Comparative study of the manual handgrip force in individuals with Down syndrome

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ABSTRACT

Introduction: The strength of manual handgrip has showed to be important for constituting a relevant indicator to assess the strength of the subjects carrying Down syndrome. The objective of this study was to compare the strength of the manual handgrip between left and right hands of men and women carriers of the Down syndrome (DS), in the cities of Itaperuna and Bom Jesus do Itabapana, in the state of Rio de Janeiro.

Materials and Methods: In this comparative study of transversal cut, 28 subjects, all carriers of DS, moderately active, 12 of whom were females aging between 14 and 38 years (24.08±6.77) and 16 males aging between 14 and 44 years (27.13±8.83) were investigated. All subjects were enrolled in Associação dos Pais e Amigos dos Excepcionais in their respective counties. Muscle strength was evaluated by dynamometry with the handgrip.

Results: The analysis of the two-way variant showed significant difference (p<0.05) between genders (male versus female) on the right (p=0.001) and left hand (p=0.001), with higher values found in the male gender.

Discussion: The male bearers of DS showed an average of the isometric strength of the handgrip superior to the female subjects in both right and left hands.

KEYWORDS

Down Syndrome; Muscle Strength; Hand Strength; Muscle Strength.

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Estudo comparativo da força de preensão manual em portadores de síndrome de Down

RESUMO

Introdução: A força de preensão manual tem se mostrado importante, por constituir um indicador relevante para a avaliação da força dos sujeitos portadores da síndrome de Down. O objetivo do estudo foi comparar a força de preensão manual entre os sexos masculino e feminino, e entre os lados direito e esquerdo de portadores da síndrome de Down (SD), das cidades de Itaperuna e Bom Jesus do Itabapoana, no estado do Rio de Janeiro. Materiais e Métodos: Neste estudo comparativo de corte transversal, foram investigados 28 sujeitos portadores da SD, moderadamente ativos, sendo 12 do sexo feminino com idade entre 14 e 38 anos (24,08±6,77) e 16 do sexo masculino com idade entre 14 e 44 anos (27,13±8,83). Todos os sujeitos estavam matriculados na Associação dos Pais e Amigos dos Excepcionais de seus respectivos municípios. A força muscular foi avaliada pela dinamometria com o handgrip. Resultados: A análise de variância two-way revelou diferença significativa (p<0,05) entre os sexos (masculino versus feminino), nas mãos direita (p=0,001) e esquerda (p=0,001), sendo os maiores valores encontrados nos homens. Discussão: Os portadores de SD do sexo masculino da amostra têm valores médicos de força isométrica de preensão manual superiores aos indivíduos do sexo feminino, tanto na mão direita quanto na esquerda.

PALAVRAS-CHAVE

Síndrome de Down; Força Muscular; Força da Mão; Dinamômetro de Força.

INTRODUCTION

Down syndrome (DS) consists of a chromosomal anomaly which may be characterized in three manners: the chromosome 21 free trisomy, translocation and mosaicism. From these, the chromosome 21 free trisomy is the most common and occurs in 92% of cases1,2. There are more than 50 identified characteristics in DS, and it is very rare to find a person with all possible phenotypic characteristics, but the most present ones are mental delay and muscular hypotonia3,4.

The muscular hypotonia symbolizes a reduced muscular tonus, so “tonus” means the state of relative tension in which a rest muscle permanently is5. Silva Junior et al.6 point out that hypotonia is responsible for the decrease in the tonus and in the strength.

Hypotonia, in Down syndrome group, is related to motor development delay and to decrease in the strength of skeletal striated muscles7. Araujo, Scartezini and Krebs8 state that DS patients present a scarcity of descendent impulses, which demand the conjunct of motor neurons of the spinal cord, thus resulting in reduced muscular strength. Other studies9,10 defend that the excitation of motor neurons matches with normal patterns during the first months of life, so the hypotonia may happen due to the delay of encephalic and cortical patches maturation. According to Prieto11, the mean weight of cerebral trunk and cerebellum are reduced, and the cerebellum may be involved in the muscular hypotonia genesis. This problem would result in difficulties of control and recruitment of muscle fibers12, or be responsible for the cognitive defi-
iciency that DS patients present\textsuperscript{11}. However, as the child with DS grows, the muscular tonus as well as the strength tend to increase\textsuperscript{13,14}. In general, the muscular hypotonia is a primary sign for neuromuscular disorders or secondary, in consequence to systemic disease (septicemias) and complex syndromes\textsuperscript{15}.

Studies have stated that DS patients present alterations in march, reduced total pulmonary capacity due to weakness of respiratory muscles, difficulty in seating, standing and walking in response to their strength debt\textsuperscript{16,17,18,19}.

The manual catching strength has been considered as one of the most reliable clinical tests for measuring human strength\textsuperscript{20}. Godoy and Barros\textsuperscript{21} assert that manual catching strength has been object for many studies, for it constitutes a relevant indicator of the general individual’s state of strength and, so, is essential for the accomplishment of daily activities.

