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Bone mineral density and respiratory muscle strength in male individuals with mental retardation (with and without Down Syndrome)

Vinicius Zacarias Maldaner da Silva [a,*], Jônatas de França Barros [a], Monique de Azevedo [a], José Roberto Pimenta de Godoy [a], Ross Arena [b], Gerson Cipriano Jr.[a]

[a] Physical Education Faculty, University of Brasilia, UnB, Brazil
[b] Department of Physical Therapy, Virginia Commonwealth University, Richmond, VA, USA

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ABSTRACT

The purpose of this study was to assess the respiratory muscle strength (RMS) in individuals with mental retardation (MR), with or without Down Syndrome (DS), and its association with bone mineral density (BMD). Forty-five male individuals (15 with DS, 15 with mental retardation (MR) and 15 apparently healthy controls), aged 20–35, participated in this study. Subject assessment included pulmonary function tests, RMS (maximal inspiratory pressure, MIP, and maximal expiratory pressure, MEP) and BMD of the second and fourth lumbar vertebrae. ANOVA was used to test differences amongst groups. Tukey post hoc test was utilized when significant differences were detected with ANOVA. Bivariate correlation for BMD and respiratory muscle strength was calculated with Pearson's coefficient of correlation. Individuals with MR, both with and without DS, have lower FEV1, FVC, MIP and MEP ($p < 0.001$) compared to controls. Individuals with DS also had lower BMD, which was associated with lower MIP and MEP. Hypotonia, sedentary lifestyle and obesity are factors that may explain lower MIP and MEP in DS. Strategies to increase RMS could decrease the risk of osteoporosis in the DS population.

1. Introduction

Previously investigators have demonstrated that individuals with mental retardation (MR), both pediatric and adult cohorts, have a lower level of physical fitness (Fernhall et al., 1996), poorer pulmonary function (Pastore et al., 2000) and lower strength compared to individuals not impacted by this condition (Morris, Vaughan, & Vaccaro, 1982). Down Syndrome (DS) is the most common genetic cause of developmental disability, characterized by MR, medical and musculoskeletal disorders (Sago et al., 2000). Expression of the DS phenotype includes cardiac malformations and hypotonia, which may affect motor skills and muscle strength (Apache, 2005).

Recently, osteoporosis has been identified in individuals with DS, being one of the main factors contributing to both premature morbidity and mortality in this population (Chaney & Eyman, 2000). Some conditions commonly presented in DS, such as thyroid dysfunction, abnormalities of sexual development, and musculoskeletal abnormalities (both peripheral and respiratory muscle strength) may contribute to the development of osteoporosis (Guijarro, Valero, Paule, Gonzalez-Macias, & Riancho, 2008). Previous research has demonstrated a relationship between respiratory muscle strength (RMS) and osteoporosis in other populations, such as chronic pulmonary obstructive disease (COPD) (Cioni et al., 1994; Zeminian, Pattarello, & Rubini, 2008) and asthma (Smith, Phillips, & Heller, 1999).

* Corresponding author at: University of Brasilia, P.O. Box 70294-010, SQS 215, Bloco A apto 305, ASA SUL, Brasília, DF, Brazil.
E-mail address: viniciusmaldaner@gmail.com (V.Z.M. da Silva).

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In addition, previous research has shown that individuals with DS have diminished leg and arm strength compared to people with MR but not DS (Cioni et al., 1994; Mercer & Lewis, 2001; Tsimaras & Fotiadou, 2004), which is and this factor is related to bone mineral density (BMD) (Angelopoulou et al., 2000). However, we are unaware of any previous investigation that has assessed the relationship between BMD and RMS in this population.

The aim of this study was to assess RMS in individuals with MR and DS and determine its relationship with BMD.

2. Methods

2.1. Participants

Forty-five male patients (aged 20–35 years) from support institutions for individuals with DS and MR were evaluated in the Exercise Physiology Laboratory of the Physical Education Department at the University of Brasilia, Brazil. Participant characteristics are listed in Table 1. The inclusion criteria were moderate to mild MR determined by intelligence quotient (IQ) (range from 45 to 61 for DS and 49–65 for MR) and comparable functional capabilities. Both groups (MR and DS) were attending special schools where they also conducted their usual daily activities (self-care and group activities such as painting, printing, theatre and hand craft). Individuals with cardiac and orthopedic disorders were excluded from this study.

