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ORIGINAL RESEARCH

Predictive equations for maximal respiratory pressures of children aged 7–10

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KEYWORDS
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Abstract
Background: Measurements of respiratory muscle strength are widely used for assessment in children; however, clearly defined predictive equations for the Brazilian pediatric population have yet to be established.
Objective: To determine the prediction equations for maximal respiratory pressures in healthy children.
Method: Cross-sectional observational study with normal-weight students aged 7–10 years ($n = 399$, 198 boys) with health attested by the (International Study of Asthma and Allergies in Childhood) questionnaire and medical history. Biometric data were evaluated (weight, height, and body mass index) as predictors. Spirometry and maximal expiratory pressure values were measured according to the recommendations of the American Thoracic Society. To verify data normality, the Shapiro–Wilk test was applied, and Pearson's test was used to verify the correlation between variables. The models were developed using simple linear regression and multivariate analyses. For all tests, the significance level was $p < 0.05$.
Results: Boys showed higher values of maximal respiratory pressures than girls, both increasing with age. For boys, these values had moderate correlation with age, weight, and height and weak correlation with body mass index. For girls, maximum inspiratory pressure had a weak correlation with age and moderate correlation with biometric data. Maximum expiratory pressure had a moderate correlation with age and biometric measures. The best predictive models were found in boys: $\text{Log(MIP)} = 1.577 + 0.006 \times \text{weight (kg)}$ ($R^2_{aj} = 14.1\%$) and $\text{Log(MEP)} = 1.282 + 0.409 \times \text{height (m)}$ ($R^2_{aj} = 13.9\%$); and for girls: $\text{Log(MIP)} = 1.548 + 0.006 \times \text{weight (kg)}$ ($R^2_{aj} = 15.0\%$) and $\text{Log(MEP)} = 1.524 + 0.012 \times \text{age (years)} + 0.005 \times \text{weight (kg)}$ ($R^2_{aj} = 21.6\%$).

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Conclusion: Prediction equations for maximal respiratory pressures were developed for boys and girls. The biometric measurements were shown to have a weak influence on the results.

Introduction

The evaluation and monitoring of respiratory function in children have improved significantly in the last 30 years. Technological advances, more reliable studies, and the recognition of the importance of monitoring in clinical practice have all contributed to a better understanding of lung function in the pediatric age range.[1,2]

The parameters often analyzed for respiratory function are maximal respiratory pressures (MRP), which are synonymous with respiratory muscle strength (RMS).[3,4] The respiratory muscles are responsible for generating the pressure differences that ensure ventilation. Strength is considered an essential measure in the evaluation of various health conditions and monitoring of respiratory muscle weakness in different illnesses.[5–7]

The MRP test consists of a non-invasive method and simple measurements; however, it requires the subject's cooperation for its proper implementation. The MRP test is a useful tool to assess the response to outpatient physical therapy procedures, respiratory rehabilitation programs, and hospital treatment. It is also useful for assessing ventilatory muscle function in pre- and postoperative situations and assessing the possibility of weaning from mechanical ventilation.[4]

The MRP test can be used to measure the severity of symptoms and for follow-up in neuromuscular and lung diseases, to guide procedures, and to prevent complications and exacerbations of lung diseases that result in respiratory muscle weakness. The indications of the MRP tests involve differential diagnosis of dyspnea and restrictive disorders without apparent cause. It is also part of diagnostic confirmation of dysfunction of the respiratory muscles in cases such as neuromuscular diseases, chest deformities, and diaphragmatic paralysis.[8]

The instrument commonly used to measure the MRP is the manometer. This device is considered useful because it is a simple, non-invasive form of measurement that involves compact and easily transportable devices.

Despite these conveniences, the reference values for MRP vary greatly,[9–13] possibly due to a lack of standardization of instruments and different collection techniques.[14] Moreover, measuring MRP requires the subject's full cooperation, which could underestimate the values of MRP even in the absence of muscle weakness.[15]

In children, there was an increase in the MRP values with increasing age.[16–18] While there are no categorical statements about the size of the contribution of anthropometric variables on RMS, some authors observed a positive correlation between the MRP and weight[9,18,19] and height.[18,19] Other studies[11,12,19] indicate the need for regional research on reference values for MRP because of the territorial dimensions and ethnic diversity of the Brazilian population. To date, there is no consensus on the MRP reference values nor on the contribution of the variables that correlate in the equations. There are indications that local differences have a strong influence on these results.

Determining reference equations allows the comparison between different populations and assists in gathering more accurate information on respiratory disorders that are related to changes in the parameters evaluated. For Brazilian children, there are few recent papers on reference values and prediction equations for schoolchildren between aged 7 and 10.[8,20–23]

The aim of this study was to determine predictive equations for MRP in children aged 7–10 and to compare normal MRP values established by different studies (including those the present study) with the values obtained for children aged 7–10.

Methods

This is a cross-sectional observational study conducted in the school district of Florianópolis, SC, Brazil from February to April 2013. The study was approved by the Human Research Ethics Committee of Universidade do Estado de Santa Catarina (UDESC), Florianópolis, SC, Brazil (CAAE 01821712.6.0000.0118/opinion 63455). The participating schools were nominated by the Continued Training Department of the State of Santa Catarina (SC) and included two municipal schools and one state school. The three public schools were contacted and agreed to take part in the study. All schoolchildren in the proposed age group were invited to participate in the study. All those who gave written consent and had approval from the parents/guardians underwent assessment. Only the schoolchildren who met the previously established inclusion criteria were included in the final sample.

The study included healthy students of both sexes, aged 7–10 years, between the 3rd and 85th percentile according to the Brazilian Health Ministry,[24] able to understand and complete all tests. The exclusion criteria were as follows: presence or history of respiratory disease identified by the International Study of Asthma and Allergies (ISAAC), questionnaire,[25,26] cardiac, neuromuscular, neurological, or rheumatologic disease, acute disease at the time of data collection, inability to perform any of the assessments properly, and dubious answers in the questionnaires. Underweight, overweight, or obese children and children with forced expiratory volume in one second (FEV_1) less than 80% predicted by Polgar and Weng[27] were also excluded.

The children's health was investigated using the ISAAC questionnaire administered by the parent or guardian. This questionnaire measures respiratory symptoms and it is used to assess the prevalence of asthma, rhinitis, and eczema, with questions relating to symptoms in the last 12 months.

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