Comparison of respiratory parameters between singing and non-singing choir children

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ABSTRACT

Introduction: musical interventions, such as choral singing, are artistic in character and are capable of promoting psychological and physiological benefits. There are no studies in the literature on the repercussion of choir on respiratory system parameters of practicing students compared to non-singers. **Objective:** compare respiratory system parameters between choir and non-choir children and adolescents. **Method:** cross-sectional observational study included students from 7 to 14 years old, with the intervention group constituted students of choir singing (GCC) paired with non-singing students (GNC). Anthropometric assessment was performed, followed by spirometry and manovacuometry, according to ATS recommendations. For comparison between groups, absolute spirometric values and predicted values were considered, as well as respiratory muscle strength. Shapiro-Wilk test was applied and the Mann-Witney U test and independent T-test were conducted, with a significance level of 5%. **Results:** 40 children (95% girls) participated, 20 in each group, with a mean age of 11.25 ± 1.80 years in the GNC and 11.20 ± 1.64 years in the GCC. Forced expiratory volume in the first second as a percentage of predicted (FEV1%) was higher in GNC (98.58 ± 12.62%) compared to GCC (87.10 ± 8.84%) (p = 0.001), GCC presented the highest absolute value of peak expiratory flow (PEF) (GNC: 4.21 ± 0.99l/s x GCC: 4.95 ± 1.29l/s; p=0.048). **Conclusion:** schoolchildren singing in the choir did not present better parameters of pulmonary function and FMR, compared to non-singers.

Keywords: Singing, Physical therapy, Child, Spirometry.

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INTRODUCTION

Human beings' experience with music has been present since antiquity. Pythagoras and Plato observed the benefits of music and referred to it as an instrument capable of harmonizing human beings[1,2]. Music has an artistic goal; moreover, it might promote psychological and physiological benefits to any individual of whichever age group[3]. It is a non-pharmacological and non-invasive intervention of low risk and cost to whom perform it[3,4].

Some studies report the use of music influencing physiological variables such as heart and respiratory rate, body temperature, blood pressure, and biochemical parameters of endocrine and immunological systems[4,5]. Its practice may help in conditions such as cystic fibrosis, bronchiectasis, and cardiac surgeries, just as increasing quality of life (QOL) and health conditions of whom practice it[3,5-7]. Choir singing is one kind of musical intervention performed in groups, which promotes social interaction, and it is perceived as a fun activity. Singing demands a higher respiratory control than speaking once it uses longer sentences and variable tone notes. To supply these demands, who sings needs a higher activation and work of respiratory muscles and optimization of the diaphragmatic breathing[3,8]. As it favors respiratory control, singing can be considered analogous to some respiratory physiotherapy resources, especially those that involve an emphasis on diaphragmatic breathing, and can be useful in managing and recovering from episodes of shortness of breath[7].

On that note, studies point to choir singing as capable of promoting benefits in different outcomes, e.g., increasing pulmonary function parameters, improving overall breathing, favoring control of dyspnea, facilitating mucociliary clearance, and stimulating social participation, besides its safeness and having no side effects[6,7,9]. Singing contributes to the health, and it is pleasant for those who practice it[3], and using it as a therapeutic resource seems to be an alternative, mainly in the presence of respiratory impairments. Despite research on the subject of individuals with pulmonary disease, there still are few studies in this field, especially among healthy children and adolescents. Therefore, it is necessary to identify the repercussion of choir singing on respiratory system parameters of singing and non-singing school children. Thus, the objective of this study was to compare pulmonary function (PF) and respiratory muscle strength (RMS) of school children, choir singers and non-singers.

