ISSN 0103-5150
Fisioter. Mov., Curitiba, v. 28, n. 2, p. 373-381, Apr./June 2015
Licenciado sob uma Licença Creative Commons
DOI: http://dx.doi.org.10.1590/0103-5150.028.002.AO18

Hippotherapy and respiratory muscle strength in children and adolescents with Down syndrome

Equoterapia e força muscular respiratória em crianças e adolescentes com síndrome de Down

Valéria Sovat de Freitas Costa[a], Hudday Mendes da Silva[b, c], Elioenai Dornelles Alves[d], Patrick Ramon Stafin Coquerel[b], André Ribeiro da Silva[d], Jônatas de França Barros[b]*

[a] Centro Universitário de Brasília (UniCEUB), Brasília, DF, Brazil
[b] Universidade Federal do Rio Grande do Norte (UFRN), Natal, RN, Brazil
[c] Faculdade Leão Sampaio (FLS), Juazeiro do Norte, CE, Brazil
[d] Universidade de Brasília (UnB), Brasília, DF, Brazil

Abstract

Introduction: Individuals with Down syndrome may have decreased respiratory muscle strength due to hypotonia, a common characteristic in this population. **Objective**: To analyze the effects of a hippotherapy program on respiratory muscle strength in individuals with Down syndrome. **Materials and methods**: The study included 41 subjects, 20 of which were in the hippotherapy practicing group (PG) and 21 of which were in the non-practicing group (NPG). Study subjects were of both sexes, aged 7-13 years, and all diagnosed with Down

* VSFC: MSc, e-mail: valeria.costa@uniceub.br
HMS: MSc, e-mail: huddaymendes@yahoo.com.br
EDA: PhD, e-mail: elioenai@unb.br
PRC: MSc, e-mail: motriz@ufrnet.br
ARS: MSc, e-mail: andrepersonalsaude@gmail.com
JFB: PhD, e-mail: jonatas@ufrnet.br

syndrome. A manovacuometer was used to measure respiratory muscle strength, following the protocol proposed by Black and Hyatt (23). Statistical analysis was performed by means of descriptive distribution. After verifying normality and homoscedasticity of the variables, the Mann-Whitney test was used to determine differences between the means of the two groups (PG and NPG), and the Spearman's rank correlation coefficient test was used to view possible relationships with age and time practicing hippotherapy. Significance was set at $p < 0.05$. **Results and discussion**: Individuals who practiced hippotherapy showed improvements in both inspiratory and expiratory respiratory muscle strength, although no significant difference was demonstrated. **Conclusion**: This study demonstrates that hippotherapy benefits respiratory muscle strength in individuals with Down syndrome, and that the youngest subjects had the best results.

Keywords: Down syndrome. Respiratory muscle strength. Hippotherapy.

Resumo

***Introdução**: Os indivíduos portadores de síndrome de Down (SD) podem apresentar uma redução da força muscular respiratória, principalmente em função da hipotonia, característica comum nessa população. **Objetivo**: Analisar o efeito de um programa de equoterapia sobre a força muscular respiratória em indivíduos com SD. **Materiais e métodos**: Participaram do estudo 41 indivíduos, sendo 20 pertencentes ao grupo praticantes (GP) e 21 ao grupo não praticante (GNP), de ambos os sexos, com idades compreendidas entre 7 e 13 anos, todos diagnosticadas com síndrome de Down (SD). Utilizou-se a manovacuometria para aferição da força muscular respiratória, seguindo o protocolo proposto por Black e Hyatt (23). A análise estatística deu-se a partir de uma distribuição descritiva. Após verificado a normalidade e homocedasticidade das variáveis utilizou-se o teste de Mann Whitney para verificar as diferenças entre as médias dos grupos (GNP e GP), como a utilização do teste de correlação de Spearman para visualizar possíveis relações com a idade e o tempo de prática de equoterapia. Adotou uma significância de $p < 0,05$. **Resultados e discussão**: Os indivíduos que realizavam a equoterapia apresentaram melhoras em relação à força muscular respiratória, tanto inspiratória (MIP) quando expiratória (MEP), embora não apresentando diferença significativa em relação ao grupo não praticante. **Conclusão**: Este estudo demonstra que o programa de equoterapia apresenta benefícios na força muscular respiratória em indivíduos com SD e que principalmente os mais jovens obtiveram melhores resultados.*