In this manner, the present study has the objective of comparing the isometric strength of manual catching between males and females to right and left sides of DS patients from the cities of Itaperuna and Bom Jesus do Itabapoana, Rio de Janeiro State, Brazil.

MATERIALS AND METHODS

Study approval

The study project was submitted to and approved by the Ethics Committee of Universidade Castelo Branco, Rio de Janeiro, Brazil, under the protocol number 0154/2008.

Sample

In this comparative study of transversal cohort, the investigated sample was constituted by 28 DS patients of both sexes that were moderately active, that is, who go in for physical activities twice a week; 12 of them were females aging from 14 to 38 years old (24.08±6.77) and 16 were males aging from 14 to 44 years old (27.13±8.83). All of them were inhabitants of Itaperuna (n=20, 11 males and 9 females) and Bom Jesus do Itabapoana municipalities (n=8, 5 males and 3 females), Rio de Janeiro, Brazil. All participants were enrolled in the Associação dos Pais e Amigos dos Excepcionais (Apae) of each municipality.

As inclusion criteria, DS patients should be enrolled in Apae with regular frequency and present grade 5 for the system of classification of voluntary hand motor activity, as proposed by Omer\textsuperscript{22}. Exclusion criteria comprised individuals younger than 14 years old and non-comprehension of information.

The participants, together with their parents or responsible ones, signed the informed consent, and the experimental proceedings were carried out in compliance with the ethical rules established by resolution 196/96 of Conselho Nacional de Saúde.

Procedures

For the measurement of manual catching strength, a dynamometer adjustable to the measures of hand was used, as it was prepared to incase a traction-compression strength transducer (EMG System, Brazil) with 0 to 200kg scale, which is connected to a modulation of data acquisition model EMG800C (EMG System, Brazil), gauged with a 2.000 times gain and sampling rate of 2KHz. The strength transducer generates an electrical signal (mV) with an amplitude proportional to the applied charge, and this signal is registered and stored in a computer by the software AqData5 for Windows\textsuperscript{®} (Ohio, USA) and converted from Newton (N) to kilogram-force (kg/f) through calibrating coefficient and presented in strength graphics (kg/f) x time (s), allowing data storage, reading and interpretation.

Collection of data on strength of manual catching was made in accordance to American Society of Hand Therapists\textsuperscript{23}, which postulates that the individual must be seated with the shoulder adduced and neutrally turned, 90 degrees-bent elbows, forearm in neutral position and wrist positioned between 0 and 30\degree of extension and 0 to 15\degree of ulnar deviation.

Patients were told to perform maximum contraction when a resonant signal started and to sustain it for six seconds. Each individual had three catching attempts on each hand with a two-minute interval between them, as the right hand was first tested, followed by the left one.

The mean value of the three attempts was used as isometric strength value for posterior statistical analysis. The descriptive analysis consisted of mean value, standard deviation, minimum and maximum values. Shapiro-Wilk and Levene tests were employed as to verify the normality of data and homogeneity of variants, respectively. The two-way analysis of variance (ANOVA) in sex (male and female) and side factors (right and left) was employed for intra and intergroup comparisons, followed by Scheffé post hoc to identify possible differences. The study admitted \(p<0.05\) as statistical significance. The software SPSS 14.0 was used for data treatment.

RESULTS

The results from the descriptive analysis are presented in Table 1, in which it is possible to observe that the sample obtained a homogeneous data distribution.

Table 2 presents the comparison of the results from the sample’s isometric strength of manual catching; it is possible to observe a significant difference (\(p<0.05\)) between sexes in the right hand (\(p=0.001\)) as much as in...
the left hand (p=0.001). The highest values of strength were verified among men in comparison to women. There were no significant differences between the right and left sides of the same sex in male and female groups.

**DISCUSSION**

The attainment of isometric strength of manual catching was described in the present study in terms of hand (right and left). It is suggested that the study of manual catching strength has a higher relevance when the right and the left hands are compared.24

The study of Godoy and Barros21 aimed at indicating a scale of strength for DS patients. In their studies, 56 individuals were assessed (28 normal patients and 28 DS patients), as they observed that women (normal patients and DS carriers) presented lower mean values for catching strength than men (normal patients and DS carriers) for both right and left hands. The present study confirms the abovementioned research, for the mean value of catching strength of men was superior to those of women. Though Godoy and Barros’21 study compares the strength of patients with and without DS, it demonstrates that, independently on sex, DS patients present reduced muscle strength in comparison to normal individuals.

Pérez25 assessed 135 DS patients of both sexes aging from 6 to 16 years old and concluded that there was a predominance of catching strength for boys in relation to girls, with a statistically significant difference of p<0.05. Esteves et al.26 carried out a study of manual catching in 1,247 normal individuals of both sexes aging from 7 to 14 years old and observed that boys presented a higher catching strength in relation to girls. The reported studies bring data similar to those of the present research, even though they were carried out with individuals in pre-puberty and puberty periods.

