Grip strength and manual dexterity in Down Syndrome children

Força de preensão e destreza manual na criança com Síndrome de Down

Fuerza de prensión y destreza manual en el niño con Síndrome de Down

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ABSTRACT | Children with Down Syndrome (DS) present delays in motor skills acquisition compared to those with normal development, which may interfere in activities such as grip strength and manual dexterity. The evaluation of these activities can provide performance indicators in daily activities. The objective was to analyze the correlation between grip strength and manual dexterity in children with DS and healthy children aged 7 to 9 years old. Twenty-six children with DS, of both genders, who formed the DS Group, and 30 healthy ones, constituting the Control Group (CG) participated in this study. The grip strength evaluation was performed with the Jamar dynamometer and manual dexterity through the Box and Block Test. The DS Group presented a lower performance in both grip strength and in manual dexterity compared to CG. There was no significant correlation between grip strength and manual dexterity in the DS Group, but in the CG there was it. There was no difference in performance between genders for the items assessed in the two groups; performance on tests of grip strength and manual dexterity in the CG showed an evolution in the course of aging, in the DS Group these developments did not happen. It is concluded that differences were found in the performance of the two groups, indicating peculiar characteristics to DS. Further investigation must be done on these data, since they can contribute to the identification of objectives to be considered in stimulation programs.

Keywords | children; Down Syndrome; hand strength; motor skills.

RESUMO | Crianças com Síndrome de Down (SD) apresentam atraso na aquisição das habilidades motoras em relação às crianças com desenvolvimento normal, podendo interferir em atividades como a força de preensão e a destreza manual. A avaliação destas atividades pode fornecer indicadores de desempenho nas atividades diárias. O objetivo deste estudo foi analisar a correlação entre força de preensão e destreza manual em crianças com SD e crianças saudáveis com idade entre 7 e 9 anos. Participaram 26 crianças com SD, de ambos os sexos, que constituíram o Grupo SD, e 30 crianças saudáveis, compondo o Grupo Controle (GC). A avaliação da força de preensão foi realizada com o dinamômetro Jamar, e a da destreza manual pelo Teste Caixa e Blocos. O Grupo SD apresentou desempenho inferior tanto na força de preensão quanto na destreza manual, quando comparado ao GC; não houve correlação significativa entre a força de preensão e a destreza manual no Grupo SD; no GC esta correlação existiu; não houve diferença de desempenho entre os sexos para os itens avaliados; o desempenho nos testes de força de preensão e destreza manual no GC mostrou uma evolução com o decorrer da idade; no Grupo SD esta evolução não ocorreu. Conclui-se que foram encontradas diferenças no desempenho dos dois grupos, indicando características peculiares para a SD. Estes dados merecem maior investigação, uma vez que podem contribuir para a identificação de objetivos a serem considerados nos programas de estimulação.

Descritores | crianças; Síndrome de Down; força da mão, destreza motora.

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RESUMEN | Niños con Síndrome de Down (SD) presentan atraso en la adquisición de habilidades motoras con relación aquellos con desarrollo normal, lo que puede interferir en actividades como la fuerza de prensión y la destreza manual. La evaluación de esas tareas puede fornecer indicadores de desempeño en las actividades diarias. El objetivo de este estudio fue analizar la correlación entre fuerza de prensión y destreza manual de niños con SD y de los saludables con edades entre siete y nueve años. Veinte seis niños con SD, de ambos los géneros, fueron los participantes, constituyendo el Grupo SD y 30 niños saludables compusieran el Grupo Control (GC). La evaluación de la fuerza de prensión fue realizada con el dinamómetro Jamar y en la destreza manual se utilizó el Test de Caja y Bloques. El Grupo SD presentó desempeño inferior tanto en la fuerza de prensión cuanto en la destreza manual, cuando fue comparado al GC. No hubo correlación significativa entre la fuerza de prensión y la destreza manual en el Grupo SD. En el GC, esa correlación existió y no hubo diferencia de desempeño entre los géneros para los ítems evaluados. Lo desempeño en los testes de fuerza de prensión y destreza manual en el GC mostró una evolución con el decurso de la edad; pero en el Grupo SD eso no ocurrió. Se concluyó que fueron encontradas diferencias en el desempeño de los dos grupos, lo que indica características peculiares para la SD. Esos dados deben ser mas investigados ya que pueden contribuir a la identificación de objetivos que van a ser considerados en programas de estimulación.

