

Comparison of maximal respiratory pressures between schoolchildren from public and private schools

Comparação das pressões respiratórias máximas entre escolares das redes pública e privada

Comparación de las presiones respiratorias máximas entre escolares de las redes pública y privada

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ABSTRACT

Objective: To compare the values of maximal inspiratory pressures (MIP) and maximal expiratory pressures (MEP) between students from public and private schools.

Methods: Observational cross-sectional study of 144 children from public and private schools. Maximal respiratory pressures were measured with an MVD300 (Globalmed®). Student's *t*-test was applied to compare average pressures and chi-square test was used to compare the frequency of children who performed or not physical activity.

Results: Students from private and public schools showed a mean MIP of 77.0±21.5 and 65.7±18.7cmH₂O (*p*=0.002) and MEP of 90.1±22.5 and 79.4±19.0cmH₂O (*p*=0.005), respectively. Boys from private and public schools showed a mean MIP of 85.0±20.8 and 74.4±17.1cmH₂O (*p*=0.051) and MEP of 98.5±22.5 and 89.2±16.3cmH₂O (*p*=0.103), respectively. Girls from private and public schools showed a mean MIP of 70.0±19.8 and 60.2±17.8cmH₂O (*p*=0.027) and MEP of 82.6±20.0 and 73.2±18.1cmH₂O (*p*=0.035), respectively. Approximately 40% of public school students performed physical activity, in private schools, this percentage was 95%. Children who performed or not physical activity showed a mean MIP of 76.0±20.7 and 63.2±20.0cmH₂O (*p*=0.002) and MEP of 89.0±21.6 and 77.4±20.5cmH₂O (*p*=0.006), respectively.

Conclusions: Respiratory muscle strength of students from private schools was significantly higher than that of students from public schools, especially among girls, and possibly related to the practice of physical activity, more frequent in private schools.

Key-words: schools; motor activity; muscle strength.

RESUMO

Objetivo: Comparar os valores obtidos das pressões inspiratórias máximas (PImáx) e pressões expiratórias máximas (PEmáx) entre estudantes das redes pública e privada de ensino.

Métodos: Estudo observacional do tipo descritivo transversal. Foram avaliadas 144 crianças nas duas redes de ensino. As pressões respiratórias máximas foram mensuradas com o MVD300 (Globalmed®). Aplicou-se o teste *t* de Student não pareado para comparar as médias das variáveis estudadas e o teste do qui-quadrado para comparar a frequência de crianças que realizavam ou não atividade física.

Resultados: Os alunos das escolas privadas e públicas apresentaram, respectivamente, média de PImáx 77,0±21,5 e 65,7±18,7cmH₂O (*p*=0,002) e PEmáx 90,1±22,5 e 79,4±19,0cmH₂O (*p*=0,005). Os meninos, das escolas privadas e públicas, apresentaram médias de PImáx 85,0±20,8

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e $74,4 \pm 17,1 \text{ cmH}_2\text{O}$ ($p=0,051$) e PEmáx $98,5 \pm 2,5$ e $89,2 \pm 16,3 \text{ cmH}_2\text{O}$ ($p=0,103$), respectivamente. As meninas, das escolas privadas e públicas, apresentaram médias de PI máx $70,0 \pm 19,8$ e $60,2 \pm 17,8 \text{ cmH}_2\text{O}$ ($p=0,027$) e PE máx $82,6 \pm 20,0$ e $73,2 \pm 18,1 \text{ cmH}_2\text{O}$ ($p=0,035$), respectivamente. Aproximadamente 40% dos alunos da rede pública e 95% dos alunos da rede privada realizavam atividade física. As crianças que realizavam ou não atividade física apresentaram PI máx $76,0 \pm 20,7$ e $63,2 \pm 20,0 \text{ cmH}_2\text{O}$ ($p=0,002$) e PE máx $89 \pm 21,6$ e $77,4 \pm 20,5 \text{ cmH}_2\text{O}$ ($p=0,006$), respectivamente.