***Palavras-chave**: Síndrome de Down. Força muscular respiratória. Equoterapia.*

Introduction

Every minute, about 20 babies are born with some kind of disability, totaling approximately 9.8 million babies per year. Down syndrome (DS) has the highest incidence (91%) among genetic syndromes (1). According to the 2010 census of the Brazilian Institute of Geography and Statistics (2), 23.9% of the national population has some type of disability; of these, 2,617,025 people have an intellectual disability. According to the non-profit organization *Movimento Down* [Down Movement] (3), there is no specific statistic on the number of Brazilians with Down syndrome; however, based on the ratio of 1 per every 700 births, it is estimated that about 270 thousand people have this syndrome in Brazil. Most are poor, with little or no access to care or information, and unable to attend early stimulation treatment clinics (4).

The evolution of DS treatment is undergoing important advances. Comparing the data available from the middle of last century and today, the increase in life expectancy of this population is evident (5).

The main physical characteristics common to children with DS include hypotonia, ligament laxity and reduced muscle strength. Over the years, joint wear and musculoskeletal abnormalities that affect muscle strength quality can also develop (6). Moreover, individuals with DS are predisposed to respiratory complications resulting from obstruction of the upper airway, lower airway disease, pulmonary hypertension, pulmonary hypoplasia, congenital heart disease, obstructive sleep apnea, immunodeficiency, obesity and hypotonia (7), which can be aggravated by general weakness of the muscles of the torso and extremities, as well as postural deviations adopted by these individuals (8).

Due to the reasons above, individuals with DS have low respiratory pressure values. According to Biasoli and Machado (8), maximal expiratory pressure (MEP) values tend to be below 50%, while maximal inspiratory pressure (MIP) values tend to be below 60% of that expected for populations of healthy, sedentary youth, for which the normal range for these variables are MEP from 100 to 150 cmH_2O, and MIP from -90 to -120 cmH_2O.

The measurement of maximal respiratory pressures can help to direct therapeutic objectives, identify early respiratory diseases and classify their severity, and evaluate responses to therapies (9). The measurements of maximal inspiratory and expiratory pressures are determinant in the appropriate assessment of lung function, and can be performed on healthy individuals of different ages, or on individuals with disorders and/or different types of alterations, such as Down syndrome (10). In these patients, the sequential measurement of maximal respiratory pressures enables quantification of progression of respiratory muscle weakness (11).

Policarpo and Santos (11) claim that individuals with DS have a deficit of respiratory muscle strength, and believe that these individuals benefit from muscle training, which minimizes future respiratory complications.

According to a study by Herrero et al. (12), the inability to maintain quality of posture and movements, a characteristic common to people with SD, affects the torso and alters the harmony of breathing mechanics, modifying thoracic and abdominal pressures. Assisted motor development balances the thorax and abdomen, maintaining a balance point between these two cavities, and thus adjusting lung capacity and volumes.

It is generally agreed that in hippotherapy, the movement of the horse, which, like humans, has three-dimensional motion that consists of movements on three axes (vertical, right and left, and front and back) (13), transmits these movements to the rider. In turn, the rider must stay balanced on the animal by performing postural adjustments in the pelvis, upper limbs and head (14), a process that encourages favorable changes in some kinematic variables in the gait of children with DS, and contributes to improve balance deficits, stability of the walking pattern and also in the torso musculature, which is responsible for respiratory dynamics.

Hippotherapy is a therapeutic and educational method that uses horseback riding in an interdisciplinary approach to education and health, mainly aiming for motor rehabilitation and education for the biopsychosocial development of poeple with disabilities. Hippotherapy uses horses to promote physical, psychological and educational benefits (15).

