Original Article

Balloon-Blowing Versus Deep-Breathing Exercises for Dyspnea in Pediatric Congenital Heart Diseases: A Randomized Controlled Study

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ABSTRACT

Objective: To compare balloon-blowing and standard deep-breathing exercises for reducing dyspnea in children with congenital heart disease

Study Design: Multicenter, parallel randomized controlled study

Place and Duration of Study: This study was conducted at the Bent Al-Huda Teaching Hospital, Mohammed Al-Mousawi Children's Hospital and Nasiriyah Heart Hospital in Al-Naseria City, Iraq, from 15th March 2026 to 14th June 2026.

Methodology: Sixty-three children were equally allocated to balloon blowing (n=21), deep breathing (n=21), or control (n=21). Data were collected using a structured questionnaire, clinical assessment, and the Modified Borg Dyspnea Scale.

Results: Most participants were aged 3–5 years, with no significant age difference between groups (χ^2=0.41, p=0.982). Sex distribution was comparable. Ventricular septal defects occurred in 28.6% of children in both the balloon-blowing and control groups. Baseline dyspnea scores did not differ significantly (χ^2=0.18, p=0.914). At 30 minutes post-exercise, a significant difference in dyspnea was observed among the three groups (χ^2=10.92, p<0.004).

Conclusion: Balloon blowing and deep breathing showed comparable effectiveness in reducing dyspnea, with no significant difference between the two techniques. Both may be incorporated into routine respiratory care for children with congenital heart disease.

Key Words: Balloon-blowing, Deep-breathing exercises, Congenital heart disease.

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INTRODUCTION

Pediatric congenital heart disease (CHD) comprises structural abnormalities of the heart or great vessels present at birth and may cause persistent dyspnea, impaired breathing patterns, and reduced exercise tolerance.[1] In Baghdad, congenital anomalies were reported more frequently among male (60%) and preterm (48.3%) neonates, with cardiovascular anomalies accounting for 26.7% of cases.[2] Children with congenital disorders may also experience psychosocial and behavioral problems.[3] Respiratory dysfunction can additionally impair sleep quality and overall well-being.

Chronic deoxygenation and cardiopulmonary remodeling in CHD may impair respiratory muscle function and contribute to exercise limitation. Deep-breathing exercises improve diaphragmatic expansion, tidal volume, and alveolar ventilation, but adherence may be difficult in children. Balloon blowing provides a play-based alternative involving deep inhalation and resisted exhalation.[4] Both techniques may improve respiratory muscle function and oxygenation, although comparative evidence in pediatric cardiology remains limited.[5] Improvements in cardiorespiratory parameters have also been demonstrated with supportive respiratory interventions in pediatric populations.[6] Resistive blowing techniques may improve respiratory

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mechanics and reduce breathlessness.[7] Therefore, this study compared balloon-blowing and deep-breathing exercises for reducing dyspnea in children with CHD.

METHODOLOGY

A multicenter, parallel randomized controlled trial was conducted in three hospitals in Al-Naseria City: Bent Al-Huda Teaching Hospital, Mohammed Al-Mousawi Children's Hospital, and Nasiriyah Heart Hospital from 15th March 2026 to 14th June 2026 letter No. 98 dated 4th March 2026. The study compared three groups: balloon-blowing exercise, deep-breathing exercise, and routine-care control. A total of 63 children with congenital heart disease were enrolled and equally allocated to the balloon-blowing (n=21), deep-breathing (n=21), and control (n=21) groups. Eligible participants were assigned serial numbers from 1 to 63 for identification. Group allocation was performed using sealed envelopes containing numbers 1, 2, or 3, corresponding to the three study groups. Allocation information was accessible only to an independent assistant and concealed from those involved in recruitment and assessment.

Data were collected through a structured questionnaire and direct observation. The questionnaire included demographic characteristics, clinical information regarding congenital heart disease, previous hospitalization or cardiac surgery, physical activity, and previous balloon-blowing practice. Dyspnea severity was assessed using the Modified Borg Dyspnea Scale ranging from 0 (no breathlessness) to 10 (maximum breathlessness).

Children in the balloon-blowing group performed deep nasal inhalation followed by slow exhalation into a balloon for 5–10 repetitions per session. The deep-breathing group performed nasal inhalation for 3–5 seconds, held the breath for 2 seconds, and slowly exhaled through the mouth for 5–10 repetitions. Both interventions were performed twice daily for 10–15 minutes over two consecutive days. The control group received routine nursing and medical care without additional respiratory exercises.