Conclusões: A força muscular respiratória dos alunos da rede privada foi significativamente superior à dos alunos da rede pública, especialmente entre as meninas. Possivelmente, essa diferença esteja relacionada à prática de atividade física, mais frequentemente observada nas escolas privadas.

Palavras-chave: instituições acadêmicas; atividade motora; força muscular.

RESUMEN

Objetivo: Comparar los valores obtenidos de las presiones inspiratorias máximas (PI máx) y presiones espiratorias máximas (PE máx) entre estudiantes de las redes pública y privada de enseñanza.

Métodos: Estudio observacional de tipo descriptivo transversal. Se evaluó a 144 niños en las dos redes de enseñanza. Las presiones respiratorias máximas fueron medidas con el MVD300 (Gobalmed®). Se aplicó la prueba t de Student no pareada para comparar los promedios de las variables y la prueba de chi cuadrado para comparar la frecuencia de niños que realizaban o no actividad física.

Resultados: Los alumnos de las escuelas privadas y públicas presentaron, respectivamente, promedio de PI máx $77,0 \pm 21,5$ y $65,7 \pm 18,7 \text{ cmH}_2\text{O}$ ($p=0,002$) y PE máx $90,1 \pm 22,5$ y $79,4 \pm 19,0 \text{ cmH}_2\text{O}$ ($p=0,005$). Los muchachos de las escuelas privadas y públicas presentaron promedios de PI máx $85,0 \pm 20,8$ y $74,4 \pm 17,1 \text{ cmH}_2\text{O}$ ($p=0,051$) y PE máx $98,5 \pm 2,5$ y $89,2 \pm 16,3 \text{ cmH}_2\text{O}$ ($p=0,103$), respectivamente. Las muchachas de las escuelas privadas y públicas presentaron promedios de PI máx $70,0 \pm 19,8$ y $60,2 \pm 17,8 \text{ cmH}_2\text{O}$ ($p=0,027$) y PE máx $82,6 \pm 20,0$ y $73,2 \pm 18,1 \text{ cmH}_2\text{O}$ ($p=0,035$), respectivamente. Un 40% de los alumnos de la red pública y un 95% de los alumnos de la red privada realizaban actividad física. Los niños que realizaban o no actividad física presentaron PI máx $76,0 \pm 20,7$ y $63,2 \pm 20,0 \text{ cmH}_2\text{O}$ ($p=0,002$) y PE máx $89 \pm 21,6$ y $77,4 \pm 20,5 \text{ cmH}_2\text{O}$ ($p=0,006$), respectivamente.

Conclusiones: La fuerza muscular respiratoria de los alumnos de la red privada fue significativamente superior a la de los alumnos de la red pública, especialmente entre las muchachas, y posiblemente esa diferencia esté relacionada a la práctica de actividad física, observada con más frecuencia en las escuelas privadas.

Palabras clave: instituciones académicas; actividad motora; fuerza muscular.

Introduction

The assessment of respiratory muscle strength is of great clinical importance⁽¹⁾, because it is useful to detect the presence of muscle weakness and to quantify its severity⁽²⁾. Such assessment can be performed by the measurement of maximal respiratory pressures (MRP). This has been considered since the 1960s and 1970s a simple, convenient and accurate assessment of respiratory muscle strength in both healthy subjects and patients with respiratory or neurological disorders⁽³⁾. The values of maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) depend on the strength of respiratory muscles and vary depending on the lung volume at which measurements are performed and the corresponding value of the elastic recoil pressure of the respiratory system⁽⁴⁾. Moreover, this is a volitional test, well tolerated and that requires the full cooperation of the subject⁽⁵⁻⁷⁾.

Respiratory muscles, like all skeletal muscles, improve its function in response to training. However, unlike peripheral muscles, they contract repeatedly in a short period of time without allowing rest. This can cause wear in these muscles, leading to an overload of the respiratory system⁽⁸⁾. Respiratory muscle weakness is present in many individuals. It may result from various conditions such as neuromuscular diseases, chronic obstructive pulmonary disease, metabolic diseases, sepsis and malnutrition⁽²⁾. Dysfunctions in these muscles can cause hyperventilation and decreased exercise tolerance, with respiratory failure⁽¹⁾.