Descriptores | niños; Síndrome de Down; fuerza de la mano; destreza motora.

INTRODUCTION

The development of a child with Down Syndrome (DS) is slower than one without development alterations. This delay affects the neuropsychomotor performance. Studies using different approaches are found in the literature, with the aim of analyzing the possible reasons for this delay[1,2].

Most investigations show that the main reasons for the motor deficit come from the syndrome characteristics itself, such as hypotonia, physical growing, obesity, and skeletal, balance, heart, and perception problems. The articular hyper-mobility also contributes to the delay in the motor development[3]. In order to soften this deficit, body movements of the DS child must be stimulated since his/her birth, which will then strengthen his/her gross and fine motor skills from exploratory experiences[4,5].

Amongst the common characteristics of the syndrome, some authors mention small and thick hands, with short fingers and an arched little finger[5], which could cause some difficulties in manipulative activities.

The studies performed by Sharav and Bowman[6] and Pitetti et al.[7] emphasize aspects about manual grip strength in DS subjects. It was seen that people without the syndrome present strength values higher than those with it, and there is a strong association between muscle hypotonia and strength deficit. Furthermore, in this study, lower scores for leg strength in DS subjects were also found, which could cause an impact on daily life activities and on work opportunities for this population.

Godoy and Barros[8] carried out a study associating muscle hypotonia with grip strength, with the aim of indicating parameters and a strength scale for DS adults. Among other results, they verified that there is a predominance of grip strength in men compared to women; there is a significant deficit of grip strength in the group including DS subjects when compared to people without DS; also, it should be taken into account the characteristics of a DS person's hand when activities using manual functions are proposed. From these data, the authors reflect upon the possible impact that strength deficit may cause on daily life activities like changing clothes, eating, handling objects, among others.

With regard to manual dexterity, Germano[9] performed a study using the Blocks and Box Test[10]. It was assessed DS children and adolescents aged 7, 8, 9, 14 and 15 years. A total of 50 DS children and adolescents took part in the study, of both genders, and 50 without it, but also of both genders as the Control Group (CG). The results indicated a disadvantage in the manual dexterity of the DS participants compared to the CG. In addition, no statistically significant alteration was seen in the manual dexterity for the DS Group in the age range from 7 to 9 years old, when compared to the ages of 14 and 15, which evidences that for the studied group there was no evolution in the manual dexterity with the course of age. However, for the CG, this development was statistically significant. Differences in how the blocks were gripped in DS subjects were also seen, with the use of a gripper between the thumb and middle finger, in 36% of the cases, *versus* 4% in the CG.

Coppede et al.[11], in their study, analyzed the fine motor performance and functionality in two-year-old DS children, and they concluded that skills using visuomotor integration and manual dexterity need to be developed.

Motor alterations present in DS individuals can be functionally manifested, interfering in the ability to perform several activities and in daily routine tasks that use gross and fine motor coordination. Information about DS subjects' functionality is extremely relevant for health professionals, since the expectations of parents and caregivers are more associated with functional information than with data about symptomatology and specific performance components[12].

The grip strength and manual dexterity are basic elements to be analyzed when investigating manipulative skills. Therefore, the main objective of this study was to analyze the correlation between grip strength and manual dexterity in DS children aged 7 to 9 years. As specific objectives, the variables grip strength and manual dexterity were assessed with regard to the ages of 7, 8 and 9 years and to the female and male genders.