Hippotherapy has been shown to produce improvements in postural and motor control in special populations with cerebral palsy, genetic disorders, developmental delays and Down syndrome (16), which reaffirms the theory that this therapy is beneficial for individuals with these conditions. In addition to improvements of motor and postural control, social and emotional interactions may have positive effects on quality of life and self-esteem (17).

Studies show that muscular hypotonia in individuals with SD leads to increased susceptibility to reduced cardiorespiratory capacity due to disability of the transversus abdominis muscle, which fails to create synergy with the diaphragm, and decreases the action of the oblique muscles, which biomechanically stabilize the ribcage. This effect also reduces the action of the intercostal muscles, interfering in the quality of deep, ample and adequate breathing, and reducing the physical conditioning of these individuals (18, 19).

By being seated on a horse, a hippotherapy patient receives around 1,800 to 2,250 tonic adjustments/30 min, and about 90 to 110 multidimensional impulses/minute, stimulating the proprioceptive system and the receptors of the vestibular system, thereby developing dynamic and static balance reactions (20).

Each and every movement of the horse requires the rider to adjust their muscle tone to the body schema, which is neurological and established by simultaneous proprioceptive and exteroceptive information, and hippotherapy multiplies these effects (21).

Disabled individuals tend to adapt to the horse's movements, learning to balance and perform movements while being supervised by an instructor. Hippotherapy helps patients to firm their hypotonic musculature (22).

This study aimed to analyze the effect of hippotherapy on the respiratory muscle strength of patients with Down syndrome aged between 7 and 13 years in the Federal District of Brazil.

Materials and methods

This study was a cross-sectional, analytical, observational study. Inclusion criteria included: being diagnosed with DS; aged between 6 and 14 years; not using medication that influenced the variable studied; signing of a free and informed consent form (FICF) by an adult guardian; signature of the Term of Institutional Science by participating institutions and the group practicing hippotherapy; medical evaluation with authorization to participate in the study; and, for the group that practiced hippotherapy, medical evaluation with authorization to practice hippotherapy as well as having practiced for at least 3 months; and, for the non-practicing group, to not perform any kind of activity with the same objectives as hippotherapy.

The sample was composed of children and adolescents of both sexes, selected by convenience, where a prior visit to the institutions was undertaken to present the project to the [therapy] coordinators and preselect the subjects who could participate in the study, according to the inclusion criteria described above. After this process, the institutions indicated 45 children and adolescents with SD with the desired characteristics. Those interested in participating were given the FICF for inclusion in the study, which 41 signed.

The project, developed in the institutions, was forwarded, evaluated and approved by the Research Ethics Committee of the Faculty of Health Sciences at the University of Brasilia, according to resolution 196/96 under protocol 004/2011.

After collecting the FICFs, the participants were divided into two groups (non-practicing = NPG; practicing = PG). The PG was composed of 20 individuals (11 boys and 9 girls), while the NPG was composed of 21 (12 boys and 9 girls). The activity proposed for the PG was hippotherapy lessons, while the NPG did not undertake any type of activity with objectives similar to those of hippotherapy. To select the individuals in the PG, the institutions that offer hippotherapy were selected, including the *Associação Nacional de Equoterapia* [National Association of Hippotherapy] (ANDE-BRASIL), located in the Federal District, and the *Instituto Cavalo Solidário* [Horse Outreach Institute], headquartered in Brasília and Ceilândia, following the same treatment criteria proposed by ANDE-BRASIL. For selection of NPG participants, it was decided to select from the following institutions: the *Associações de Mães, Pais, Amigos e Reabilitadores de Excepcionais* [Association of Mothers, Fathers, Friends and Rehabilitators of Exceptional People] (AMPARE), located in the Federal District, and *Instituto Ápice Down* [Down Apex Institute], also located in the Federal District.

