

## Effect of short-term practice of breathing exercises on the breathing capacity in school-age girls

### Efecto de la práctica a corto plazo de ejercicios respiratorios sobre la capacidad respiratoria en niñas en edad escolar

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**Abstract.** Background: The breathing mechanism has existed since our birth and accompanies us throughout life. Breathing is an important function in the regulatory process of numerous body functions, its optimization can bring many health benefits. However, many children are unaware of the mechanisms of breathing, namely abdominal or diaphragmatic breathing, and in addition to this, many breathe normally through their mouths. Methods: The present study aimed to verify the influence of a short-term breathing exercise program in school-age girls breathing capacity. Fourteen female students aged between 8 and 10 years were selected, from this selection two groups were formed, the control group (CG) with 7 children and the experimental group (EG) with 7. Through a spirometric test, an assessment of breathing capacity (ABC) was carried out for both groups. The GE participated in a program of breathing exercises (BEP) lasting 15 to 20 minutes for 5 weeks. Then, the ABC was performed again for both groups. Discussion: The results demonstrate a significant increase in the values ( $p < 0.01$ ) of the forced vital capacity (FVC) of the EG, thus suggesting that the application of a BEP promotes the breathing capacity of school-aged girls. Further studies should be performed with larger samples and with a longer protocol.

**Keywords:** education; school-aged; girls; breathing exercises; spirometry; FVC.

**Resumen.** El mecanismo respiratorio existe desde nuestro nacimiento y nos acompaña durante toda la vida. La respiración es una función importante en el proceso regulador de numerosas funciones corporales, su optimización puede traer muchos beneficios para la salud. Sin embargo, muchos niños desconocen los mecanismos de la respiración, a saber, la respiración abdominal o diafragmática, y además de esto, muchos respiran normalmente por la boca. El presente estudio tuvo como objetivo verificar la influencia de un programa de ejercicios respiratorios de corta duración en la capacidad respiratoria de niñas en edad escolar. Se seleccionaron catorce alumnas de entre 8 y 10 años, de esta selección se conformaron dos grupos, el grupo control (GC) con 7 niños y el grupo experimental (GE) con 7. Mediante una prueba espirométrica, una evaluación de la capacidad respiratoria (ABC) se llevó a cabo para ambos grupos. El GE participó en un programa de ejercicios respiratorios (BEP) que duró de 15 a 20 minutos durante 5 semanas. Luego, se realizó nuevamente el ABC para ambos grupos. Los resultados demuestran un aumento significativo en los valores ( $p < 0.01$ ) de la capacidad vital forzada (FVC) del GE, sugiriendo así que la aplicación de un BEP promueve la capacidad respiratoria de las niñas en edad escolar. Se deben realizar más estudios con muestras más grandes y con un protocolo más extenso.

**Palabras clave:** educación; edad escolar; chicas; ejercicios de respiración; espirometría; FVC.

## Introduction

One of the practices, present in our day-to-day lives and in many areas of research, often overlooked or lessened, is breathing. The breathing mechanism has existed since our birth and accompanies us throughout life. We understand it commonly by a static and acquired process, however and mainly in the West, we do not always breathe correctly. Many children are not aware of diaphragmatic breathing and, in addition to this, they

normally breathe through their mouths. Such facts lead to several problems that are not always identified.

We can define breathe as: (1) the movement of air or dissolved gases in (inhalation) and out (exhalation) of the lungs (2) the physical and chemical processes by which an organism supplies cells and tissues with the oxygen necessary for metabolism and frees them from carbon formed in energy-producing reactions (Merriam-Webster Dictionary, 2020).

This process is considered a key function of the body because it has several functions that contribute in an essential way to self-regulation and homeostasis, such as (1) the regulation of the metabolic and chemical functions of the blood, taking oxygen (O<sub>2</sub>), eliminating carbon dioxide (CO<sub>2</sub>) and keeping the blood pH at

appropriate levels; (2) the regulation of the autonomic nervous system (ANS); (3) promoting synchronization of the body's oscillatory systems with the breathing rhythms, which optimizes the functions of all systems; (4) regulation of the circulatory system, by influencing heart rhythms and blood flow in the body; (5) influence on the lymphatic system, contributing to the drainage of toxins through the movements of the breath; (6) regulation of psychological states and (7) participation of the breathing muscles in postural and motor control (Cruz, 2016; Guyton e Hall, 2006; Courtney, 2009; Jerath, 2006).