Respiratory muscle strength may be influenced by factors such as age, sex, weight, height, physical activity level and ethnicity^(1,9). Studies carried out in order to provide normal values for MRP in children showed, besides the existence of differences between the sexes for these measurements, a correlation of MRPs with weight^(5,10), age^(5,10-14) and height⁽¹⁰⁻¹²⁾. This study works with the presupposition that there exists the possibility of differences in anthropometric characteristics, already established in the literature as predictors of respiratory muscle strength of children enrolled in public and private schools. Therefore,

the purpose of this study was to compare the MRPs of healthy school children from public and private schools.

Method

This is an observational, descriptive, cross-sectional study. The project was approved by the Research Ethics Committee of Universidade Federal do Rio Grande do Norte (UFRN). All children participating in the research and their parents received information about the objectives, the importance and necessary procedures for performing the study. The data were collected after parents signed an informed consent (IC).

Children of both sexes were eligible to participate in this study. The subjects were aged from 7 to 11 years, enrolled in primary schools in the state-level public school system or on private schools in the city of Natal, state of Rio Grande do Norte, Brazil.

A confidence level of 95% was considered for the calculation, for which the value z is equal to 1.96. The values of the standard deviation and the error estimate used were those found by Wilson *et al*⁽⁵⁾. The error estimate was calculated from the difference between the mean MIP between the groups of boys and girls. The calculation was performed by sex, resulting in 14 boys and 12 girls for each age group, totaling a minimum sample of 130 children.

Children could not be already diagnosed with chronic, cardiovascular or neuromuscular lung disease⁽¹⁵⁾; history of recent trauma of the upper airways, thorax or abdomen⁽¹⁶⁾; fever (three weeks)^(6,16) and flu and/or cold on the week before the procedure⁽¹⁶⁾; history of smoking^(6,16); evident deformity in the thorax⁽¹⁶⁾; acute problem of the middle ear⁽¹⁵⁾; abdominal hernia⁽¹⁶⁾; glaucoma or retinal detachment⁽¹⁶⁾; neurological and/or cognitive impairment^(15,16); use of medications such as inhaled or systemic glucocorticoids, mineralocorticoids, central nervous system stimulants, barbiturates or muscle relaxants⁽¹⁵⁾; percentile outside the range 5 to 85 in the graph for body mass index (BMI) for age and sex⁽¹⁷⁾.

Age limits were set according to Article 2 of the Children and Adolescents Statute (Estatuto da Criança e do Adolescente)⁽¹⁸⁾, which defines as children individuals under 12 years of age. The minimum age was determined according to the ability to understand and perform correctly the maneuvers⁽⁵⁾.

Children who failed to perform the necessary procedures, those who declined to participate in the study during the assessment, those who presented some acute respiratory disease during the data collection period, or who missed class during the assessment period in their school were excluded from the sample.

Initially, a contact was made with the 1st Regional Board of Education (1ª Diretoria Regional de Educação) to obtain approval for the study and a list of all the primary schools of the state public school system in the city of Natal, state of Rio Grande do Norte. Subsequently, a request was made to the State Department of Education of Rio Grande do Norte's Department of Statistics (Departamento de Estatística da Secretaria Estadual de Educação do Rio Grande do Norte) a list with information regarding the number of students divided by age and sex of each public and private school with primary school classes. Of the 104 public schools and 163 private schools, 27 schools were randomly selected, representing 10% of the total. The selection was proportional to the number of public and private schools. To obtain the final sample, the number of students enrolled in primary school in public schools (41%) and private (59%). After the draw, approval by the principals from the selected schools was requested. To supplement potential losses in obtaining the sample, it was determined that in each school 50 students would be randomly selected, 5 girls and 5 boys for each studied age.