METHODS

Population and sample

A quantitative transversal observational study included school children from Greater Florianópolis/SC (Brazil), seven to 14 years old. All participants had signed the Assent form for Minors and the parents the Free and Informed Consent form. This study was approved by the Ethics and Research with Human Beings Committee of the Santa Catrina State University (CEPSH/UDESC) – Brazil, under the CAAE number (03926918.2.0000.0118; 38770314.1.0000.0118 and 52891215.7.0000.0118). Data collections were in Florianópolis/SC – Brazil, at the Instituto Estadual de Educação (IEE) and Physiotherapy clinic school from the College of Health and Sport Science (Cephid) of UDESC.

There were considered as apt to participate in the research, healthy school children, oriented, collaborative, that had not shown acute respiratory disease on the day of the evaluations, nor cognitive, physical, hearing, or visual disorders that could interfere in choir singing learning or to perform any of the evaluation procedure. Those criteria were investigated through a health record, elaborated by the researchers, and answered by the legal guardians. Besides the health record, to control children's health, there were mandatory values of forced expiratory volume in 1 second, (FEV_1) and forced vital capacity (FVC) above 75%, and peak expiratory flow (PFE) above 60% of the predicted values proposed by Knudson et al. (1976)[10] and Polgar et al. (1971)[11]. The *International Study of Asthma and Allergies in Childhood* (ISAAC) module I questionary to identify asthma was applied, in a manner that was considered healthy the participants from five to nine years old that showed scores lower than 5, and school children from 10 to 14 years old scores lower than 6. Individuals that could not perform all assessment procedures were excluded[12].

To compose the intervention group (IG), healthy school children from the children choir Vozes do Amanhecer of IEE that have been practicing

singing for at least three months were recruited, considering this period as a minimum to acquire learning and possible systemic adaptations. In the control group (CG), those who attended the inclusion criteria were selected, and later they were paired with IG by gender, age, body mass, and stature.

The sample size was calculated based on a pilot study, which included five individuals in each group[9]. To this estimate, the difference of the spirometric parameter FVC between groups was used since this parameter showed a difference between singing and non-singing children in the other study. Difference to be detected of 8% of the predicted value, a standard deviation of 5%, alfa of 0,05, and a beta of 0,01 was set, calculating 16 individuals for each group as sufficient for the research. Considering a sample loss of 20%, a total of 20 school children were estimated as sufficient for the final sample.

Intervention – choir singing classes

Choir singing classes occurred two to four times a week, for one hour and thirty minutes. Every class started with global stretching, vocal warm-up with vocalizes, and respiratory exercises, emphasizing diaphragmatic breathing. In sequence, the repertoire was conducted, without a fixed order, mutable from one class to another. This repertoire was a construct of about six songs, preferably in higher pitches. Children were oriented by their teachers to train at home every time possible, later, they reported this practice performed.

Assessment procedures

Data collections included anthropometry, and respiratory system parameters assessment, specifically PF and RMS, totaling one hour and thirty minutes of procedures. Anthropometry included measuring stature by portable stadiometer from Sanny®, in which every participant was oriented to be straight, aligned, wearing light clothing, and barefoot; all records were made in meters (m). Body mass was obtained by a digital glass balance, model Ultra Slim W903 from Wiso®, and the measurement was recorded in kilograms (Kg). After obtaining stature and mass data, body mass index (BMI) was calculated in kg/m².

To evaluate PF, the EasyOne® portable spirometer from Fleximed was used, following the American Thoracic Society (ATS) guidelines[13]. Predicted values by Knudson et al.[10] and Polgar et al.[11] were considered; they are identified by initials and percentage (%). For data analysis, absolute and percentage values of the parameters: FVC, FEV_1, forced expiratory flow at 25–75% of forced vital capacity (FEF_{25-75}), FEV_1/FVC ratio (FEV_1/FVC), and PFE were compared.

RMS was assessed by manovacuometry (MVD-300Globalmed), considering values of maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP), following ATS recommendations[14], and the predicted values proposed by Da Rosa et al.[15] to children of 7 to 10 years old, and by Domènech-Clar et al.[16] to children between 11 to 14 years old.

