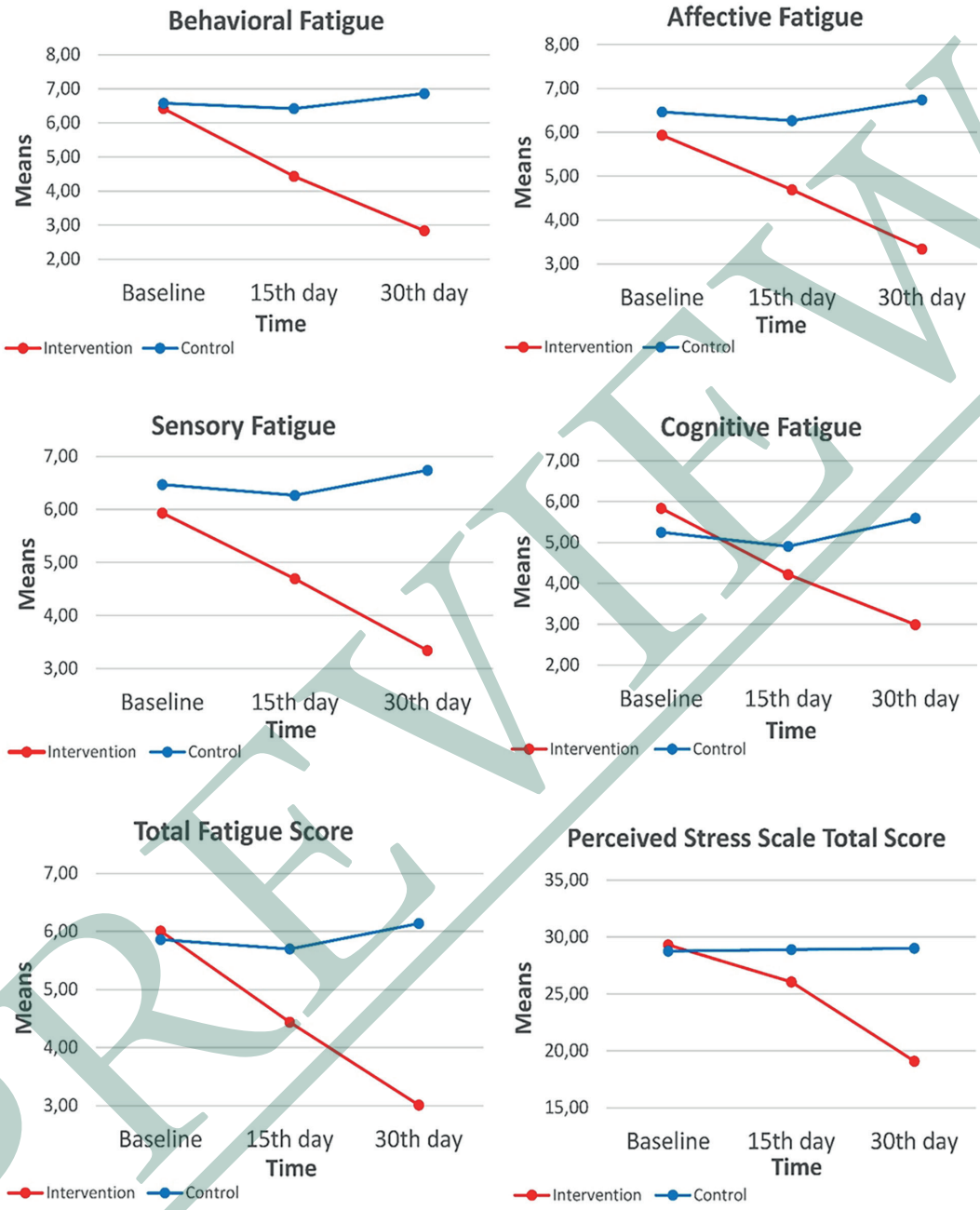


**Figure 2.** Changes in mean fatigue and stress scores of the intervention and control groups over time.

for 15th day, $p < 0.001$ for 30th day), affective fatigue ($p < 0.001$ for both), and sensory fatigue ($p < 0.001$ for both) mean scores were lower in the intervention group (Table 2) (Figure 2). Additionally, there was no statistically significant difference between the PFS total score ($p = 1.000$ for baseline-15th day, $p = 0.755$ for baseline-30th day, $p = 0.086$ for 15th-30th days) and subscale behavioral fatigue ($p = 1.000$ for baseline-15th day, baseline-30th day, 15th-30th days), affective fatigue ($p = 1.000$ for baseline-15th, baseline-30th day, $p = 0.240$ for 15th-30th days), sensory fatigue ($p = 1.000$ for baseline-15th day, baseline-30th day, $p = 0.098$ for 15th-30th days), cognitive fatigue ($p = 0.817$ for baseline-15th day,

$p = 0.965$ for baseline-30th day, $p = 0.106$ for $15^{th}$-$30^{th}$ days) mean scores in the control group over time. In the intervention group, a statistically significant difference was observed between the PFS total score and the subscale mean scores measured at three time points ($p < 0.001$; Table 2) (Figure 2).

The PSS total mean scores were similar between the groups before the intervention. The PSS mean scores were lower in the intervention group than in the control group on the $30^{th}$ day ($p < 0.001$, Table 2) (Figure 2). Moreover, the PSS mean scores did not change statistically significantly in the control group over time ($p = 1.000$). In the intervention group, the PSS mean score on the $30^{th}$ day was significantly lower than the pre-intervention and $15^{th}$-day mean scores ($p = 0.001$, Table 2) (Figure 2).

The intervention had a large effect size on the PSS total mean score and subscale mean scores ($\eta 2 > 0.14$). However, it had a medium effect size on the PSS mean score ($\eta 2 = 0.128$, Table 2).

## 4. Discussion

This study was designed as a single-blind, randomized, controlled trial to investigate the effects of breathing exercises for ICU nurses on their fatigue and stress. Although the effects of breathing exercises on stress and fatigue have been assessed in different groups, no study on ICU nurses has been found. In the literature, breathing exercises are most often included in interventions such as progressive