METHODOLOGY

Subjects

The samples were chosen for non-randomized convenience in the institutions where the contact and invitation to take part in the research were done. This study included 28 DS children from both genders, aged 7 to 9 years, in the DS Group, which had as its exclusion criteria the existence of an orthopedic or neurological compromise diagnosis associated with the syndrome. The sample loss included two children that were excluded of the study for not taking part in the collection of the second manual dexterity measure; the collection of this group ended with 26 children, 12 female and 14 male. Furthermore, 30 children without DS (15 female and 15 male) were also assessed and included in the CG, whose ages were between 7 and 9. This group did not include children diagnosed by a physician with a development disease or disorder, and on a continuing medication regimen. All participants had their legal guardians contacted in order to get an authorization to take part in the study; the information letter had to be read; and the free informed consent had to be signed. Children were reached in specialized institutions in Barueri, São José dos Campos, Sorocaba and Campinas, and in regular schools in São Paulo and Barueri. The evaluations happened in the place established by the support institution of the study, normally under the therapeutic situation present in the institutional routine. The school representative also received the information letter sent to the institution, and should sign the agreement to participate in the study.

The project was registered in SISNEP, under cover page 234.970, which was then followed and approved by the Research Ethics Committee of Universidade Presbiteriana Mackenzie, under record CEP/UPM 1104/11/2008 and CAAE 0079.0.272.00-08.

Procedures

The choice of tests was based on literature indications and easiness to apply the instruments, considering the studied population. It was also used a form to register all the results.

A Jamar® dynamometer was used to assess grip strength, which consists on a hydraulic measuring system. When the participant presses the bars, they become folded, causing a change in the resistance of measurers and a similar alteration in the voltage production that is directly proportional to the strength performed over the bars. This dynamometer has an adjustable gauntlet for 1, 1.5, 2, 2.5 and 3 inches spacing, i.e. 1st, 2nd, 3rd, 4th and 5th positions, one inch corresponds to the first position and so on. The second position is the most used. The strength scale in the dynamometer is described in up to 200 pounds and/or 90 kilograms (kgf).

The grip test was applied using the standards recommended by the American Society of Hand Therapists (ASHT) on the correct use of this instrument, both from the device gauntlet and the position of the subject to be tested, in order to obtain an accurate and correct analysis[13]. In 1981, the ASHT suggested using such device with the gauntlet in the second position because it has the best results for grip strength[14]. Despite the recommendations established by the ASHT, there is not yet a common protocol during the test procedure. New studies should be standardized with regard to grip strength, concerning, among other issues, body mass index, pathologies and sports practice[15].

The use of such dynamometer to determine the squeeze strength is a very simple method that qualifies an important aspect of the muscle function, which is associated with chronological age, and provides data about the skeletal musculature development[16].

Before beginning the test, the children could handle the equipment the way they wanted to, under the evaluator's supervision. Then, they were oriented to remain sit on a chair, whose height allowed the correct support of the feet and lumbar back. Their shoulders should be

brought together with the trunk or be adducted, the elbows should be flexed in 90 degrees, with the examiner's charge, and children should exert the gauntlet grip only once, as strong as possible to. Three repetitions were performed, alternating the assessed limb, respecting a one-minute interval between the attempts. The best measure achieved between the three collected ones was taken into consideration.

In order to assess manual dexterity, the Blocks and Box Test was used, which consists on the transportation of small wood cubes from one side to the other for one minute (blocks/minute). These blocks must be taken from one end to the other of a partition wooden box. The number of blocks must be registered for right and left upper limbs, by means of three attempts for every limb (R and L)[10]. For this study, the results achieved in the second attempt were chosen because they presented the best values for manual dexterity and due to a peculiar characteristic of the assessed group, i.e. the delay in motor learning, when compared to other groups.

A 53.7 cm wooden box was used to apply this test, with a wooden partition that is taller than the box edges, separating it into two equal compartments. One hundred and fifty wooden blocks were used as cubes with 2.5 cm of diameter. In the test description, a silent room is required.

The evaluations were scheduled according to the place and participants' availability. It was required a room where the child could be at her/his will, with the presence of only the examiner and a research assistant who followed-up the evaluations in order to record data informed by the researcher.

Each evaluation lasted around 15 minutes, initially the grip strength was assessed and, later, the manual dexterity for both right and left sides, the dominant side was always the first one.