Through a previous contact with the selected students, an envelope was handed for their parents and/or guardians, containing a letter of presentation of the study, which explained what were the documents they were received and how they should proceed; the IC for the parents, containing explanations about the objectives, importance and procedures of the study; and a questionnaire that should be answered by the parent or legal guardian, which had questions about the general health condition of the child, as well as some recommendations for the assessment day.

The second contact with the selected children occurred in a previously set date, at which time the children returned the IC signed by their parents, as well as the filled general health questionnaire. The child's desire to participate was respected.

A standardized assessment form was used to collect personal and anthropometric data, physical activity, vital signs, MIP, MEP and information obtained from the respiratory assessment.

To assess the body weight, a digital scale was used (*Personal Scale – QIE 2003b*, China). Height was measured with a 150 cm tape measure, mounted on the wall 50 cm above the floor. The weight/height² formula was applied to calculate the body mass index (BMI) and the value was plotted on a graph specific for age and sex in order to obtain the percentile value. This indicates the relative position of the child in relation to other children of the same sex and age, the eutrophic child with a percentile between 5 and 85⁽¹⁷⁾.

To measure the MRP a MVD300 digital vacuum manometer (Globalmed®, Brazil) was used, calibrated from -300 to

+300 cmH₂O, with an accuracy of 1cmH₂O. The interface used was a rigid plastic flanged mouthpiece (Globalmed®, Brazil) with a 2mm diameter hole at the top to dissipate additional pressures caused by the contraction of facial muscles⁽¹⁹⁾. In order to prevent air leakage a nose clip was used. The assessment was performed with the manometer connected to a netbook (Acer, operating system Windows® 7 Starter, Intel® Celeron® processor). Through the equipment's data acquisition software, the child received visual and auditory feedback.

MIP and MEP measurements were performed by two trained assessors according to the method proposed by Souza⁽¹⁶⁾. Initially, the child randomly selected the maximum respiratory pressure which would be assessed first. To measure the MIP the command to breathe normally (tidal volume) for three breaths was given, then the subject performed the maximum expiration (approximately up to the residual volume – RV). The child indicated the end of expiration by a prearranged gesture. At this point, the assessor closed the hole that connected the system to ambient air and asked the subject to perform a maximal inspiration (up to approximately total lung capacity – TLC). To assess MEP the subject was asked to perform a maximal inspiration and, after the prearranged signal, a maximal expiration⁽¹⁹⁾ and that during this measurement the assessor performed a manual cheek support of the child to ensure a lower pressure loss due to the complacency of the oral cavity⁽²⁰⁾. The maneuvers were demonstrated and explained verbally. Because it is an effort dependent test, the assessor provided verbal encouragement during the measurement. A one minute rest between each maneuver and five minutes between the measurement of MIP and MEP was given. Throughout the test, the student remained comfortably seated.

A maximum of nine maneuvers for MIP and MEP was carried out, as suggested by Domènech-Clar *et al*⁽¹⁰⁾. At least three acceptable maneuvers were obtained from these (with no leak and a duration of at least two seconds) and, between the acceptable ones, it was necessary to have at least two reproducible maneuvers (with values that differ from each other by no more

than 10% of the higher value), of which the highest was used the greatest of these⁽¹⁹⁾. However, if the highest measurement was the last to be performed, another assessment was made.

During MRP measurements, blood pressure (BP), heart rate and oxygen saturation were checked four times (before and after the MIP and MEP), in order to monitor the assessed child for the interruption of assessment in the presence of complications. The instruments used were a digital sphygmomanometer Visomat® Handy IV (Uebe Medical GmbH, Germany) and a pulse oximeter Onyx® II 9550 (Nonin Medical, Plymouth - MN, USA).