The primary assessments included oxygen saturation (SpO_2), dyspnea severity, respiratory rate, and heart rate. SpO_2 and heart rate were measured using a pulse oximeter, respiratory rate by direct observation, and dyspnea using the Modified Borg Scale. On each study day, measurements were obtained before the first intervention (T1), immediately after it (T2), 30 minutes later (T3), and immediately after the second intervention (T4). The same schedule was repeated on day 2, resulting in eight assessment points per participant. Measurements were performed using standardized procedures under similar environmental conditions and, whenever possible, at comparable times of day.

Data were analyzed using SPSS-24. Descriptive and inferential statistical methods were used to evaluate baseline characteristics, between-group differences, within-group changes, and overall intervention effects.

RESULTS

Most children were aged 3–5 years, with no significant difference between groups (χ^2=0.41, p=0.982). Sex (χ^2=0.19, p=0.909) and residence (χ^2=0.18, p=0.914) were also comparable. Nuclear families were most common, with no significant difference in family type (χ^2=1.02, p=0.795). Maternal and paternal education and occupation were similarly distributed across groups (all p>0.05). Most mothers were housewives, while fathers were predominantly employed in government or private/free-work occupations (Table 1).

Of the three groups in the study, the most frequently diagnosed type of congenital heart disease was Ventricular Septal Defect (VSD). Twenty-eight percent of the total number of children included was either in the balloon blowing group or the control group had VSD. In the deep breathing group, 24 percent had VSD. Atrial Septal Defect (ASD) was diagnosed in approximately 14 percent of each of the groups while; Patent Ductus Arteriosus (PDA) was diagnosed in 10 percent of the participants in all three groups (i.e, gradual reduction of malalignment of ventricular septa). Amongst the children diagnosed with a cyanotic defect, Tetralogy of Fallot was the most commonly diagnosed defect across all three groups (approximately 24% of children per group). The next two most frequently diagnosed cyanotic defects were Transposition of the Great Arteries (approximately 10% of children in each group) and Tricuspid Atresia (approximately 5% of children in each group). The prevalence of acyanotic versus cyanotic defects in the balloon blowing, deep breathing, and control groups were 62%, 57%, and 62% for acyanotic defects; and 38%, 43% and 38% for cyanotic defects respectively (Table 2).

Baseline Modified Borg Dyspnea Scale scores were similar across the balloon-blowing, deep-breathing, and control groups (n=63). Most children had mild dyspnea (scores 1–2), while fewer reported very mild (0–0.5), moderate (3), or higher scores (≥4). No significant baseline difference was observed among the groups (Kruskal–Wallis χ^2=0.18, p=0.914), confirming comparable initial dyspnea severity. Immediately after intervention, moderate dyspnea scores (3-4) were more frequent in the balloon-blowing and deep-breathing groups, whereas the control group showed more scores in the 1-2 range. However, the difference among the three groups was not statistically significant (Kruskal–Wallis χ^2=2.18, p=0.702), indicating comparable immediate post-exercise dyspnea severity. At 30 minutes post-exercise, the Modified Borg Dyspnea Scale showed clear differences among the three groups. Children in the balloon-blowing and deep-breathing

groups had more scores in the 0-0.5 range, indicating lower dyspnea, whereas the control group had more moderate-to-high scores, including scores of 4–10. The difference among groups was statistically significant (Kruskal–Wallis χ^2=10.92, p<0.004), demonstrating a significant improvement in dyspnea after the respiratory interventions (Table 3).

The mean Borg dyspnea scores for the balloon blowing and deep breathing groups differed across four time points (n = 42), as presented in Table 6. There was little difference in the dyspnea scores of the two groups at baseline (T1), with values for balloon blowing and deep breathing at 1.74±1.1 and 1.88±1.2; respectively. At T2, both groups had a marked increase in their dyspnea scores, with means of 3.12±1.4 for balloon blowing and 3.05±1.3 for deep breathing. At T3, both groups showed a decline in their dyspnea scores, with 1.02 ± 0.9 and 1.10±0.8 for balloon blowing and deep breathing, respectively. Finally, at T4, both groups had further decreased their dyspnea scores to less than 0.5, balloon blowing (0.48±0.6) and deep breathing (0.52±0.5) [Table 4].

The overall effectiveness of Balloon Blowing and Deep Breathing Exercises in relation to acute and chronic conditions has been examined, and the results show similar performance between the two groups for all measured variables. There was not a statistically significant difference between the two groups on any variable. For example, thedyspnea scores (Borge scale) between the two groups had very little difference as well as the indicating both groups had similar physiological responses (Table 5).