relaxation and yoga [13, 15]. In this regard, our research is the first to evaluate the effects of breathing exercises alone on fatigue and stress among ICU nurses. The current study revealed that breathing exercises positively affected fatigue and stress among ICU nurses. According to the research findings, applying breathing exercises for 30 days reduced fatigue and stress levels among nurses in the intervention group, confirming the hypotheses of our study.

Due to the nature of intensive care, ICU nurses experience greater fatigue and stress than nurses in other units. Fatigue and stress can also deteriorate an individual's quality of life and pose significant risks to the safety and health of patients and nurses [7]. Breathing exercises are effective non-pharmacological methods for reducing fatigue [17]. This study found that nurses in both groups initially experienced moderate fatigue, as measured by the PFS. Following the breathing exercises administered to the intervention group, nurses' overall fatigue decreased to mild levels. However, the fatigue levels of nurses in the control group, which received no intervention, remained moderate. Additionally, the breathing exercise intervention had a large effect on fatigue. Hence, we could not make a direct comparison with the current research results. In the literature, breathing exercises are included in progressive relaxation, music therapy, and mindfulness-based non-pharmacological interventions for nurses. It was determined that the interventions applied in these studies reduced fatigue and, similar to our research findings, had medium-to-large effect sizes [13, 15, 35]. However, breathing exercises applied to patients effectively reduce fatigue [36, 37]. In light of these findings, studies in the literature support our research results. Controlled breathing helps balance the autonomic nervous system by suppressing excessive sympathetic activity and increasing parasympathetic activity [38]. Inhibition of the sympathetic nervous system reduces energy consumption, whereas increased activation of the parasympathetic nervous system reduces it. This reduces fatigue effectively [39]. In this regard, the present study is significant for evaluating the effectiveness of breathing exercises in reducing fatigue among ICU nurses. It appears that the research protocol effectively reduces fatigue among nurses.