The sample data were analyzed using the Statistical Package for Social Science (SPSS) 17.0, assigning a significance level of 5%. Descriptive statistics were performed using means and standard deviations. The Kolmogorov-Smirnov test was used to test the normality of the data. Normal distribution was found for weight, height, BMI, percentile and for the MRP. The unpaired Student's *t* test was used to verify the difference between the mentioned variables in children enrolled in public and private schools and to check the MRP difference according to sex. To compare the frequency of children who performed or not physical activity in public and private schools, the chi-square test was used.

Results

The study included 157 children enrolled in public and private schools, of which 4 were excluded for refusing to participate, 5 did not understand the requested command, 3 for failing to perform acceptable and reproducible maneuvers within the maximum number of measures established in the study and 1 for presenting fever during the assessment week. Therefore, the final sample consisted of 144 children: 52 were in public schools, of which 32 girls and 20 boys (mean age 8.8±1.4 and 9.0±1.3 years, respectively); and 92 in private schools, of which 49 girls and 43 boys (mean age of 8.7±1.1 and 8.9±1.1 years, respectively). Table 1 shows the characterization of the sample.

Table 1 - Characterization of the sample: weight, height, BMI and body mass index percentile according to sex and age for the assessed children from both kinds of school

	Female		p-value	Male		p value
	Public (n=32)	Private (n=49)		Public (n=20)	Private (n=43)	
Weight (kg)	30.2±7.3	29.6±5.7	0.660	29.8±5.2	31.0±4.3	0.332
Height (cm)	1.35±0.1	1.34±0.09	0.711	1.35±0.1	1.35±0.07	0.710
BMI (kg/m ²)	16.2±1.6	16.2±1.5	0.985	16.3±1.6	16.7±1.3	0.267
BMI percentile	43.6±24.2	44.3±23.6	0.889	45.6±30.5	54.5±24.9	0.222

BMI: body mass index

On average, five maximal efforts were needed to obtain acceptable and reproducible measurements for MIP and MEP of the children in both school systems.

As for physical activity, approximately 40% of children enrolled in public schools performed some physical activity, while 95% of children in private schools performed physical activity, and of these approximately 67% practiced their activities regularly, at least twice a week. In Table 2, it is possible to observe the MRP averages, according to the performance or not of physical activity by assessed students in both school systems.

The MRP averages of children enrolled in public and private schools are presented in Table 3. In Table 4, it is possible to analyze comparatively the respiratory muscle strength between genders in children enrolled in both school systems.

Discussion

The homogeneity observed in the anthropometric characteristics of the studied groups suggests that the observed differences in student's respiratory muscle

strength, in both school systems, cannot be attributed to nutritional status and/or to weight and structural development of the children. However, for further investigation it would be necessary to perform a nutritional assessment⁽⁷⁾. A previous study by Ziegler *et al*⁽⁷⁾ assessed the MRPs of 39 patients with cystic fibrosis and indicated that respiratory muscle strength does not differ if the patient has normal nutritional status or depletion, concluding that lower values for MRP are not significantly related to nutritional status, but to the heterogeneity of the studied population⁽⁷⁾.

According to Panizzi *et al*⁽²¹⁾, the anthropometric index (BMI) influences the levels of MRP. These authors assessed 195 young adults divided into three groups according to the BMI: below the desirable level, at the desired level and above the desired level. They concluded that MRP, in men, were higher in the group of individuals with a desirable BMI. When evaluating women they noted that MIP was higher in the desirable BMI group. However, a different trend was identified by analyzing MEP, since these pressures were higher in the group with below desirable BMI⁽²¹⁾.

A previous study with Brazilian children and adolescents showed that the prevalence of weight and height deficit was low⁽²²⁾. The authors stated that health care can help to counteract this process. Thus, if socioeconomic indicators point to an unfavorable situation, health indicators and access to health care go in reverse to this trend and can impact positively on the nutritional profile of the assessed children⁽²²⁾. However, in a study involving Latin American populations and some Brazilian states and regions of a low socioeconomic status, a high prevalence of low height for age was found, and, simultaneously, a negligible prevalence of weight deficit for height⁽²³⁾. In this study, the methodological aspects ensured that the BMI of the children, classified by percentile rank according to the National Center for Health Statistics⁽¹⁷⁾, were within the limits of normality.

