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Manual Dexterity of Children and Adolescents with Down Syndrome: Systematic Review of the Literature

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Abstract

Purpose: Children with Down syndrome present particular characteristics from the diagnosis, specially hands with particularities like regarding size, strength, folds, among other features. Such characteristics can affect the functional performance in relation to manual skills. This study aims to check the scientific literature available in digital media studies on children and adolescents with Down syndrome from 0 to 17 years of age who have undergone evaluation aiming to improve manual dexterity ability.

Methods: The methodology consisted of extensive research conducted in the last 10 years of scientific literature with the approach of the above theme, selected from LILACS, MEDLINE, SciELO, PubMed, Scopus described according to pre-defined DeCS and Mesh: manual dexterity, fine hand skills, fine motor skills, Down syndrome, evolution and intervention.

Results: Only eight articles addressing manual dexterity assessment in children with Down syndrome were found, however not all of them presented appropriate tools for fine motor skills evaluation.

Conclusion: There are few studies related to the theme comprising this population. More specific evaluation studies and intervention should be developed with this population, because these children and adolescents present slower manual dexterity, when compared to typical children.

Keywords: Manual dexterity; Down syndrome; Evaluation

Introduction

Down syndrome, also known as trisomy 21, a genetic alteration which occurs in fetus formation, more specifically in the cell division period. It constitutes a chromosomal abnormality characterised by a series of signs and symptoms.

An abnormal chromosome causes physical, intellectual and motor development alterations. Physical characteristics of Down syndrome can be observed, such as: short stature, brachycephaly with flattened occiput, short neck with redundant skin, flat nasal bridge, low implantation ears [1] and the eyes present Brush field spots around the iris margin, oblique eyelid closure, permanently open mouth, furrowed and protruding tongue, short and broad hands often with a single transverse palmar crease (simian crease) and deflected fifth fingers, or Clinodctilia, groove between the big toe and second toe and low tonus [1-3].

Down syndrome development and motor control of children have been described as atypical, presenting "clumsy" manual skills [4,5] Brain anatomy characteristic features, as well as hypotonia, probably contribute to atypical manual skills development [6,7].

Investigations employing motor standardised scales, such as: Movement Assentment Batery for Children (MABC) and Bruininks-Oseretsky Test of Motor Proficiency (BOT), have demonstrated several damages in fine motor skills and manual dexterity in Down syndrome children, thus presenting lower developmental progress [8,9] reaching and gripping delayed activities in Down syndrome children [10,11]. Kearney and Gentile [12] demonstrated deficient hand-reaching control and coordination in 3-year-old-children with Down syndrome, in their researches.

Charlton et al. [13] also found these characteristics in 8-10-year-old children with Down syndrome. Reaching movements were described as slow, irregular, variable and inaccurate and gripping was atypical in children with Down syndrome [12-14].

Comparisons were carried out on fine motor skills between children with Down syndrome and typical children, paired by age and motor development (Battelle Developmental Inventory, Child Development Bayley Scales and/or Stanford-Binet Intelligence Scale), aiming to reduce differences between the groups [12,13,15]. Children with Down syndrome presented low performance in fine motor skills, when compared to mentally retarded children without Down syndrome [16] Employing MABC manual dexterity items for children [17] Spano et al. [8] found little difference between chronological age and motor development in Down syndrome children.

We have hypothesized that in face of such differences between the typical development and the development of children with Down syndrome, especially in relation to manual dexterity, we believe it is possible to find in the scientific literature, experimental and exploratory studies, which aim to assess in syndromic children.

Since children with Down syndrome have motor difficulties, due to their diagnosis, manual dexterity (manual dexterity is a manual dexterity of fast motor coordination, involving fine or gross voluntary movements, related and developed through training, learning and experience) constitutes a skill often affected by the syndrome characteristics.

Therefore, this study aimed to verify in the scientific literature,

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researches related to assessment concerning manual dexterity of children and adolescents with Down syndrome, identifying assessment tools, amount of participants and the predominant age group.

Materials and Methods

This study is characterised as an exploratory and descriptive literature review, realized by digital media in accordance with the recommendations of the Cochrane Handbook for Systematic Reviews [18] and PRISMA Statement for systematic reviews preparations [19].

Materials and equipment

For developing this research, the following materials and equipments were applied; a) Internet-connected notebook for accessing databases; b) peripheral devices (pen drive) for storage and transport of the collected data; c) software: Excel®.

Data sources

Databases comprised Latin American and Caribbean Health Sciences (LILACS), Medical Literature Analysis and Retrieval System Online (Medline), National Library of Medicine (PubMed), Scientific Electronic Library Online (Scielo) Índice Bibliográfico Espanhol de Ciências da Saúde (IBECS) and SciVerse Scopus (Scopus). These databases showed the highest number of articles indexed in the area of research.