All recommendations to apply the Blocks and Box Test were used in this test[17]. Only one adjustment was performed by closing the box central holes in order to avoid attention dispersion during the exam[9]. The child practiced for 15 seconds. A one- minute period was timed using the Sport Time chronometer. When the blocks were being transported, the number of transported blocks was counted aloud.

Statistical analysis

Data were analyzed using the statistical program Minitab. A 5% significance level was established.

Parametric hypothesis tests used to compare means require the normal distribution assumption for samples with a size lower than 30, therefore Anderson-Darling adherence tests were carried out to confirm it with regard to all variables involved. The Student's *t*-test was used to compare means for two non-paired samples with unknown variances. This is performed differently when variances of both groups are or are not statistically equally considered. In order to check if such variances are the same, since the distributions of the variables adhered to the normal distribution, Fisher's F-tests were performed[18]. In order to illustrate the comparisons of means of the two samples, graphics of individual values were made.

When comparing the mean of three groups (in the case of answers with regard to age, 7, 8 and 9), non-parametric variance analyses were done by applying the Kruskal-Wallis tests, due to the fact that the number of elements in each groups was very reduced and it was a non-balanced experience, taking into consideration the even positions. When the mean equality hypothesis was rejected, two by two contrasts were done[19].

The correlations between dominant grip strength and manual dexterity were also tested by means of Pearson's correlation coefficient. Such tests were illustrated through graphics of dispersion with a least squares line[18].

RESULTS

The studied sample presented in the DSG a mean age of 7.9 years (±0.90) for boys and 7.6 (±0.63) for girls; and in the CG, the mean age of 8 years for both genders, with a 0.84 standard deviation for boys and girls.

There was no significant difference in the Control and DS Groups with regard to the variables age (p=0.488) and gender (p=0.774), which may suggest the existence of homogeneity between both groups about such variables.

When the dominant grip strength and manual dexterity variables were correlated for the Control and DS Groups, by means of Pearson's correlation, in the CG a r=0.473 (p=0.008) value was observed, therefore there was a linear relation (in the increasing case) between the dominant grip strength and manual dexterity variables for this group.

Figure 1 presents the dispersion results for dominant grip strength and manual dexterity in the CG, with the estimated least squares line.

For the DS Group, Pearson's correlation coefficient between dominant grip strength and manual dexterity was r=0.317 (p=0.115), therefore there is not a linear relation between the dominant grip strength and manual dexterity variables for the DS Group. Figure 2 presents the dispersion results for dominant grip strength and manual dexterity in the DS Group, with the estimated least squares line.

For all the mean comparison tests, the probability distributions of each variable were tested and they all followed the normal distribution. Thus, all mean comparison tests used Student's *t*-test distribution.

For the mean comparison between dominant grip strength among the groups, the F variance equality test was rejected (p=0.032). In this situation, the Student's *t*-test was carried out. This test was rejected (p=0.000), therefore the dominant mean grip strength of the CG was higher than the dominant mean grip strength of the DS Group (Figure 3).

For the mean comparison between dominant manual dexterity among the groups, the F variance equality test was not rejected (p=0.337). In this situation, the Student's *t*-test was carried out. This test was rejected (p=0.000), therefore the dominant mean manual dexterity of the CG was higher than the mean manual dexterity of the DS Group (Figure 4).

When testing similarity of means for the dominant grip strength in three ages, in the CG, H=7.92 (p=0.021) was obtained, therefore the mean grip strength was not the same in the three ages, and their means are respectively 13.4; 15.7 and 18.7 for 7, 8 and 9 years. Since in this situation different means, whose distances are higher than 7.07, must be considered, it was concluded that the dominant grip mean strengths are different for children aged 7 and 9 years.