It is worth noting that the two institutions' treatment protocols for hippotherapy are based on the courses of ANDE-BRASIL, in the city of Brasília, Federal District, although each individual has their specificity of care according to individual physical and psychological characteristics. The protocol method of ANDE-BRASIL is based on promoting physical and psychological gains, requiring participation of the entire body, thus contributing to the development of muscle strength, relaxation, body awareness and improved motor coordination and balance.

The methodology proposed by Black and Hyatt (23) was used for control of the variable respiratory muscle strength, with the device duly calibrated, and individuals were instructed to perform maximal expiration (MEP) and maximal inspiration (MIP) maneuvers, coupling the mouth of the GERAR™ manovacuometer in the mouth of individuals in sitting position, with the hips and knees flexed at a 90° angle, and their spine duly supported. The maneuvers were sustained for a minimum period of 2 seconds, with verbal encouragement from the evaluator. All measurements were performed with the nostrils closed with a nasal clip, in order to prevent air from escaping through the nose.

Statistical analysis was by means of descriptive distribution of means, minimum, maximum and standard deviation. The Kolmogorov-Smirnov test was performed to evaluate the normalcy of data distribution. Inferential statistics by means of the Levene test were used to check the homoscedasticity of the variables, evaluating equality or not of the variances between variables of the groups. After the verifications above, the Mann-Whitney test was used to verify the differences between the means of the groups (NPG and PG), and Spearman's correlation test to view possible relationships with age and time practicing hippotherapy. A significance level of $p < 0.05$ was adopted.

Results and discussion

The tests were selected and applied on 41 individuals; however, during analysis of the data, by means of the boxplot, discrepant (outlier) values of two individuals in the NPG were found, which could have influenced the results of the analysis. For this reason, these values were excluded. Thus, the data analysis was performed with results from 39 individuals with Down syndrome, divided into two groups: the PG was composed of 20 individuals (11 boys and 9 girls), while the NPG was composed of 19 participants (12 boys and 7 girls). Participants were aged between 7 and 13 years. The majority of participants in both groups were male, and aged 7 years.

In the Figure 1, it is observed that the median of the MIP variable is the same for both groups, meaning that the halves of the values of the two groups were the same, even though the mean of the PG (-69.75 ± 5.63) was higher than that of the NPG (-62.37 ± 3.38). It also shows that for the two variables, the PG has widely dispersed data. The means show that for both variables, the values for the PG are higher than the NPG, thus indicating that the respiratory muscle strength of the PG is better than that of the NPG.

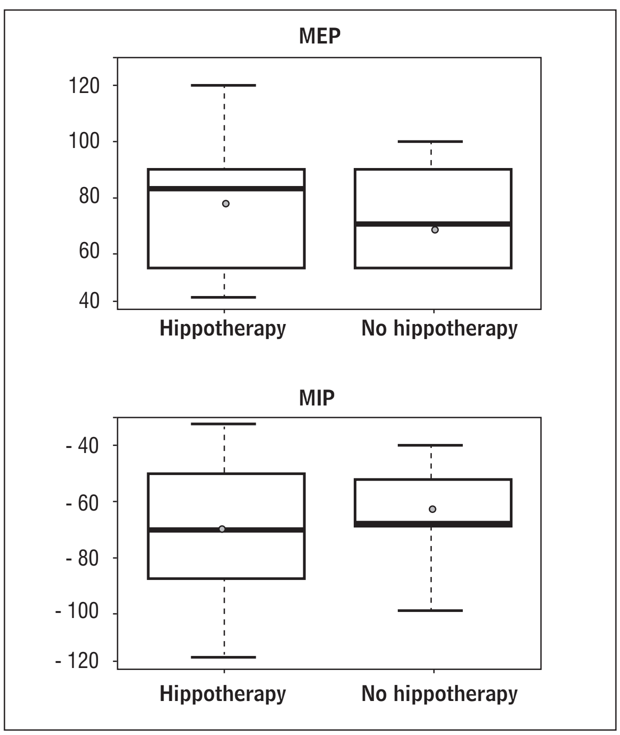

Figure 1 - Boxplot for the variables maximal expiratory pressure (MEP cm/H_2O) and maximal inspiratory pressure (MIP cm/H_2O)

After checking the normality and homoscedasticity of the data by means of the Kolmogorov-Smirnov and Levene tests, respectively, a normal sample was identified; however, unequal variances were observed for the Levene test ($p < 0.05$) (Table 1). For this reason, an inferential, nonparametric statistic was maintained with the Mann-Whitney U test, adopting significance levels of $p < 0.05$.