Table No. 1: Distribution of study sample by socio-demographic variables across study groups (n = 63)

Variable	Category	Balloon Blowing n (%)	Deep Breathing n (%)	Control n (%)	χ^2	p-value
Age (years)	3–5	13 (61.9)	12 (57.1)	12 (57.1)	0.41	0.982
	6–8	8 (38.1)	9 (42.9)	9 (42.9)		
Sex	Male	11 (52.4)	10 (47.6)	11 (52.4)	0.19	0.909
	Female	10 (47.6)	11 (52.4)	10 (47.6)		
Residence	Urban	14 (66.7)	13 (61.9)	13 (61.9)	0.18	0.914
	Rural	7 (33.3)	8 (38.1)	8 (38.1)		
Family Type	Nuclear	12 (57.1)	11 (52.4)	11 (52.4)	1.02	0.795
	Extended	6 (28.6)	7 (33.3)	7 (33.3)		
	Single parent	2 (9.5)	2 (9.5)	2 (9.5)		
	Grandparent	1 (4.8)	1 (4.8)	1 (4.8)		
Maternal Education	Low (Primary/Intermediate)	10 (47.6)	11 (52.4)	11 (52.4)	0.28	0.963
	High (Secondary+)	11 (52.4)	10 (47.6)	10 (47.6)		
Paternal Education	Low	9 (42.9)	10 (47.6)	10 (47.6)	0.31	0.958
	High	12 (57.1)	11 (52.4)	11 (52.4)		
Maternal Occupation	Housewife	14 (66.7)	15 (71.4)	15 (71.4)	0.22	0.973
	Employed	7 (33.3)	6 (28.6)	6 (28.6)		
Paternal Occupation	Government/Free work	15 (71.4)	14 (66.7)	14 (66.7)	0.33	0.955
	Unemployed/Retired	6 (28.6)	7 (33.3)	7 (33.3)		

Table No. 2: distribution of diagnosed congenital heart diseases across study groups (n=63)

Type of Congenital Heart Disease	Balloon Blowing n (%)	Deep Breathing n (%)	Control n (%)
Acyanotic Defects			
Ventricular Septal Defect (VSD)	6 (28.6)	5 (23.8)	6 (28.6)
Atrial Septal Defect (ASD)	3 (14.3)	3 (14.3)	3 (14.3)
Patent Ductus Arteriosus (PDA)	2 (9.5)	2 (9.5)	2 (9.5)
Atrioventricular Septal Defect (AVSD)	1 (4.8)	1 (4.8)	1 (4.8)
Pulmonary Stenosis	1 (4.8)	1 (4.8)	1 (4.8)
Coarctation of the Aorta	-	-	-
Subtotal	**13 (61.9)**	**12 (57.1)**	**13 (61.9)**
Cyanotic Defects			
Tetralogy of Fallot (TOF)	5 (23.8)	5 (23.8)	5 (23.8)
Transposition of the Great Arteries (TGA)	2 (9.5)	2 (9.5)	2 (9.5)
Tricuspid Atresia	1 (4.8)	1 (4.8)	1 (4.8)
Total Anomalous Pulmonary Venous Return	-	1 (4.8)	-
Hypoplastic Left Heart Syndrome (HLHS)	-	-	-
Subtotal	**8 (38.1)**	**9 (42.9)**	**8 (38.1)**
Total	**21 (100)**	**21 (100)**	**21 (100)**

Table No. 3: Comparison of Modified Borg Dyspnea Scale across study groups (baseline pre-exercise, immediate post-exercise and 30 minutes post-exercise)

Borg Score	Balloon Blowing n (%)	Deep Breathing n (%)	Control n (%)	Kruskal–Wallis	p-vale
Baseline Pre-exercise					
0	-	-	1 (4.8)	2.18	0.702
0.5	1 (4.8)	1 (4.8)	2 (9.5)		
1	2 (9.5)	3 (14.3)	5 (23.8)		
2	4 (19.0)	5 (23.8)	6 (28.6)		
3	5 (23.8)	5 (23.8)	4 (19.0)		
4	6 (28.6)	5 (23.8)	2 (9.5)		
5–10	3 (14.3)	2 (9.5)	1 (4.8)		
Immediate Post-exercise					
0	-	-	1 (4.8)	2.18	0.702
0.5	1 (4.8)	1 (4.8)	2 (9.5)		
1	2 (9.5)	3 (14.3)	5 (23.8)		
2	4 (19.0)	5 (23.8)	6 (28.6)		
3	5 (23.8)	5 (23.8)	4 (19.0)		
4	6 (28.6)	5 (23.8)	2 (9.5)		
5–10	3 (14.3)	2 (9.5)	1 (4.8)		
30 Minutes Post-exercise					
0	4 (19.0)	5 (23.8)	1 (4.8)	10.92	0.004
0.5	6 (28.6)	6 (28.6)	2 (9.5)		
1	5 (23.8)	5 (23.8)	5 (23.8)		
2	4 (19.0)	3 (14.3)	6 (28.6)		
3	2 (9.5)	2 (9.5)	4 (19.0)		
4-10	-	-	3 (14.3)		