With regard to dominant manual dexterity variable in the three ages, H=9.64 (p=0.008) was achieved, therefore for the CG the mean manual dexterity was not the same in the three ages, and these means are respectively 37.3; 48.5 and 49.9 for 7, 8 and 9 years. Since in this situation different means, whose distances

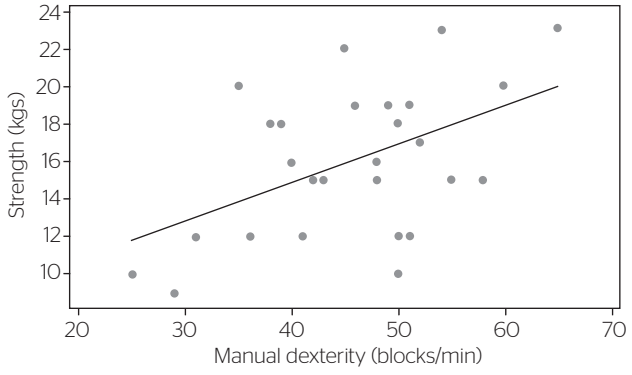

Figure 1. Correlation between grip strength and manual dexterity in the control group. Regression equation: Dominant strength = 6.730 + 0.2035 of the dominant dexterity

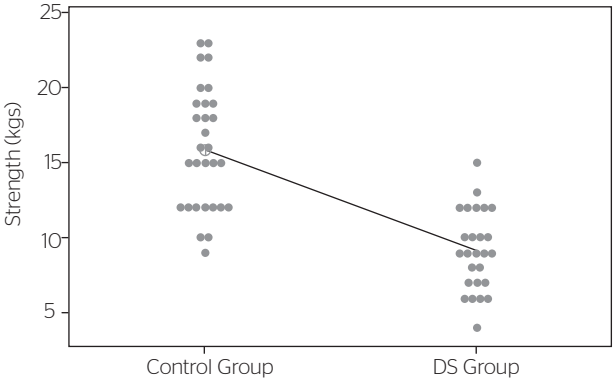

Figure 3. Individual values for dominant grip strength in the control and Down Syndrome (DS) groups. The line between columns form the union of means

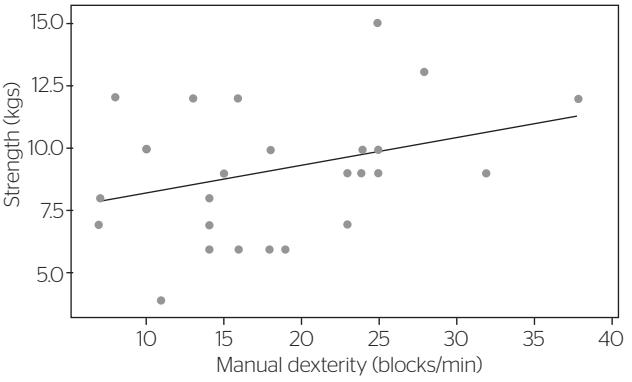

Figure 2. Correlation between grip strength and dominant manual dexterity in the Down Syndrome group. Regression Equation: Dominant strength = 7.174 + 0.1073 of the dominant dexterity

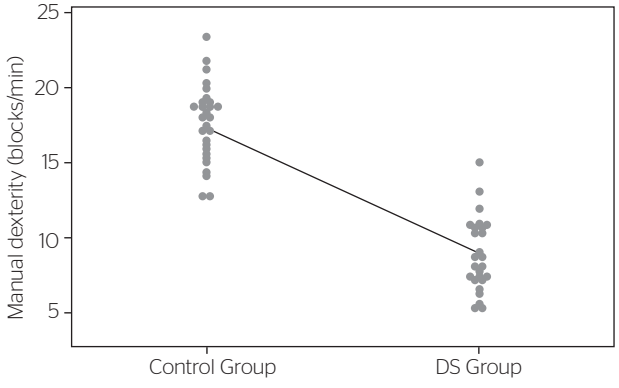

Figure 4. Individual values for dominant dexterity in the control and Down Syndrome (DS) groups. The line between columns form the union of means

are higher than 6.83, must be considered, it was concluded that the dominant manual dexterity was lower at 7 years old.

When testing mean equality for the dominant grip strength, in the DS Group, H=9.64 (p=0.902) was achieved, therefore there was a similarity for all the means in the group.

For the dominant manual dexterity, H=2.39 (p=0.303) was achieved, therefore there was also equality for all the means in the DS Group.

