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COMPARISON OF GAME-BASED BREATHING EXERCISE AND TRADITIONAL PURSED LIP BREATHING EXERCISE IN YOUNG ADULTS

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Abstract

Objective: The study explores the potential of game-based breathing exercises in improving respiratory functions, compared to traditional methods like pursed lip breathing. Pulmonary rehabilitation, widely acknowledged for its short-term benefits on conditions like dyspnea, exercise capacity, and quality of life, incorporates breathing exercises to enhance respiratory capacity and reduce the workload on the lungs. These exercises, including diaphragmatic breathing, are also effective in alleviating anxiety, improving pain thresholds, and lowering heart and respiratory rates.

Methods: The research involved 40 participants aged 18-24, divided into two groups: a game-based exercise group and a traditional breathing group. Participants in the game-based group used the Breathing+ application, performing three 6-minute bouts per session with 2-minute rest intervals, twice a week for four weeks. The traditional group followed similar intervals with diaphragmatic and pursed lip breathing exercises. Data on respiratory rate, chest circumference, and heart rate were collected before and after the intervention, and statistical analyses compared the two groups.

Results: The game-based group demonstrated significant improvements in respiratory rate and chest circumference compared to the traditional group. While both groups showed reductions in heart rate and respiratory rate, the game-based group achieved superior outcomes in enhancing chest wall mobility and reducing respiratory rate.

Conclusion: Game-based breathing exercises are effective in improving respiratory functions, offering a motivating and engaging alternative to traditional methods. These findings suggest that game-based applications could play a significant role in respiratory rehabilitation.

Keywords: *Breathing exercises, game-based exercises, pursed lip breathing, respiratory therapy, vital signs.*

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Introduction

Respiratory rehabilitation is a multidisciplinary intervention aimed at improving cardiopulmonary exercise capacity and alleviating functional limitations in individuals with respiratory conditions. Pulmonary rehabilitation programs have demonstrated significant short-term benefits in reducing dyspnea and enhancing both exercise capacity and quality of life.[1] Among the commonly employed techniques in these programs are breathing exercises such as diaphragmatic breathing, pursed lip breathing, and thoracic expansion exercises. These methods not only support lung capacity and reduce respiratory workload but are also associated with improvements in anxiety, pain thresholds, and autonomic function.[2]

Pursed lip breathing, in particular, prevents airway collapse by prolonging exhalation, and it has been shown to enhance tidal volume and oxygen saturation while lowering respiratory rate and perceived dyspnea.[3] This makes it one of the most accessible and effective strategies for managing breathlessness in both clinical and home-based settings.[4,5]

Notably, game-based digital applications simulating guided breathing exercises have emerged as innovative tools for increasing patient engagement and adherence. These interventions aim not only to elicit physiological benefits but also to deliver interactive and enjoyable user experiences.[6]

Breathing+ is a mobile platform that allows users to perform breathing exercises through a gamified interface. The validity and reliability of this application were assessed in a clinical study involving individuals with a history of stroke. In that study, the outcomes of Breathing+ were compared with those of standard spirometry and were found to be statistically significant and reliable.[7]

Despite the growing popularity of such applications, few studies have systematically compared their effectiveness with traditional breathing exercises. Integrating game-based tools into respiratory rehabilitation holds clinical relevance due to their potential to deliver measurable improvements in pulmonary function through accessible, portable, and cost-effective means. However, evidence supporting their physiological impact—particularly regarding quantifiable respiratory parameters—remains limited.

The aim of this study is to evaluate the effectiveness of the game-based mobile application Breathing+ in improving respiratory function and to compare its outcomes with those of traditional breathing exercises.

The hypotheses tested in this study are:

H_1: Game-based breathing exercises result in greater chest expansion than traditional breathing exercises.

H_2: Game-based breathing exercises yield greater improvements in respiratory rate and heart rate compared to traditional breathing exercises.

Methods

This study was approved by the Ethics Committee of Sakarya University of Applied Sciences, Akyazı Campus (Approval No: E-26428519-050.99-123590) and was conducted in accordance with the principles of the Declaration of Helsinki. All participants provided written informed consent prior to their inclusion in the study.

Participants and Study Design

The study sample consisted of 40 volunteer students from Sakarya University of Applied Sciences, Akyazı Campus. Participants were recruited via campus-wide announcements. Inclusion criteria were: aged between 18-24 years, absence of acute or chronic respiratory or cardiovascular conditions, and not participating in any regular breathing or physical training program. Exclusion criteria included inability to complete the intervention schedule or presence of medical conditions contraindicating exercise.