We understand that breathing is an important function in the regulatory process of numerous body functions, its optimization can bring many health benefits. Studies reveal that the use of breathing, through specific exercises can be beneficial for the prevention of cardiac events (Barrientos, 2021; Yesmin, 2017; Reis et. Al., 2015; Jerath, 2006; Shannahof-Khalsa et al., 2004; Van Dixhoorn, Duivenvoorden, 1999), for the treatment of asthma (Dressendorfer, 2019; Karam, 2017; Cowie et al., 2008; Mchugh et al., 2003; Slader et al., 2000; Opat et al., 2000; Bowler et al., 1998) of anxiety, stress, post-traumatic stress disorder and depression (Mohamed, 2019; Brown and Gerbag, 2005).

Studies like that of Petrofsky et al. (2016) demonstrate that daily breathing exercise programs promote improvements in sleep, strength, weight and fat loss and in the increase of oxygen saturation in the blood of young people between 15 and 17 years old. According to the literature review presented by Calmon (2017), exercises based on diaphragmatic breathing promote clinical improvements in children in diseases such as asthma and cystic fibrosis. Kupersmidt (2019) in his study he found an improvement in lung function in individuals who participated in a breathing exercise program for six weeks. This pilot study demonstrated an improvement in the participants' maximum expiratory flow rate and forced expiratory volume.

Csepregi (2019) suggests in his study that the practice of breathing exercises improves endurance performance in healthy female college students. Also Kondakov (2020) presents a study where a model of respiratory training improves vital capacity, strength, flexibility and coordination of movements in female students.

The aim of this study was to verify the influence of a short-term breathing exercise program on school-age girls breathing capacity.

## Material and Methods

### Study participants

The present study was carried out with 14 young females, aged between 8 and 10 years old, students in the 3rd year, of two classes from Godinho public basic education school in the municipality of Matosinhos (Portugal). From these 14 children, two groups were formed: the control group (CG) composed of 7 students and the experimental group (EG) with 7 students.

All parents and guardians, as well as the direction of the school group, were informed about the details of the program to be applied (BEP), as well as the procedures for assessing breathing capacity (ABC), before (pre-test) and after (post-test) the application of the program.

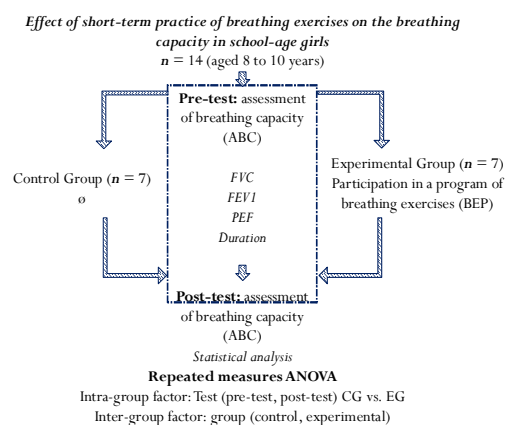


Figure 1. Study design.

### Procedure

In a first phase, both groups were assessed through a physical examination, where we identified height, weight and sex, and the assessment of breathing capacity (ABC). ABC was performed through a spirometry test with the Air-Smart Spirometer<sup>®</sup> equipment, validated by Ramos et al. (2018). In this evaluation we analyzed the forced expiration maneuver to obtain the values of forced vital capacity (FVC); the maximum expiratory volume in the 1st second (FEV<sub>1</sub>); the peak expiratory flow or maximum expiratory flow (PEF) and the duration.

After the first assessment, the GE followed the daily BEP for five weeks. This program was carried out at the beginning of each class with a duration of 15 to 20 minutes. The first part of the program focused on the correction of body posture through stretching exercises of the accessory muscles of breathing, stretching of the pectoral and great dorsal muscles, abdominal strengthening in order to favor the diaphragmatic work. The girls were also sensitized to a posture correction

with attention to the care with the position of the head, shoulders and dorsal spine. The second part consisted of learning and training for diaphragmatic or abdominal breathing. After learning how to use the diaphragm, through the abdominal muscles, the third part of the BEP was carried out, where the girls learned to «ventilate» their lungs with vigorous inhalation and / or exhalation. The fourth part of the program consisted of creating breathing cycles where the girl began to inhale, first filling the lower, abdominal or diaphragmatic area with air, then the middle, intercostal or thoracic area and finally the upper or subclavicular area: exhalation followed the reverse path twice the inspiration time. The fifth and last part of the training, after mastering the breathing cycle (fourth part), consisted of holding the breath with the lungs full for short periods of time (10 to 30 seconds).