In the comparison of the dominant grip strength mean, there was not a significant difference between genders, both for the CG (p=0.379) and for the DS Group (p=0.756). The same result was seen in the comparison of the dominant manual dexterity mean between genders in the C (p=0.778) and DS (p=0.338) Groups.

DISCUSSION

Motor and sensorial tasks performed by the hand are organized in order to reach a good general behavior of the body with regard to performance in the daily life activities needed for survival[20].

In this study, both the manual grip strength test with Jamar dynamometer and the Blocks and Box Test for manual dexterity could be applied to all the DS population.

According to the statistical analyses, despite the sample size of the studied groups (C and DS) be different, the statistical tests showed that the gender and age were distributed homogeneously in both groups, which allowed their comparison.

In this study, the lower performance of DS children compared to those without it, both for the grip strength and manual dexterity, could have been influenced by some factors like intellectual deficit[4,5], hypotonia[5], physical growth — which is early ceased, resulting in small stature[21], hand anthropometric characteristics[5]. The atypical grip standards in DS children, like using less fingers and hyper-extending them when catching objects, may compromise manipulative abilities[22].

Besides the described factors, others may also influence the grip strength and manual dexterity of people at different age ranges, whether they have or do not have DS, which are: body mass, fat percentage, and nutritional status[8,10,23-25].

As to gender, results showed that both grip strength and manual dexterity were similar for girls and boys in the two studied groups (CG and DSG).

Studies about gender difference are not in agreement. Some authors state that the grip strength is always higher in the male gender in all ages[8,10,24,26,27], others report that the strength is similar until 12 years old between the genders and, later, there is a predominance of strength in the male gender[23,28]. The study carried out by Godoy and Barros[8], with adults aged 20 to 40 years with DS, showed that the strength results remained pretty close with regard to gender, both in the C and in the DS Group, similarly to the results of the present investigation. However, a study carried out by Silva et al.[29], which assessed the grip strength in adolescents and adults with DS, between 14 and 44 years old, found differences in the performance of both genders, therefore men presented higher values than women with DS in the strength evaluation.

Yim et al.[27] analyzed the grip strength, precision strength, and manual dexterity in children and adolescents aged 7 to 12 years. They concluded that the grip strength of boys was higher than that of girls of all age ranges; however, there was no difference between genders in the results of precision strength and manual dexterity.

There was no difference in the performance between genders when using the Blocks and Box Test[10]. Guimarães e Blascovi-Assis[30] chose to not assess the differences between boys and girls in the first use of this test in a population with DS found in literature, based on this author's indications.

The lack of concordance between the investigators on these results indicate the need of other researches with bigger groups and more control of variables, such as typical body composition and hormone modifications for the different development stages.

Studies investigating the manual function could relevantly contribute for the evaluation processes of DS people and for the elaboration of intervention programs. The association between strength and functional performance, more specifically in self-care activities, was described by Souza et al.[31], demonstrating a positive correlation between strength and scores in this domain.

With these results, some limitations for this study can be showed, such as the reduced number of participants and lack of data regarding body composition. Differences between the dominant and non-dominant hands were not also studied. This aspect must be emphasized, once studies indicate that the functional

performance not always presents significant differences between the favorite and non-favorite hands in some manual tasks[32].

CONCLUSION

The delay in the development of DS children is a known fact in the scientific-academic area. However, we need studies that may translate, in a quantitative manner, this evidence. The present study demonstrated that, in the investigated age range, performance in strength and dexterity evaluation was not different for boys and girls. Also, it was seen a correlation between manual strength and dexterity and an evolution with the course of age. Knowledge about manual skills is an interdisciplinary interest, since the results may contribute to plan educational, sports or therapeutic activities guided by several professionals like physical educators, physical therapists, occupational therapists, pedagogues, psychologists and others involved in the stimulation of development and autonomy in the DS subject's daily life activities. Other researches with a bigger number of participants and more methodological detailing seem to be necessary in order to further data found in this study, as well as to deepen other variables of manual function and correlation.

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