The difference in MRP was highly significant when comparing the students who practiced physical activity, whether

Table 2 - Comparison of the average values of maximum respiratory pressures of assessed children, according to the performance or not of physical activity

	Physical activity practice		p value
	No (n=35)	Yes (n=109)	
MIP (cmH ₂ O)	63.2±20	76±20.7	0.002
MEP (cmH ₂ O)	77.4±20.5	89±21.6	0.006

MIP: maximum inspiratory pressure; MEP: maximum expiratory pressure.

Table 3 - Comparison of the averages of maximum respiratory pressures among schoolchildren from public and private schools

	Public (n=52)	Private (n=92)	p-value
MIP (cmH ₂ O)	65.7±18.7	77.0±21.5	0.002
MEP (cmH ₂ O)	79.4±19.0	90.1±22.5	0.005

MIP: maximum inspiratory pressure; MEP: maximum expiratory pressure.

Table 4 - Comparison of the averages of maximum respiratory pressures among the children enrolled in public and private schools, according to gender.

	Female			Male		
	Public (n=32)	Private (n=49)	p-value	Public (n=20)	Private (n=43)	p-value
MIP (cmH ₂ O)	60.2±17.8	70±19.8	0.027	74.4±17.1	85±20.8	0.051
MEP (cmH ₂ O)	73.2±18.1	82.6±20	0.035	89.2±16.3	98.5±22.5	0.103

MIP: maximum inspiratory pressure; MEP: maximum expiratory pressure.

from public or private schools, boys or girls, regardless of the frequency that this practice was performed. This result suggests an explanation for the fact that the MRP of private school students were significantly higher than those of public school students, since most children who practiced some kind of physical activity studied in private schools.

When assessing MRP in healthy adults, Simões *et al*⁽¹⁾ found that the sample did not reach the values predicted for the age group assessed. According to these authors, the MRPs obtained were lower than the predicted normal values because the sample was composed only of sedentary individuals. In contrast, when assessing the MRPs of children and adolescents, Szeinberg *et al*⁽¹³⁾ included individuals who performed ballet. However, when comparing respiratory muscle strength among those who practiced this sport or not, no significant differences in MRPs was found.

It is important to point out that, recently, Toigo⁽²⁴⁾ claimed that the performance of regular physical activity in adulthood is often a reflection of habits of active life acquired in childhood. Therefore, it is important to emphasize that physical activity should be a priority in childhood and adolescence and that the principles of physiological responses to exercise are the same for children, adolescents and adults, although there are some peculiarities⁽²⁵⁾. In a study conducted with a sample of asthmatic children, Silva *et al*⁽²⁶⁾ suggested that a physical training program with a lower frequency and longer duration of each session provides improved physical fitness

and an increased muscle strength, and ease the participation of these children in physical activities.

Higher MIP and MEP were observed in girls from private schools when compared to girls from public schools. However, despite the higher values observed in MRPs of male children, respiratory muscle strength does not seem to have been influenced by factors related to school. Several authors agree that, at school age, the levels of physical activity can be 15–25% higher in males⁽²⁷⁻³⁰⁾, since at this age boys are more physically active than girls, regardless of regular physical activity.

Some aspects can be considered as limitations for this study, such as the absence of a socioeconomic questionnaire and, especially, of an instrument to assess the level of children's physical activity, since this variable may have been a predictor of respiratory muscle strength. Future studies using multivariable regression may investigate whether the level of physical activity and socioeconomic factors may be significant predictors of respiratory muscle strength in children.

In conclusion, the results of this study show that girls enrolled in private schools have higher respiratory muscle strength than girls in public schools. This fact seems to be associated with the prevalence of physical activity observed in the assessed children from private schools. However, the MRPs of the boys seem to have been influenced by other factors. It is possible that this finding is a consequence of the higher baseline level of physical activity, observed in boys regardless of the stimulus received in school.

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