Table 2 presents the major descriptive measurements that represent respiratory muscle strength (MIP and MEP) and the P-value of the Mann-Whitney U test, which was applied because these variables pointed to unequal variances in the homoscedasticity test, as shown above.

According to the test, there was no significant difference for the variables under analysis, even though the raw values for the two variables were better in the PG.

The table above presents the results of tests to evaluate respiratory muscle strength. It can be observed that for both the variable that evaluates inspiratory muscle strength (MIP) and expiratory muscle strength (MEP), the values for individuals with DS are better among those who practice hippotherapy (PG), compared with those who do not practice, although there is no significant difference between the variables analyzed ($p > 0.05$).

Considering the formula presented by Neder et al. (24) as the values predicted for MEP and MIP in healthy subjects of all ages, the individuals in this study have MEP and MIP values below that expected for their age group.

In one study conducted in children with clinical diagnosis of DS, Schuster et al. (25) evaluated respiratory strength using a manovacuometer, and observed severe respiratory muscle weakness in all of

Table 1 - Normality and homoscedasticity test for the practicing and non-practicing groups (PG and NPG) in both genders

	Kolmogorov-Smirnov Test		*Levene Test*
Variable	NPG	PG	
MEP	0.66	0.03*	0.88
MIP	0.45	0.01*	0.87

Note: MEP = maximal expiratory pressure; MIP = maximal inspiratory pressure; *$p < 0.05$.

Table 2 - Variables of muscle strength with Mann-Whitney U test of both genders

Variables	Mean	SD	SD of the mean	Variation coefficient	Confidence interval (95%)		p
					Lower	Upper	
MEP - PG	79.00	25.16	5.63	31.85%	67.22	90.78	0.25
MEP - NPG	70.00	15.28	3.50	21.82%	62.64	77.36	
MIP - PG	-69.75	25.16	5.63	-36.07%	-81.52	-57.98	0.43
MIP - NPG	-62.37	14.75	3.38	-23.66%	-69.48	-55.26	

Note: Respiratory muscle strength represented by maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP).

the children, who later underwent intervention with linear load pressure and showed significant improvement. In this study, it was observed that all subjects in both groups had muscle weakness, and the MIP and MEP values of the PG, although lower than predicted in the literature, were higher than those for the NPG.

Freitas et al. (26), in a bibliographic review aiming to research values of normality for maximal respiratory pressures in the age range between 7 and 18 years, concluded that in the majority of studies, the subjects are evaluated in the seated position with a nasal clip. The maximal efforts were performed from the residual volume and total lung capacity, sustained for a period of one to three seconds. In accordance with this study, a nasal clip was used for all measurements of MIP and MEP, in a seated position, and efforts from the volumes and capacities mentioned by the author.

Similarly, Alexandre et al. (27) recommended performing three to five maneuvers in order to obtain three acceptable maneuvers in which there was no leak; of these three, two should be reproducible (with a difference less than 5%). In this study, for greater reproducibility of measurement, the MIP and MEP measurements were performed three times, and the highest value was considered, provided that it did not exceed 5% of the other measurements. In case there was a discrepancy between the measurements, the procedure was repeated.

Santos et al. (28) state that DS patients present a series of clinical characteristics, especially muscular hypotonia. This is a factor associated with deficit of torso muscle strength, which in turn results in loss of respiratory muscle strength. The same authors evaluated respiratory function and created a profile of DS children aged between 5 and 12 years, revealing low values of respiratory muscle strength. This study had a similar result, where the MIP and MEP values of individuals of both groups were far below the predicted values for age. Regardless, the values of the PG were greater than those of the NPG, showing that hippotherapy can affect this variable.