To IG, data collection was performed before choir singing class, and the participant's guardian previously signed the consent term and filled out the ISAAC questionary and the health record. CG was assessed at the physiotherapy school clinic of UDESC, and their guardians filled the referred instruments on the day of data collection. The assessments respected the organogram in Figure 1.

Statistical analysis

Analysis was performed at the IBM Statistical Package for the Social Sciences (SPSS®) 20.0 to Windows® software. Initially, descriptive and frequency statistics were carried on. Data distribution was verified through the Shapiro-Wilk test and, according to data results, there was conducted The Independent Samples t-Test or Mann–Whitney U test to compare the respiratory system parameters between IG and CG, just as between children that practiced singing at home and those that did not practice at home. All tests had a significance level set at 5%.

RESULTS

Twenty-eight choir singing school children were evaluated; however, eight did not meet inclusion criteria: five showed spirometric values below the set value, two showed unacceptable maneuvers, and one had bronchitis reported by the guardians on the health record; therefore, 20 children were

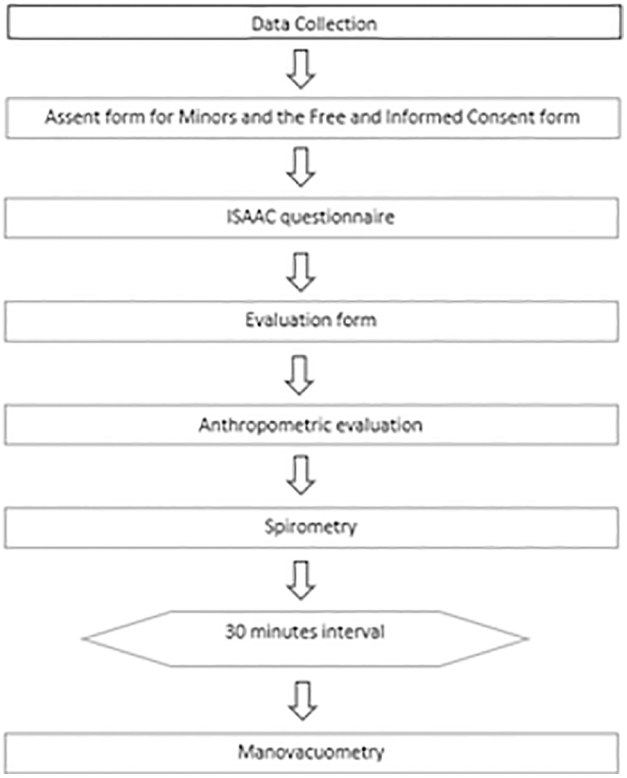

Figure 1: Research organogram.

included in the IC. Twenty healthy children were identified to pair with IC, for that reason, there were no anthropometric differences between groups (Table 1). Forty school children were included in the study, 20 in each group, and both had 95% of girls.

From IG, 89.65% joined class twice a week, while 10.35% four times/week. Concerning time of practice, 75.46% practiced choir singing for more than a year and the rest between 4 to 6 months. When questioned about practicing choir singing at home, 86.75 reported performing it, and 17.24% reported not; there was no significant difference between those who practiced at home and those that did not. All participants (100%) reported like practicing choir singing.

Relate to the analyzed spirometric parameters, only FEV_1 and PFE(1/s) showed a difference between groups. FEV_1(%) was higher in the IC compared to the CG (98,58±12,62% x 87,10±8,845%, p=0,001) and PFE(1/s) was higher in the CG (4,95±1,29l/s x 4,21±0,99l/s, p=0,048). There was no significant difference in the RMS parameters between groups (p>0,05) (Table 2).