Participants were sequentially allocated to the game-based breathing exercise group (GG) and the traditional breathing exercise group (TrG) in alternating order upon enrollment, with 20 participants in each group. Both groups participated in a total of eight exercise sessions over a four-week period, performing the assigned breathing exercises twice per week.

Intervention Procedures

The GG group performed breathing exercises using the Breathing+ application (Breathing Labs, Slovenia), a game-based system compatible with mobile devices featuring TRS (Tip-Ring-Sleeve) or TRRS (Tip-Ring-Ring-Sleeve) input, and incorporating a CE- and FCC-certified respiratory headset.

Participants in the game-based exercise group performed twice weekly 22-minute game-based breathing exercises. Similarly, the traditional exercise group completed 22-minute sessions of pursed lip breathing exercises.[8] Evaluation parameters were assessed immediately before the exercises began and again after the 4-week training period by a blinded assessor. At the end of the exercise training, all participants' respiratory rate, heart rate, and chest expansion measurements were evaluated under the same standards as the baseline measurements.

Respiratory Rate Measurement

The respiratory rate was recorded by observing the participant's chest movements for one minute.[9]

Heart Rate Measurement: Heart rate was measured using the palpation method at the radial artery (wrist) with fingertip detection.[10] Both measurements were conducted following standard clinical procedures while participants were in a resting position, seated calmly.

Chest Expansion Measurement: Chest expansion was measured at the xiphoid process level using a measuring tape. During the measurement, participants were seated comfortably in an upright position with back support. The tape was placed snugly but not uncomfortably around the chest at the xiphoid process level.[11] Participants were asked to perform a maximum inspiration followed by a maximum expiration, and the expansion value was calculated as the difference between these two measurements.[12] Measurements were repeated three times for each participant, and the best value was recorded.

Traditional Breathing Exercise Protocol

The traditional breathing exercise consisted of three distinct phases:

Phase 1: Diaphragmatic breathing for inspiration,
Phase 2: Pursed lip breathing for expiration,
Phase 3: Silent breathing (spontaneous breathing pattern).

This cycle was performed in three sets, each lasting 6 minutes, with a 2-minute rest between sets, resulting in a total session duration of 22 minutes. Before each session, participants were instructed on how to perform the breathing exercises and were asked to practice them.[13]

Game-Based Breathing Exercise Protocol

The breathing exercise for the game-based group was structured using the Breathing+ application. This game is based on the extended exhalation technique of pursed lip breathing, facilitating the exhalation of 2–3 deciliters more air than standard nasal breathing. The Breathing+ system transforms a computer, tablet, or smartphone into an engaging and interactive breathing exercise platform. It is compatible with devices that have a microphone/headphone input and includes a CE- and FCC-certified respiratory headset.[14]

Each session involved playing the game three times, with each game lasting 6 minutes and a 2-minute rest between games. The total session duration was 22 minutes. Exercises were conducted twice weekly for 4 weeks.

Statistical Analysis

A priori power analysis using G*Power (version 3.1.9.7) determined a minimum sample size of 34 participants (power:0.80, α:0.05), with 40 recruited to account for potential dropouts. Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Shapiro–Wilk test was used to assess data normality. Depending on distribution, independent samples t-test or Mann–Whitney U test was used for between-group comparisons. The significance level was set at $p<0.05$.

Results

The demographic characteristics of the participants, including age, gender distribution, body mass index (BMI), smoking status, and physical activity level, are presented in Table 1. No statistically significant differences were found between the two groups in any baseline demographic parameter ($p>0.05$) (Table 1).

Statistical analyses revealed significant within-group and between-group differences in respiratory parameters following the 4-week intervention. For clarity, p_1 values represent within-group comparisons (pre-test vs. post-test), while p_2 values represent between-group comparisons (GG vs. TrG).

Table 1. Demographic and lifestyle characteristics of participants.

Features	GG (n=20)	TrG (n=20)	Sum (n=40)	*p*-value
Age (years)	20.1±2.2	20.3±2.1	20.2±2.15	>0.05
Gender (Female/Male)	12/8	11/9	23/17	>0.05
Height (cm)	170.5±8.8	169.8±10.2	170.15±9.52	>0.05
Weight (kg)	65.3±9.1	66.0±8.7	65.6±8.9	>0.05
BMI (kg/m²)	22.4±2.3	22.8±2.1	22.6±2.2	>0.05
Smoker	3(15%)	2(10%)	5(12.5%)	>0.05

Note: Data are presented as mean ± standard deviation or n (%).
p-values calculated using independent samples t-test (continuous variables) and chi-square test (categorical variables).