In one study evaluating respiratory muscle strength in 45 subjects, of which 15 suffered from intellectual disability, 15 had Down syndrome and 15 were classified as having no mental disability, Silva et al. (29) showed that individuals with intellectual disability, with and without Down syndrome, have lower MIP and MEP.

Values of maximal expiratory pressure are greater compared to those of maximal inspiratory pressure in children and adolescents of both sexes (28). This was also observed in this study, where in both groups the mean values of these variables were greater for MEP than MIP. It is noteworthy that for Scanlan et al. (30), the minimum and maximum values for both variables are respectively 1 to 120 cmH_2O, with negative values for MIP.

In this study, we did not have access to the number of hippotherapy sessions that each individual performed. However, one inclusion criterion was having a minimum of 3 months of hippotherapy activity twice per week, making 24 months the mean time of this activity for the PG. Some authors agree that it is not necessary to publish the period, since so few sessions of hippotherapy are needed for results, yet changes after twelve sessions are cited (31, 32).

As noted in the Table 3, significant correlation was shown only for the variable MIP in relation to age; thus, the older the individual, the better the inspiratory respiratory muscle strength. For other variables, moderate but not significant correlations were observed.

Table 3 - Correlation between respiratory muscle strength variables with time practicing hippotherapy and age

Variables	Time practicing hippotherapy		Age	
	r	p	r	p
MEP	0.07	0.76	-0.39	0.09
MIP	0.05	0.85	0.65	0.01*

Note: $*p < 0.05$.

For both sexes, the mean values of the tasks performed by the PG were higher in comparison to individuals in the NPG (Table 4). As regards the variables MIP and MEP, which represent inspiratory and expiratory muscle strength, respectively, this study shows that the values of both groups and sexes are lower than those expected for individuals without disability. Considering the studied population of individuals with DS, in both groups boys showed better results only on the inspiratory muscle strength test.

Stefanutti and Fitting (33) assessed MEP and MIP, and observed larger maximal respiratory pressure in boys. In a study with 40 children aged between 8 and 17 years, Wagener et al. (34) demonstrated that sex influences respiratory muscle strength in children and adolescents. They showed that boys have higher pressures than girls, relating to the fact that they have larger muscle area, although when compared to young adults of the same sex, they had lower MEP, also due to less muscle development.

In this study, in both groups, boys showed higher values only for MIP. The studies cited above were performed with so-called "normal" children who did not have DS. In one study that conducted respiratory evaluation on 33 institutionalized individuals with DS and 33 normal subjects, the author found that individuals with SD had respiratory muscle strength 50% lower when compared to normal individuals, measured by means of manovacuometer (35).

It is worth noting that the formulas proposed for estimating MIP and MEP, which have the primary objective to quickly establish reference values in evaluation tests of respiratory muscle strength, need to be carefully observed. This is the case for the MIP and MEP values predicted by Neder et al. (24), which is the only formula for predicted values for the entire Brazilian population. The predicted values of MIP and MEP, estimated by the equation proposed by these authors, for both females and males, were higher than those obtained in the results of this study.

Conclusion

The results of this study suggest that the practice of hippotherapy may influence respiratory muscle

Table 4 - Distribution of descriptive values of mean, minimum, maximum and standard (SD) deviation in relation to sex and groups

	Practicing Group							
	Male				Female			
Variables	Minimum	Maximum	Mean	SD	Minimum	Maximum	Mean	SD
MEP	40.00	120.00	76.82	25.91	50.00	120.00	81.67	25.50
MIP	-100.00	-45.00	-70.91	16.85	-120.00	-30.00	-68.33	33.82
	Non-Practicing Group							
MEP	50.00	90.00	67.00	14.94	50.00	90.00	73.33	15.81
MIP	-100.00	-40.00	-66.50	17.65	-70.00	-40.00	-57.78	9.72

strength in patients with Down syndrome, of both sexes and aged between 7 and 13 years, when compared with individuals with Down syndrome who do not practice hippotherapy.