DISCUSSION

This is one of the few studies that compared respiratory system parameters of people that practice choir singing[17], with those that do not practice it, facing the premise that this activity might have therapeutic finalities for individuals with respiratory impairments since it includes training all muscles involved in breathing, optimize breathing control and the emphasis in the abdominal type of breathing. Moreover, singing is a ludic strategy, seen as something pleasant to whom practice it[3,8], which promotes higher social participation and does not have side effects[7,9]. In the current research, the social character of the practice was identified, accomplished in groups by the participant, and including art exhibitions to the community, reported as satisfying.

Considering literature data, it is possible to say that singing is related to individual integrability since it integrates physiological, psychological, and social aspects. Goldemberg, in their recent literature review, suggests that singing may help individuals with respiratory conditions in learning more complex respiratory techniques, such as autogenic drainage, once this activity promotes a higher respiratory awareness[9]. In studies by Bonilha et al.[18], Goldemberg[19] and Lewis et al.[7], the authors observed an improvement in mucociliary clearance during singing, which indicates the benefits of singing to hyper secretive patients. Therefore, the act of singing shows itself as a strategy to be used as an adjuvant treatment in respiratory conditions or even be included as a physiotherapeutic intervention to stimulate training and control of respiratory muscles, mostly expiratory ones.

On that note, results evinced in this current paper, when comparing respiratory system parameters of singers with non-singers, a significant difference in FEV_1(%) and PFE absolute spirometric values between groups was identified, where VEF_1(%) was higher in CG and PFE absolute higher in IG. Any significate difference was observed in the parameters representatives of RMS between groups, although there was a tendency to increase the percentage of predicted values of MIP in IG.

According to these findings, concerning the higher PFE absolute value in the IG, it is suggested that school children that sing have higher activation of expiratory muscles, even though the difference in

Table 1

Data distribution of age and anthropometric parameters of IG and CG.

	CG (mean±standard deviation) (IQR 25/50/75)	IG (mean±standard deviation) (IQR 25/50/75)	p-value
Age (years)	11.25±1.80 (10.25/11.00/12.75)	11.20±1.64 (11.00/11.00/12.75)	1.00
Body mass (Kg)	45.50±14.59 (34.12/43.55/52.67)	45.84±14.22 (33.75/43.50/55.75)	0.903
Stature (m)	1.50±0.10 (1.44/1.51/1.59)	1.50±0.12 (1.44/1.51/1.56)	0.935
BMI (Kg/m^2)	19.83±4.46 (16.81/19.27/22.44)	19.95±3.63 (16.52/19.84/21.64)	0.787

Table caption: CG: groups with children that do not practice choir singing; IG: groups with children that practices choir singing; IQR: Interquartile range (quartile 25, 50 e 75, respectively); BMI: body mass index; Kg: kilograms; m: meters; p-values: statistical significance obtained using the Mann-Whitney U test.

Table 2

Data distribution and comparison of respiratory system assessed parameters, in absolute and percentage of the predicted, from IG and CG.

	CG (mean±standard deviation) (IQR 25/50/75)	TG (mean±standard deviation) (IQR 25/50/75)	p-value
FCV (l)	2.63±0.51 (2.34/2.66/3.04)	2.55±0.63 (2.27/2.51/2.89)	0.409
FCV %	98.65±10.54 (90.75/98.50/106.50)	93.10±9.72 90.00(85.00/90.00/99.75)	0.064
FEV_1 (l)	2.25±0.36 (2.06/2.33/2.46)	2.26±0.55 (1.93/2.30/2.49)	0.946
FEV_1 %	98.85±12.62 (87.25/97.5/112.00)	87.10±8.84 (81.00/85.00/89.75)	**0.001**
FEV_1/FCV	86.67±8.17 (79.65/89.93/92.28)	88.87±4.46 (86.07/89.20/92.82)	0.570
PFE (l/s)#	4.21±0.99 (3.55/4.20/4.81)	4.95±1.29 (4.00/4.85/5.85)	**0.048**
PFE %	83.65±16.64 (69.00/79.00/102.50)	82.65±11.79 (73.00/84.00/87.75)	0.935
FEF_{25-75} (l/s)	2.67±0.92 (1.89/2.46/3.21)	2.81±0.81 (2.37/2.91/3.24)	0.449
FEF_{25-75}%	89.10±26.35 (72.5/89.00/105.25)	90.80±16.57 (77.50/90.50/102.50)	0.745
MIP (cmH_2O)	-85.20±31.66 (-63.00/-80.50/-92.75)	-81.80±29.33 (-59.25/-79.50/-97.75)	0.860
% predicted MIP (%)	94.74±50.18 (144.25/94.74/84.44)	104.65±39.54 (119.16/106.71/76.90)	0.745
MEP (cmH_2O)	71.35±23.13 (46.75/72.00/87.00)	79.00±25.62 (60.75/79.50/89.00)	0.379
% predicted MEP (%)	97.38±67.74 (63.91/77.49/105.17)	95.17±45.27 (62.08/85.50/121.29)	0.607