ICUs are specialized units where patients are continuously monitored and receive complex treatments; thus, ICUs can create a stressful work environment for nurses [2]. Breathing exercises are effective non-pharmacological interventions for reducing stress [20]. Given that the PSS score used in this study ranges from 14 to 56, nurses had moderate stress levels before the intervention. While stress levels did not change significantly in the control group after the intervention, they remained low in the intervention group. Additionally, the study found that the intervention had a moderate effect size on perceived stress levels. According to a systematic review evaluating the effects of breathing exercises in adults, these exercises reduce stress and anxiety [40]. Another meta-analysis also reported that breathing

exercises had a moderate effect size in reducing stress [41]. A study assessing the effects of breathing exercises on young women found a significant decrease in blood cortisol levels at the end of the exercises [18]. Likewise, healthy adults performed diaphragm breathing exercises for 20 sessions over 8 weeks. Participants' salivary cortisol levels decreased over time [20]. Another study revealed that anxiety decreased in the group where the 4-7-8 breathing exercise was applied to patients after bariatric surgery [16]. Studies that included breathing exercises as part of non-pharmacological interventions among ICU nurses found that these interventions reduced nurses' stress [15, 42]. Breathing exercises activate the parasympathetic nervous system, thereby lowering stress hormone levels, such as cortisol, in the body [18]. Proper breathing techniques, along with their effects on the autonomic and cerebral systems, promote increased cortical and subcortical activity [38]. Breathing exercises have also been reported to increase blood serotonin levels, increase alpha waves, and decrease theta waves on an electroencephalogram [43]. These findings demonstrate the effects of breathing exercises on stress reduction in individuals [38, 44].

### 4.1. Limitations

The study was conducted at a single center, and the sample size was limited by the small population, which restricts the generalizability of our results. Furthermore, fatigue and stress assessments were based on nurses' subjective reports. Environmental or individual factors that might confound the results could not be assessed. Confounding factors such as nurses' workload, number of shifts, or exposure to stressful situations during work were not evaluated. Nurses who received interventions or therapies that could affect stress and fatigue at the beginning of the study were excluded. However, the inability to systematically assess this situation throughout the study constitutes one of its limitations. Participants could not be blinded due to the nature of the research. This may introduce a risk of bias in the results due to nurses' self-reports. The absence of any intervention in the control group and the fact that the control group remained in constant contact with the intervention group may have influenced the independent outcomes of the breathing exercises. Our study aimed to reach the entire population, and all volunteer nurses who met the inclusion criteria were included. Therefore, stratified sampling could not be used for selecting the ICU sample. Additionally, the fact that breathing exercises were implemented for 30 days limits the ability to evaluate their effects in the future.

No study in the literature has evaluated the effects of breathing exercises on fatigue and stress among ICU nurses. Repeating our intervention with ICU nurses using a larger sample size is important for verifying and generalizing our results. Furthermore, it is recommended that future research monitor the effects of breathing exercises on fatigue and stress over a longer term. Additionally, it is recommended that our application protocol be used for intensive care nurses.

## 5. Conclusion

ICU nurses in the present study reported high levels of fatigue and stress. Intensive care nurses may experience fatigue and stress due to factors such as monitoring high-risk patients and using advanced technology. This study found that the breathing exercise protocol reduced fatigue and stress among ICU nurses. Therefore, breathing exercises can be applied to nurses through in-service training in hospitals. It can be ensured that nurses receive training certificates for breathing exercise applications. It is thought that this will be beneficial overall for nurses and the patients they care for.

**Institutional Review Board Statement:** Prior to the study, ethical approval was obtained from the Non-Interventional Research Ethics Committee at Kahramanmaras Istiklal University (Ethics approval code: 2024/11-02). Participation in the study was voluntary. Accordingly, nurses were informed about the study, and verbal and written informed consent was obtained from nurses who agreed to participate. Institutional permission was received from the institution where the research was conducted. Before starting the study, it was registered on ClinicalTrials.gov (NCT06642376; Registration Date: October 12, 2024; https://clinicaltrials.gov/). Our study was conducted in line with the principles of the Declaration of Helsinki and publication ethics.