The current study showed that the manual catching strength of DS patients is higher among males than among females, thus confirming other researchers’ results24,20,27 that indicated higher catching strength for men in relation to women of all age groups.

In an investigation carried out by Esteves et al.26 with the objective of measuring the manual catching strength of children of both sexes aging from 7 to 14 years old, it was observed that for the groups of 7, 11 and 12 (females), 12 to 14 (males) there was no difference between mean value of right and left hand; it may mean that, despite the preference (right or left-handed), muscle strength develops similarly among both hands, which confirms the current studies’ results, in which it is possible to observe that the obtained mean values of strength did not differ significantly between the right and left hands.

Moreira, Godoy and Silva Junior24 reported that there is no predominance of strength in relation to the hand dominance pattern. Pérez25 observed that mean values for catching strength between right and left hands did not present statistically significant values (p<0.05), which is in accordance to Esteves et al.26 and Godoy and Barros21. However, these studies did not mention whether the studied sample participated in any orientated physical activity program.

According to Pueschel et al.13, the muscle strength of the DS patient tends to improve as he/she grows up. Mean age of the current study is very close to those found in

**Table 1 - Descriptive results and normality analysis of the manual pressure power (right and left) in both sexes (male and female) of the DS in the researched sample**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean (kg/p)</th>
<th>Standard deviation</th>
<th>Minimum</th>
<th>Maximum</th>
<th>p-value (SW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (n=12)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right hand</td>
<td>23.39</td>
<td>1.07</td>
<td>14.14</td>
<td>31.16</td>
<td>0.987</td>
</tr>
<tr>
<td>Left hand</td>
<td>22.13</td>
<td>1.01</td>
<td>12.16</td>
<td>27.51</td>
<td>0.458</td>
</tr>
<tr>
<td>Male (n=16)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right hand</td>
<td>32.92</td>
<td>1.51</td>
<td>17.73</td>
<td>44.5</td>
<td>0.435</td>
</tr>
<tr>
<td>Left hand</td>
<td>30.64</td>
<td>1.2</td>
<td>17.85</td>
<td>39.6</td>
<td>0.615</td>
</tr>
</tbody>
</table>

SW: Shapiro-Wilk test; kg/p: kilogram-power.

**Table 2 - Absolute delta of the comparison between the manual pressure power in both sexes (male and female) and sides (right and left) of DS porters of the researched sample**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Δ (kg/p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right hand (female) versus left hand (female)</td>
<td>1.26</td>
</tr>
<tr>
<td>Right hand (male) versus left hand (male)</td>
<td>2.28</td>
</tr>
<tr>
<td>Right hand (female) versus right hand (male)</td>
<td>-9.52*</td>
</tr>
<tr>
<td>Left hand (female) versus left hand (male)</td>
<td>-8.51*</td>
</tr>
</tbody>
</table>

*p<0.05; kg/p: kilogram-power; Δ: absolute delta (difference between means).
by Godoy and Barros\textsuperscript{21}: 27.82±6.63 years old for both sexes. It is possible to observe that even though mean ages are close and contained by the age group in which higher strength levels are observed in normal individuals\textsuperscript{28}, the strength did not show to be similar between the samples of both studies.

Mean values for manual catching strength are quite superior to the results found by Godoy and Barros\textsuperscript{21}, in a study in which women presented mean of 15.14±2.28kg for the right hand and 14.43±3.56kg for the left hand, while men had 21.36±4.11kg for the right hand and 20.69±4.26kg for the left hand, which means that patients from the present study had a higher manual catching strength. Such findings may be due to the fact that the DS patients of our study were moderately active, for they participated in sport activities twice a week.

Some studies\textsuperscript{6,29,30,31} have shown that a significant increase in strength among DS patients is possible after a training program of strength or resistance. Consistent with Balic et al.\textsuperscript{32}, the individuals who were physically active showed to be significantly stronger than DS sedentary patients. An increase in the muscle strength was verified in the studies of Tsimaras and Fotiadou\textsuperscript{33}, also revealing that there was a significant improvement (p<0.05) in the dynamic equilibrium of DS patients submitted to a training program in comparison to Control Group, formed by patients without DS. In this manner, if we confront the strength obtained by DS individuals of the present study to the Brazilian standardization table of manual catching strength for DS individuals\textsuperscript{28} for normal population, it would be observed that both men and women of this study would be characterized as very weak with regard to the strength of both hands in comparison to normal population.

Despite the fact that the current study had the lack of comparison of the obtained results to a group of patients without DS as limiting factor, researches show that, independently on the assessed muscle group, DS patients present reduced muscular strength even when compared to normal or mentally delayed individuals without DS. It is suggested that controlled and randomized studies be carried out in order to draw a specific profile of muscle strength for DS patients and to observe the effect of a training program on this muscular hypotonia.

Based on the results and analysis of isometric manual catching strength of DS patients, we conclude that DS male patients present mean values of isometric manual catching strength superior to values achieved by females in both hands side. No differences of catching strength were observed between the right and the left hand in both sexes.

REFERENCES


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