This study aimed to analyze the respiratory muscle strength of individuals with Down syndrome and, specifically, to verify the possible effect caused in patients of hippotherapy. It was also possible to compare, within the group that practiced hippotherapy, the difference between boys and girls, and, with the results of the tests, to correlate this difference to age and time practicing hippotherapy.

Among individuals who practice hippotherapy, the best results for respiratory muscle strength were for more advanced ages. In addition, the results of inspiratory and expiratory muscle strength of individuals with Down syndrome who practice hippotherapy were greater than those who do not.

References

1. Projeto Down. Com sua mão, essas crianças vão longe. 2012 [cited 2012, July 1]. Available from: http://www.projetodown.org.br/
2. Instituto Brasileiro de Geografia e Estatística. Censo demográfico 2010: características gerais da população, religião e pessoas com deficiência. Rio de Janeiro: IBGE; 2012.
3. Organização Movimento Down. Estatísticas sobre síndrome de Down. 2013 [cited 2015, Feb 21]. Available from: http://www.movimentodown.org.br/2013/08/estatisticas-sobre-sindrome-de-down/
4. Centro de Informação e Pesquisa da Síndrome de Down. Projeto Down [website]. 2012 [cited 2014, Jan 20]. Available from: http://www.projetodown.org.br/
5. Berg P, Becker T, Martian A, Primrose KD, Wingen J. Motor control outcomes following Nintendo Wii use by a child with Down syndrome. Pediatr Phys Ther. 2012;24(1):78-84.
6. Reis CS, Ladewig I. Efeitos do uso de dicas agudas, com dois focos atenção, em uma criança como síndrome de Down. Pensar Prát. 2013;16(3):775-93.
7. Newson-Davis J. The respiratory system in muscular distrophy. Br Med Bull. 1998;36(2):135-8.
8. Biasoli MC, Machado CC. Hidroterapia: aplicabilidades clínicas. Rev Bras Med. 2006;63(5):123-32.
9. Venkateshiah S, Iochimescu O. The utility of spirometry in diagnosing pulmonary restriction. Lung. 2007;186(1):19-25.
10. Oliveira KM, Macêdo TM, Borja RO, Nascimento RA, Medeiros Filho WC, Campos TF, et al. Força muscular respiratória e mobilidade torácica em crianças e adolescentes com leucemia aguda e escolares saudáveis. Rev Bras Cancerol. 2011;57(4):511-7.
11. Policarpo CL, Santos LJ. Avaliação da força muscular respiratória em indivíduos portadores de síndrome de Down. Rev Bras Fisioter. 2010;14(Supl 1):310.
12. Herrero P, Asensio A, Garcia E, Marco A, Olivan B, Ibarz A, et al. Study of the therapeutic effects of an advanced hippotherapy simulator in children with cerebral palsy: a randomised controlled trial. BMC Musculoskelet Disord. 2010;11:71.
13. Espindula AP, Assis ISA, Simões M, Ribeiro MF, Ferreira AA, Ferraz PF, et al. Material de montaria para equoterapia em indivíduos com síndrome de Down: estudo eletromiográfico. ConScientiae Saúde. 2014;13(3):349-56.
14. Silveira MM, Wiberlinger LM. Reeducação da postura com a equoterapia. Rev Neurociênc. 2011;19(3):519-24.
15. Associação Nacional de Equoterapia. Apostila do curso básico de equoterapia. Brasília: ANDE; 2012.
16. Torquato JA, Lança AF, Pereira D, Carvalho FG, Silva RD. A aquisição da motricidade em crianças portadoras de síndrome de Down que realizam fisioterapia ou praticam equoterapia. Fisioter Mov. 2013;26(3):515-24.
17. Bass M, Duchowny C, Llabre M. The effect of therapeutic horseback riding on social functioning in children with autism. J Autism Dev Disord. 2009;39(9):1261-7.
18. Santos S. Fisioterapia na equoterapia: análise de seus efeitos sobre o portador de necessidades especiais. Aparecida: Idéias e Letras; 2005.
19. Silva CP, Valadares YD. Avaliação da força muscular respiratória em indivíduos com síndrome de Down. Conexão Ci R Cient. 2014;9(2):24-37.