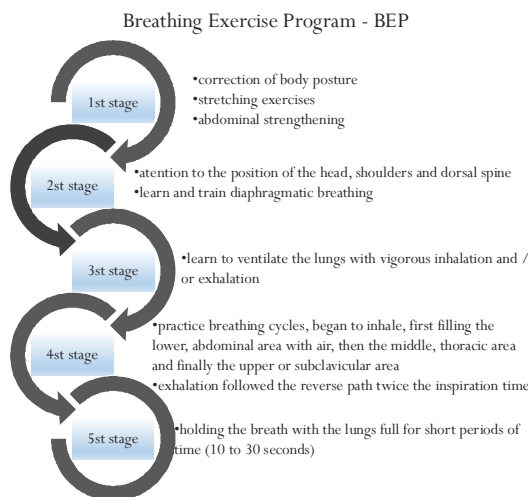


Figure 2. Breathing Exercise Program – BEP.

After the BEP was completed, the breathing capacity was reevaluated following the same procedures as the initial ABC. Based on the results of the pre-test and post-test, a comparative and descriptive analysis of them was carried out through the analysis of variance of two criteria (ANOVA) in the program SPSS version 20.

## Results

The girls who participated in this study 79% were 8 years old, 14% 9 years old and 7% 10 years old (GC 86% aged 8, 14% aged 9; GE 72% aged 8, 14% aged 9 and 14% aged 10 years old). As for the body mass index (BMI), the EG presented an average of 18.15 and the CG, 19.02.

### Intra-subject factors: pre-test vs. post-test and inter-subject factors: GC vs. GE

Table 1 shows the distribution of values by group and by gender during the pre-test and the post-test. According to the Levene's test, the groups did not show significant differences with regard to age ( $p = 0.40$ ) and BMI ( $p = 0.55$ ).

Table 1. Distribution of values by group.

Variables	Total sample (n = 14)		
	Mean	SE	(CI 95%)
PreFVC	2,00	0,15	(1,67-2,33)
PreFEV <sub>1</sub>	0,92	0,19	(0,70-1,13)
PrePEF	1,23	0,19	(0,81-1,64)
PreDuration	6,95	0,59	(5,68-8,23)
PostFVC	2,70	0,23	(2,20-3,20)
PostFEV <sub>1</sub>	1,03	0,11	(0,80-1,26)
PostPEF	1,19	0,13	(0,91-1,48)
PostDuration	6,94	0,71	(5,42-8,47)

Regarding the interaction with the intra-subject and inter-subject: significant correlations were found in the intra-group test ( $p < 0,01$ ) in the FVC variable; when analyzing table 2, no significant correlations were found in the inter-subject test.

Table 2. Analysis of variables by test and by group. ANOVA multiple comparison test

Variables	Inter-group factor <sup>B</sup>	Intra-group factor <sup>A</sup>					
		Pre-test		Post-test		Test <sup>A</sup>	A.B
		Mean	SE	Mean	SE	F-p	F-p
FVC	Cont	1,70	0,19	2,12	0,21	$< 0,01$	$<$
	Exp	2,30	0,19	3,28	0,27		
FEV <sub>1</sub>	Cont	0,87	0,07	1,08	0,48	$< 0,33$	$<$
	Exp	0,96	0,20	0,98	0,32		
PEF	Cont	1,16	0,10	1,31	0,23	$< 0,87$	$<$
	Exp	1,29	0,38	1,08	0,14		
Duration	Cont	6,31	0,84	5,60	0,56	$< 0,99$	$<$
	Exp	7,59	0,82	8,29	1,11		

Table 3 shows the variation in the averages of the test results of the two groups. It appears that the variation of the FVC values from the pre-test to the post-test were significant in EG ( $p < 0.01$ ). No significant correlations were found at the remaining results (FEV1, PEF and Duration). Regarding the variations of the means of the post-test between groups, there are significant changes at FVC both groups (EG  $p < 0.01$ ; CG  $p < 0,04$ ) and Duration ( $p < 0.05$ ) in the EG. No significant correlations were found at the remaining results (FEV1, PEF).