2.2. Design and procedures

This was a cross-sectional study. All the participants were given clinical and orthopedic examination as well as resting electrocardiogram and echocardiogram. Intelligence quotient assessment, evaluated by the Stanford–Binet Scale (Thorndike & Sattler, 1985), was included in this study. All participants in this study were euthyroid, based on clinical examination and normal thyroid-stimulating hormone (TSH) and free T4 values. All participants included in the present study have not taken any medication that affect bone mineralization.

The MR group comprised individuals without chromosomal disorders, idiopathic etiology of MR, birth hypoxia and prematurity.

The control group comprised of apparently healthy individuals without chromosomal disorders, idiopathic etiology of MR, birth hypoxia and prematurity.

Participants in the control group were fully informed of the studies purpose and the procedures used. Participants signed their own informed consent. In the DS and MR groups their legal guardians signed an informed consent. This study was approved by the Ethics Committee of the University of Brasilia, Brazil.

2.2.1. Pulmonary function tests

Spirometry was performed with a computerized spirometer (VMAX–22 series spirometer SensorMedics®, Yorba Linda, CA, USA) and analyzed according to Wanger et al. (2005) European Respiratory Society (ERS) guidelines. All tests were conducted in an environment at equal temperature and humidity. The spirometry unit was calibrated according to manufacturer's specifications prior to each assessment. Participants became familiar with spirometric testing 1 week before baseline measurements were conducted. Participants were taught how to perform the procedure correctly and were given verbal feedback about their performance. They were able to perform the procedure correctly and reliably, demonstrating less than 10% variation between the final two forced volumes in 1 s (FEV_1) and between the final two forced vital capacity (FVC) values (Khalili & Elkins, 2009). The FEV_1 and FVC were also expressed as % predicted (Knudson, Slatin, Lebowitz, & Burrows, 1976).

Table 1
Physiological characteristics, BMD and RMS in all groups.

Variables	Mean (SD)		
	DS ($n = 15$)	RM ($n = 15$)	Control ($n = 15$)
Age (years)	$28.75 \pm 7.71^{3*}$	28.14 ± 5.61	24.57 ± 3.87
Weight (kg)	$76.2 \pm 3.5^{3*}$	73.9 ± 4.6	69.3 ± 4.64
Height (cm)	$153.2 \pm 1.9^{1,3**}$	169.1 ± 3.1	173 ± 4.81
BMI (kg/m^2)	$27.2 \pm 4.12^{3*}$	24.5 ± 3.68	22.91 ± 2.51
BMD (g/cm^2)	$0.94 \pm 0.11^{3**}$	1.26 ± 0.14	1.28 ± 0.09
FVC % predicted	$66.02 \pm 12.35^{1,3**}$	91.07 ± 9.98	97.80 ± 6.75
VEF_1% predicted	$59.38 \pm 8.35^{1,3**}$	89.98 ± 6.21	95.33 ± 8.45
VEF1/CVF (% predicted)	$84.61 \pm 8.11^{1,3**}$	86.67 ± 7.25	91.16 ± 9.45
MIP (cm H_2O)	$48.95 \pm 4.9^{1,3**}$	99.25 ± 6.8	103.87 ± 8.29
MEP (cm H_2O)	$45.15 \pm 5.6^{1,3**}$	96.50 ± 7.71	102 ± 7.91
MIP (% predicted)	$37.80 \pm 6.25^{1,3**}$	93.15 ± 6.29	101 ± 6.29
MEP (% predicted)	$41 \pm 5.78^{1,3**}$	95.15 ± 5.39	103 ± 5.32

DS, Down Syndrome; MR, mental retardation; BMI, body mass index; BMD, bone mineral density; FVC, forced vital capacity; FEV_1, forced vital capacity; MIP, maximal inspiratory pressure; MEP, maximal expiratory pressure; 1, DS/MR; 2, MR/control; 3, SD/control.

* $p < 0.05$.

** $p < 0.001$.