Shapiro–Wilk tests were conducted to evaluate the distributional characteristics of both pre-test and post-test variables. As shown in Table 2, none of the pre-test variables—including heart rate ($p=0.005$), respiratory frequency ($p=0.004$), and chest circumference ($p<0.001$)—met the assumption of normality. Similarly, in the post-test data (Table 3), heart rate ($p=0.001$) and respiratory frequency ($p=0.025$) exhibited significant deviations from normal distribution, while chest circumference ($p=0.325$) was the only variable to conform to normality following the intervention. These findings guided the selection of appropriate parametric or non-parametric statistical tests for subsequent analyses.

Table 2. Shapiro-Wilk normality test results for pre-test variables.

	W	*p*
Heart Rate (bpm)	0.846	0.005
Respiratory Frequency (breaths/min)	0.845	0.004
Chest Circumference (cm)	0.798	<0.001

Note: A low *p*-value suggests a violation of the assumption of normality.
Units: bpm = beats per minute, cm = centimeters, breaths/min = breaths per minute.

Independent samples t-tests revealed no significant baseline differences between groups in heart rate ($p=0.471$) or respiratory frequency ($p=0.849$). However, chest circumference at baseline was significantly higher in the GG group compared to the TrG group ($p=0.008$) (Table 4).

Table 3. The results of the Shapiro-Wilk normality test conducted for the post-intervention variables: post chest circumference, heart rate, and respiratory frequency.

	W	*p*
Heart Rate (bpm)	0.894	0.001
Respiratory Frequency (breaths/min)	0.936	0.025
Chest Circumference (cm)	0.969	0.325

Note: A low p-value suggests a violation of the assumption of normality.
Units as in Table 2.

Heart Rate

Both the Game-Based Breathing Exercise Group (GG) and the Traditional Breathing Exercise Group (TrG) showed statistically significant reductions in heart rate from pre-test to post-test ($p_1<0.001$ for both). However, no statistically significant difference was observed between the groups in post-test values ($p_2>0.05$) (Table 5).

Respiratory Frequency

Statistically significant decreases in respiratory frequency were observed in both groups after the intervention ($p_1<0.001$). The between-group comparison revealed a significant difference favoring the GG group ($p_2<0.05$) (Table 5).

Chest Circumference

Chest circumference increased significantly from baseline to post-test in both groups ($p_1<0.001$). The between-group comparison indicated significantly greater improvements in the GG group ($p_2<0.05$) (Table 5).

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Table 4. Independent samples t-test results comparing the pre-test measurements of heart rate, respiratory frequency, and chest circumference between the game-based breathing exercises group (GG) and the traditional breathing exercises group (TrG).

Student's t	Statistic	df	p	Mean difference	SE difference		Effect Size
Heart Rate (bpm)	0.728	38.0	0.471	2.50	3.43	Cohen's d	0.230
Respiratory Frequency (breaths/min)	-0.191	38.0	0.849	-0.100	0.523	Cohen's d	-0.0605
Chest Circumference (cm)	-2.79	38.0	0.008	-0.550	0.197	Cohen's d	-0.883

Note: H_a: $\mu_1 \neq \mu_2$
Provides statistical values; degrees of freedom (df), *p*-values, mean differences, standard error (SE) differences, and effect sizes (Cohen's d) for the comparisons Units as in Table 2.

Discussion

This study demonstrated that both traditional and game-based breathing exercises led to significant improvements in heart rate, respiratory frequency, and chest circumference in healthy young adults. Notably, participants in the game-based breathing group (Breathing+) exhibited superior improvements in respiratory frequency and chest expansion compared to the traditional group.

Lin and Chu (2023) similarly reported that the use of a game-based respiratory training system enhanced participants' adherence to breathing exercises and resulted in significant improvements in respiratory function.[15] These findings underscore the potential of game-based systems as effective tools in respiratory rehabilitation, particularly due to their capacity to increase user motivation. In addition, previous literature has shown that a five-week game-based breathing exercise program improved lung function in stroke patients, with improvements linked to increases in lung volume and respiratory muscle strength.[13] Although spirometric assessments were not conducted in the present study, chest wall expansion was employed as an indirect marker of inspiratory capacity.[16] This approach allowed for the clinical tracking of respiratory improvements achieved through game-based breathing interventions.