Table 3. Comparison between the values of the test factor and the values of the group factor.

Variables	Group	Comparisons between the levels of the test factors (post-test vs. pre-test) in each level of group factors (experimental—control).		Comparisons between the levels of the group factors (experimental vs. control) in each level of test factors (post-test—pre-test).		
		Post-test vs. Pre-test		Experimental vs. Control		
		MD (Post-Pre)	P	Test	MD (Exp-Cont)	P
FVC	Cont	0,43	$< 0,08$	Pre	0,61	$< 0,04$
	Exp	0,98	$< 0,01$	Post	1,15	$< 0,01$
FEV <sub>1</sub>	Cont	0,21	$< 0,19$	Pre	0,09	$< 0,67$
	Exp	0,01	$< 0,94$	Post	- 0,11	$< 0,63$
PEF	Cont	0,14	$< 0,40$	Pre	- 0,13	$< 0,74$
	Exp	- 0,21	$< 0,57$	Post	- 0,22	$< 0,42$
Duration	Cont	- 0,72	$< 0,57$	Pre	1,27	$< 0,30$
	Exp	0,70	$< 0,49$	Post	2,70	$< 0,05$

## Discussion

According to the World Health Organization (2020), about 235 million people suffer from asthma, most of them children. More and more, studies demonstrate that the use of adequate breathing exercises, have benefits in the recovery of several diseases, both in a clinical approach (Manandhar & Pramanik, 2019; Gamboa, 2019; Harvard Medical School, 2018; Vieira et al., 2018; Karam, 2017; Curtney, 2009; Hosking, 2009) as in the improvement of the individual's capacities, in a more holistic approach (Kupersmidt & Barnable, 2019; Marques & Fagali, 2018; Petrofsky, 2016).

This study aimed to investigate the influence of a breathing exercise program (BEP) on the breathing capacity of school-aged children. When analyzing the results, there is a significant increase in the forced vital capacity (FVC) in the experimental group (EG) both in relation to the results of the CG ( $p < 0.027$ ) and in relation to the variation between the pre-test and the post-test ( $p < 0.01$ ). Like Lima (2018), there was a significant increase in the forced vital capacity of children who were subjected to a BEP, also Banstola (2016), Holland et al. (2012 and 2016) and Sharifi (2014) refer to the increase in FVC in individuals who underwent breathing training. Authors such as Vinay (2017), Yamaguti et al. (2012) and Pal (2004) present significant results in the application of short-term programs or training. Han (2019) mentions in his studies that a short-term breathing training intervention can lead to an improvement in body posture, which can promote a decrease in heart rate, which in turn can be responsible for improvements in the parasympathetic system (ANS). Petrofsky (2016) presented positive results in terms of physical and breathing capacity in his study where he verified the influence of a short-term BEP (8 minutes) for six weeks.

Also in the duration of ABC, there was an increase in EG compared to CG, it suggests a greater lung capacity in the EG. Csepregi (2019), Kondakov (2019) and Yadav (2001) in their studies suggest that breathing exercises, individual or included in other practices, promote breathing capacity in young females.

## Limitations of the study

As limitations of this study, the small sample size of 14 girls stands out. In this study, 20 girls were evaluated, however, after the initial and final ABC, only 14 evaluations were validated. In addition to the sample

size, the short study time. If BEP had been greater than 5 weeks it could have promoted superior results.

## Conclusion

The results obtained in this study suggest that the application of a short-term daily breathing training has positive effects on the breathing capacity (FEV) of school-age girls. It is also important to emphasize that the breathing exercises used in the present study were chosen because children can learn them after only a few sessions and subsequently practice them by themselves with or without continuous direct supervision of teachers. The BEP can be therefore accessible to a large number of students.

## Recommendations

The study presented can be a starting point for studies with higher samples and with longer application time of the experimental part. Other variables such as gender and age of participants in future studies could also be assessed.

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