20. Paiva ARF, Pedrosa ACP, Senna INP, Coelho PV, Souza MBA, Fontes PLB. Efeito da hippoterapia no desenvolvimento funcional de duas crianças portadoras de síndrome de Down. Temas Desenvolv. 2005;13(78):22-8.

21. Silveira MM, Wibelinger LM. Reeducação da postura com a equoterapia. Rev Neurocienc. 2011;19(3):519-24.

22. Angonese RRD, Wisniewski MSW. Os benefícios da equoterapia sobre o equilíbrio e tônus muscular de crianças de necessidades especiais. Rev Perspect. 2006 [cited 2015, Jun 1];30(109). Avalaible from: http://www.uricer.edu.br/rperspectiva/inicio.php?id_numero=15

23. Black LF, Hyatt RE. Maximal respiratory pressures: normal values and relationship to age and sex. Am Rev Respir Dis. 1969;99(5):696-702.

24. Neder JA, Andreoni S, Lerario MC, Nery LE. Reference values for lung function tests. II. Maximal respiratory pressures and voluntary ventilation. Braz J Med Biol Res. 1999;32(25):719-27.

25. Schuster RC, Rosa LR, Ferreira DG. Efeitos do treinamento muscular respiratório em pacientes portadores de síndrome de Down: estudo de casos. Rev Fisioter S Fun. 2012;1(1):52-7.

26. Freitas DA, Borja RO, Ferreira GM, Nogueira MAS, Mendonça KMPP. Predictive equations and normal values for maximal respiratory pressures in childhood and adolescence. Rev Paul Pediatr. 2011;25(4):656-62.

27. Alexandre BL, Araújo SG, Machado MG. Pressões respiratórias máximas. In: Machado MG. Bases da fisioterapia respiratória: terapia intensiva e reabilitação. Rio de Janeiro: Guanabara Koogan; 2008. p. 111-24.

28. Santos AM, Lobo VCT, Lourenço MGF. Perfil da função respiratória de crianças portadoras de síndrome de Down na faixa etária de 5 a 12 anos de idade. Fisioter Bras. 2009;10(3):153-8.

29. Silva VZ, Barros JF, Azevedo M, Godoy JR, Arena R, Cipriano G. Bone mineral density and respiratory muscle strength in male individuals with mental retardation (with and without Down syndrome). Res Dev Disabil. 2010;31(6):1585-9.

30. Scanlan CL, Wilkins RL, Stoller JK. Fundamentos da terapia respiratória de Egan. São Paulo: Manole; 2000.

31. Casady RL, Nichols-Larsen DS. The effect of hippotherapy on ten children with cerebral palsy. Pediatr Phys Ther. 2004;16(3):165-72.

32. Graup S, Oliveira RM, Link DM, Copetti F, Mota CB. Efeito da equoterapia sobre o padrão motor da marcha em crianças com síndrome de Down: uma análise biomecânica. Revista Digital (Buenos Aires). 2006 [cited 2015, May 30];11(96). Available from: http://www.efdeportes.com/efd96/equot.htm

33. Stefanutti D, Fitting JW. Sniff nasal inspiratory pressure. Reference values in Caucasian children. Am J Respir Crit Care Med. 1999;159(1):107-11.

34. Wagener JS, Hibbert ME, Landau LI. Maximal respiratory pressures in children. Am Rev Respir Dis. 1984;129(5):873-5.

35. Romano AMC. Avaliação funcional respiratória em indivíduos com síndrome de Down [dissertação]. Piracicaba: Universidade Metodista de Piracicaba; 2007.

Received: 06/11/2014
Recebido: 11/06/2014

Approved: 02/27/2015
Aprovado: 27/02/2015