A notable baseline difference observed in this study was the significantly greater chest circumference in the game-based breathing exercise group (GG) compared to the traditional breathing group (TrG). This initial imbalance may have influenced the degree of post-intervention improvement, as individuals with greater thoracic mobility may naturally exhibit larger chest expansion.[12] However, previous studies have shown that Breathing+ games can enhance ventilatory efficiency regardless of baseline measurements.[15] In the present study, the use of prolonged expiration breathing in the game-based intervention group yielded beneficial physiological outcomes. Therefore, despite the initial discrepancy in chest circumference, the greater improvement observed in the GG group likely reflects a genuine effect of the intervention. Nonetheless, we acknowledge this baseline difference as a limitation of the study and recommend that future research ensure group equivalence at baseline in intervention trials.

The present findings are also in line with those of Garcia-Hernandez et al. (2024), who demonstrated that a gamified respiratory training system significantly enhanced maximum inspiratory pressure and overall pulmonary function. Their study emphasized the importance of real-time biofeedback and interactive design in fostering adherence and physiological gains.[17] Similarly, in our study, the interactive and engaging nature of the Breathing+ system likely contributed to the enhanced respiratory outcomes observed in the game-based group.

Furthermore, a prior study involving 12 participants who engaged in diaphragmatic breathing exercises for 30 minutes per day, three days a week, reported significant increases in chest circumference after four weeks.[18] This supports the role of diaphragmatic breathing in improving thoracic mobility and overall respiratory function. In parallel, our results demonstrated that both intervention groups experienced significant gains in chest expansion, further validating the effectiveness of structured breathing exercises in respiratory rehabilitation.

Table 5. Merged pre-test, post-test, and between groups table.

Variable	Pre-test Mean±SD GG	Post-Test Mean±SD GG	p^1 GG (n=20)	Pre-test Mean±SD TrG	Post-Test Mean±SD TrG	p^1 TrG (n=20)	p^2 (Between Groups)
Heart Rate	88.5±11.98	70±6.46	<0.001**	86±9.6	70±6.46	<0.001**	>0.05
Respiratory Frequency	21.4±1.67	16.9±1.10	<0.001**	21.4±1.67	17.5±1.64	<0.001**	<0.05*
Chest Circumference	2.10±0.641	3.63±0.841	<0.001**	2.10±0.641	3.17±1.029	<0.001**	<0.05*

Data are presented as mean± standard deviation unless otherwise stated.
GG; Game-Based Breathing Exercises Group, TrG; Traditional Breathing Exercises Group.
p^1)A significant difference from baseline after intervention in each group using Wilcoxon signed rank test.
p^2)A significant difference between the 2 groups using Mann-Whitney U-test
*$p<0.05$, **$p<0.001$
Units as in Table 2.

This study has several limitations that should be acknowledged. First, the relatively small sample size (n=40) limits the statistical power and may restrict the generalizability of the findings. Second, although individuals who reported engaging in regular physical activity were excluded during recruitment, physical activity levels were not formally assessed or quantified, which may have introduced variability in the results. Third, the study sample consisted exclusively of healthy young adults aged 18-24 years, thereby limiting the applicability of the findings to broader populations, including older adults or individuals with respiratory or chronic health conditions. Fourth, while respiratory rate, heart rate, and chest expansion were measured, no objective assessments of pulmonary function (e.g., spirometry) were conducted, reducing the physiological comprehensiveness of the respiratory evaluation.

Conclusion

This study compared the effects of game-based and traditional breathing exercises on heart rate, respiratory rate, and chest circumference. The results showed that game-based exercises significantly reduced respiratory rate and increased chest expansion more than traditional methods. This may be due to the interactive and engaging nature of the game-based platform, which offers real-time feedback and encourages deeper, more controlled breathing.

Although no significant difference was found between groups in heart rate, the similar outcomes suggest both methods are equally effective in this regard. However, the greater improvements in respiratory rate and chest circumference in the game-based group likely reflect the increased motivation, adherence, and effort driven by the gamified approach. These findings highlight game-based breathing exercises as a promising and innovative option in respiratory rehabilitation, especially where patient engagement and compliance are key. Importantly, the study adds to the literature with its clear, replicable protocols and detailed methodology, offering practical guidance for clinical and field use. The structured breathing programs presented may serve as useful models for professionals seeking non-invasive, accessible, and engaging respiratory therapy strategies.

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Conflict of Interest

The author declares no conflicts of interest.

Compliance of Ethical Statement

Approval for the study was obtained from the Sakarya University of Applied Sciences Ethics Committee (E-26428519-050.99-123590), and written informed consent was obtained from all participating individuals.

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Author Contributions

C.K.: Study idea/Hypothesis; C.K.: Design; C.K.: Data Collection; C.K., N.Ş.Y.: Analysis; C.K.: Literature review; C.K.: Writing; C.K.: Critical review.

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