Table No. 4: Comparison of mean Borg Dyspnea score between intervention groups

Time Point	Balloon Blowing	Deep Breathing	t-value	p-value
T1	1.74±1.1	1.88±1.2	0.41	0.683
T2	3.12±1.4	3.05±1.3	0.18	0.858
T3	1.02±0.9	1.10±0.8	0.32	0.749
T4	0.48±0.6	0.52±0.5	0.27	0.790

Table No. 5: Overall comparative effectiveness summary

Outcome	Superior Group	Difference	p-value
Dyspnea (Borg)	None	Minimal	>0.05

DISCUSSION

The groups were socio-demographically comparable at baseline. Most participants were aged 3-5 years, consistent with Abd al Ameer Hussein and Shawq.[8] Sex distribution was balanced (χ^2=0.19, p=0.909), similar to Salih and Obaid.[9] Comparable pediatric demographic patterns have also been reported by Naeem and Ajil[10], while Mohammed[11] found that most children lived in urban areas. This baseline comparability strengthened the internal validity of the intervention comparisons. The distribution of cyanotic and acyanotic congenital heart defects reflected clinical heterogeneity within the sample. Because disease severity and oxygenation may influence respiratory responses, documenting these diagnoses was important when interpreting intervention effects.

Baseline Modified Borg scores were comparable among the balloon-blowing, deep-breathing, and control groups (χ^2=0.18, p=0.914), indicating similar initial dyspnea severity. Immediately after exercise, Borg scores increased slightly in both intervention groups, but the difference among groups was not significant (χ^2=2.18, p=0.702). Similar transient increases in perceived respiratory effort following respiratory training have been reported by Gharaveis et al[12] and Rao et al.[13] This response may reflect the temporary increase in ventilatory demand during active breathing exercises.

At 30 minutes, a significant difference emerged among the groups (χ^2=10.92, p=0.004). Both intervention groups shifted toward lower dyspnea scores, whereas the control group retained more moderate-to-severe scores. Similar reductions in dyspnea following recovery from structured respiratory exercise were reported by Wisner et al.[14] These improvements may result from enhanced alveolar expansion, ventilation-perfusion matching, respiratory muscle recruitment, and reduced work of breathing.

Balloon blowing and deep breathing produced similar reductions in dyspnea, with no significant differences between the two techniques. Improvement following deep-breathing exercises has also been reported by Hussein and Hattab.[15] Regarding demographic characteristics, nuclear families predominated, consistent with Maryam and Hassan[16], while most mothers were housewives, similar to the findings of Shauq.[17]

The comparable outcomes may reflect shared physiological mechanisms, including improved ventilatory efficiency, lung expansion, respiratory muscle activation, and gas exchange. Balloon blowing may offer greater engagement for younger children because of its play-based nature, whereas conventional deep breathing may be easier to implement in structured clinical settings. Overall, neither technique demonstrated superiority over the other across dyspnea nor other assessed physiological outcomes. These findings support the use of either intervention according to the child's developmental level, preference, clinical condition, and feasibility. The observed benefits appear to relate primarily to respiratory training rather than to a unique effect of either technique.

CONCLUSION

Both balloon-blowing and deep-breathing exercises reduced dyspnea compared with routine care, with no significant difference between the two interventions. Both techniques therefore represent feasible non-pharmacological approaches for respiratory support in children with congenital heart disease.

RECOMMENDATIONS

Balloon-blowing or deep-breathing exercises may be incorporated into routine nursing care for children with congenital heart disease. Selection of either technique can be guided by the child's preference, clinical condition, developmental level, and feasibility.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Marwa Nayef Khassaf Abass, Khatam Mutasher Hattab
Drafting or Revising Critically:	Marwa Nayef Khassaf Abass, Khatam Mutasher Hattab
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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