Caption: CG: groups with children that do not practice choir singing; IG: groups with children that practices choir singing; IQR: Interquartile range (quartile 25, 50 e 75, respectively); FVC: forced vital capacity, FEV_1: forced expiratory volume in one second. $FEF_{25-75\%}$: forced expiratory flow at 25-75% of forced vital capacity; FEV_1/FEV: ratio between FEV_1/FEV; PFE: FEV_1/FEV, MIP: maximal inspiratory pressure; and MEP: maximal expiratory pressure; % predicted: percentage of predicted values; p-value: statistical significance obtained using the T tests for independent samples and the Mann-Whitney U test with the rest.

strength was not observed in vacuometry. Therefore, investigating respiratory muscle resistance – through the spirometric maneuver maximal voluntary ventilation- may perhaps bring up answers to this research finding. Once to vocalize, muscle contraction is important; in singing – which implicates fast and strong inspirations, just as prolonged and controlled expirations – this muscle action is even more accessed. Thus, children who practice singing, like those from IG, probably show higher respiratory muscle resistance compared to those that do not practice singing, which deserves further investigation.

Expiration, which physiologically is a passive process of diaphragm return, when prolonged or forced, it becomes active, leading to a prolonged contraction of expiratory muscles to result in vocal cords vibrations and producing sound. Yet, inspiration is also important during singing; expiration is intrinsically attached to producing sounds, and in consequence, controlling this action has a higher focus during singing training[17]. PFE is measured during the expiratory stage and is considered an effort-dependent variable, and, as cited before, in singing, this stage of breathing is emphasized. If during singing, airflow is weak, voice production is also going to be weak[17]; therefore, during singing is needed a good modulation and control of generated expiratory flows, which matches with this here evinced results.

Corroborating with the results here verified, Wade[20] compared the effects of singing with assisted relaxation by music in PFE rates of nine children with asthma between 8 to 13 years old. The intervention was performed in public schools for four weeks, where were conducted two interventions, progressive muscle relaxing and singing, at the same session, and PFE was measured after each of them. An increase or maintenance of PFE after singing was observed; there was no difference after relaxing. The results of this study corroborate with the current investigation regarding increasing PFE in the IG.

Concerning the VEF_1(%) parameter, which was higher in CG, it may be because all the IG group participants perform deep sustained breathings during singing practices, but they are more used to modulate expiratory volumes. Therefore, singers tend to start from a pulmonary capacity that is not total, which may compromise parameters derivates of the initial volume, such as FEV_1. This hypothesis may justify the lower values of FEV_1% in IG, just as difficult to perform forced maneuvers since people who sing are trained and used to conduct more controlled and soft expirations. Another possibility to this finding is due to the kind of repertoire practiced by the IG, which included higher pitches that may lead to airway narrowing, and even a transitory instability, deriving lower values of FEV_1. However, the literature does not present this supposition, which must be investigated better.