**Informed Consent Statement:** Informed consent, both verbal and written, was obtained from all participating nurses.

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**Declaration of Interest:** The authors declare no conflict of interest.

**Data Availability:** The data that support the findings of this study are available from the corresponding author upon reasonable request.

**Author Contribution Statement:** Y.S.: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Methodology, Investigation, Formal analysis, Conceptualization. M.K.: Writing – review & editing, Writing – original draft, Visualization, Validation, Investigation, Conceptualization. N.O.: Writing – review & editing, Validation, Supervision, Resources, Conceptualization.

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## APPENDIX

**Supplemental Material S1.** Breathing exercise application protocol

**Preparation stage before applying the breathing exercise**

The setting (quiet, calm, etc.) where the application will be performed should be prepared.

Individuals should have a meal at least 2-4 hours before the application.

The bladder and intestines should be empty before the application.

Individuals should wear comfortable clothing during the application.

According to an individual's preference, they should be ensured they feel comfortable, sit on the chair/sofa with their knees and hips at the same level, or take a semi-lying position with the spine straight.

Since the nose is used during breathing exercises, the tongue should be touched to the point where the teeth and palate meet without applying pressure (in some cultures, it is called the "fire point" to increase energy).

Individuals are asked to close their eyes and obey the commands.

| Application Stage | Duration | Applications |
|---|---|---|
| 1. **Focusing on breathing** | 2-3 min | Relax, close your eyes, and place your hands on your knees, palms down.<br>Breathe in and out through your nose.<br>As you breathe in and out, try to feel your breath. Relax and do not try to control your breathing.<br>Just try to feel your breath and how it spreads through your body.<br>Do not try to control your breathing. Just try to feel your breath and your body. |
| 2. **Three-part breathing technique (full yogic breathing)** | | |
| **Stage 1: abdominal breathing** | 5 min | Place your right hand on your abdomen to feel your breath. Continue breathing in and out through your nose.<br>Imagine a colorful balloon in your abdomen; inflate it while breathing deeply through your nose, and deflate it while breathing. Notice that your abdominal swelling is reduced.<br>Feel the movement of your hand on your abdomen. |
| | 30 s | Breathe normally. |
| **Stage 2: chest breathing+abdominal breathing** | 5 min | Place your left hand on your chest while your right hand is on your abdomen.<br>Keep breathing through your nose.<br>As you breathe, feel the air first expand into your belly and then fill your chest.<br>Feel the movement in your hands.<br>Slowly exhale, feeling the air that has been in your chest first and now in your abdomen emptying. |
| | 30 seconds | Breathe normally. |
| **Stage 3: shoulder breathing+chest breathing+abdominal breathing** | 5 min | Place your left hand on your right collarbone while your right hand is on your abdomen.<br>Keep breathing through your nose.<br>As you breathe, feel the air first inflate your abdomen and then fill your chest and rise to your collarbone.<br>Feel the air filling up your shoulders.<br>Monitor the movements of both your hands. |

(*Continued*)

| Application Stage | Duration | Applications |
|---|---|---|
| | 30 s | Breathe normally. |
| **4-7-8 Breath** | 4 times | With your mouth closed and your tongue tip at the point of fire, breathe in through your nose for a count of 4.<br>Hold your breath for a count of 7.<br>Exhale the breath you are holding by making a wind sound with your mouth for a count of 8.<br>Then breathe in again through your nose, counting to 4 for the second time. |
| | 30 s | Breathe normally. |
| **3. Focusing on breathing** | 2-3 min | Use only your nose to breathe.<br>Observe your breathing and try to feel the distribution of your breath throughout your body.<br>Relax, listen to your inner voice, and try to feel the air you breathe in and out.<br>Do not think about how to breathe better. Release these feelings.<br>Do not try to control your breathing. Just try to feel your breath and your body.<br>Slowly open and close your eyes several times. Then, slowly open your eyes. |