What is known as the Irzaldy et al.[17] study, which compared vital pulmonary capacity among singer and non-singer college students, is the presence of higher values of vital pulmonary capacity and FVC of singers. Those authors do not observe differences in the inspiratory capacity between groups, which is also related to the inspiratory stage.

Even though the results here are conflicting, the importance of this investigation is grasped once the potential benefit of practicing choir singing may have repercussions on the respiratory system, especially in pediatric respiratory diseases. Literature related to the effects of singed songs is yet scarce and existing studies approach, mostly, effects of singing in healthy adults[15] or diseases such as Parkinson's, cancer, chronic obstructive pulmonary disease (COPD), asthma, and cystic fibrosis (CF)[6,9,20,21]. These investigations have evaluated outcomes such as PF[20], QoL[7,9,21], and airways clearance, mainly the FEV_1 and FVC parameters; increase of respiratory muscles strength, inspiratory and expiratory; in addition to the benefits in the QoL[7]. Airways clearance, identified by the increase in sputum production during singing[18,19] is another event reported, and it has been justified by pressure oscillations and increase of peak of airflow during practice, the second one when above 0,5 l/s, has attributed the forces of shear leading to viscoelasticity diminishment, change the mucus rheology[19].

Considering the same outcomes of the current investigation, Goldenberg[9] analyzed 17 studies about singing interventions to the respiratory system health, of which samples included diseases such as COPD, asthma, CF, Parkinson's disease, cancer, quadriplegia, and multiple sclerosis; several studies observed a tendency aiming increase of PF and RMS parameters, particularly MEP. Of the total analyzed publications, 11 included spirometry, and 2 reported a significant increase of spirometric variables in adults when compared to the same individual pre and after a period of singing intervention. Specifically, FEV_1 and FCV variables increased in COPD, and

in another research, functional residual capacity increased in Parkinson's disease.

Despite RMS and PF parameters, the same review[9] discusses the psychological benefits of singing, such as mood betterment, vitality, diminishment of pain, and increase of QoL. These positive outcomes of QoL were also verified by Lord et al.[21], in a COPD study that reported a significant improvement of QoL, mostly in the physical component of the questionnaire SF-36 after eight weeks of practicing singing, this outcome was not assessed in the current investigation. Up to this moment, there were no identified publications with samples of healthy children and adolescents; thus it justifies the relevance of the current investigation.

Activities of singing to an individual with respiratory diseases have been encouraged, mainly by the British Lung Foundation, since these individuals may benefit themselves from the practice of singing; once this one promotes an increase in posture and breathing control, reduce dyspnea sensation, helps mucociliary clearance, besides promoting psychological and social interaction benefits[7]. Nevertheless, it still is necessary to investigate the immediate effects, in the long-term, provoked by the practice of singing in an individual with respiratory diseases.

Other study designs must be conducted to verify the effects of choir singing once the method here proposed faced some limitations. Among them, the short Weekly time of the participants included in the IG, and the lack of familiarization with the assessment methods of the respiratory system, from both groups, resulted in the non-inclusion of some children for showing difficulty to perform them. So that singing can be used as a physiotherapeutic resource, there is a need of studying this intervention in new studies, with bigger sample sizes, involving analyzes of the immediate and late effects of singing on respiratory system parameters, enlarging the time of practice, and including new outcomes in assessment.

CONCLUSION

Differences in spirometric parameters (FEV_1 % and PFE) were verified between school children that sing in a choir and those that do not sing. That difference seems to be related to the expiratory component of singing, of which practice reduces forced exhalations, depicted by lower values of FEV_1 in the IG, although it optimizes expiratory muscles actions, which was evinced by the higher PFE compared to non-singers. The parameter representatives of RMS, MIP and MEP, do not differ between groups, which refer to the absence of training load of respiratory muscles compatible with strength gain in the act of singing of the evaluated school children.

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Conflict of interest
None.

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