Procedures for selection of items

MeSH- Medical Subject Headings (MeSH) was selected for searching keywords, a medical classification system based on English-language articles indexed in health sciences area. MeSH remains supported in MEDLINE-PubMed system; and DeCS- Descriptors in Health Sciences, which is a unique descriptor indexing articles from scientific journals and other materials, as well as recovery of research and subjects from scientific literature in available information sources at LILACS, Scielo and others. The terms employed were: manual dexterity, fine motor skills, fine hand skills, fine motor coordination, Down syndrome, evaluation and intervention. Terms were grouped by four terms simultaneously/connected by and/or, to make a directed search. Three researchers, blindly and independently based on the title and summary, initially performed digital literature search. To avoid exclusion of important articles from the systematic review those were totally read. All the researchers applied a standardised checklist, adapted from PEDro scale for verification of the methodological characteristics and quality of the selected intervention studies.

Eligibility criteria

Criteria for this first sample selection, were: 1) Population: children and adolescents with Down syndrome, from 0-17 years; 2) Utilisation of assessments for manual dexterity 0skills; 3) Assessment tools: standardised motor batteries; 4) English and Portuguese languages; 5) Type of study: it cannot be a systematic review of the literature. If the title and/or the summary of the study did not present, at least, one of five criteria, the article was automatically ruled out of selection.

Ethical aspects of the research

As for the ethical aspects of a documentary research, submission and approval by the Ethics Committee was not necessary. Data were collected and analysed and the names of the authors are of public domain, online databases.

Results

The bibliographic survey comprised 38 scientific papers published in national and international journals. A total of 17 repeated articles were excluded and 21 selected in order to check the survey eligibility criteria (Figure 1), of which 13 were excluded; for addressing other issues, with different population, in another language, not in accordance to the period delimited for the research and/or was not available in full. A total of eight selected articles remained in common agreement among the judges (Figure 2).

Eight items, which remained in this study, are demonstrated below. Selected items according to search eligibility criteria (Table 1). The articles were categorised according to databases, country, title, authors, journal, impact factor, year of publication and language.

Regarding the journals impacting factor of the selected studies published, it was observed that they followed a proportional ranking, with mean 1,978 (± 1.855DP). The lowest score was observed in a Brazilian journal, with mean 0.201 and the highest one in a Dutch journal, with 6,209. Overall, the journals aiming motor rehabilitation area present an average score of 1.38 (± 0.462DP).

Most studies are international, only two are from Brazil, published in national journals [20,21] This fact highlights the country fragility regarding researches about motor rehabilitation in children with

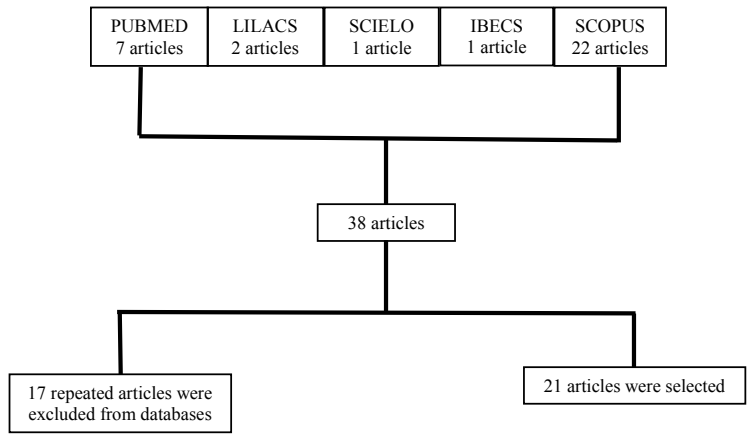

Figure 1: Total of 17 repeated articles were excluded, and 21 selected in order to check the survey eligibility criteria.

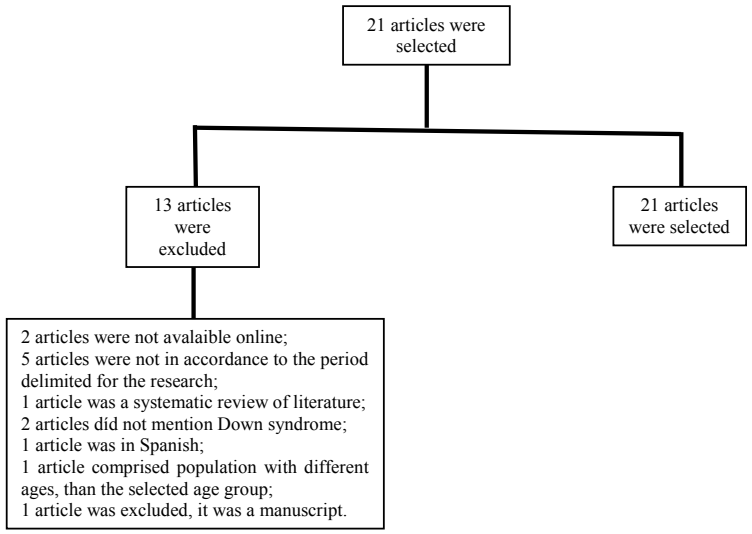

Figure 2: Total of eight selected articles remained in common agreement among the judges.

Number-Database-country	Title	Author	Periodic impact factor	Year of publication	Language
1-Scopus Italy	Clumsiness in fine motor tasks: evidence from the quantitative drawing evaluation of children with syndrome	Vimercati SL; Galli M; Stella G; Caizzo G; Ancillao A; Albertini G[20]	Journal of intellectual disability research/ **1.788**	2015	ENGLISH
2- SCOPUS Sweden	Late effects of early growth hormone treatment in down syndrome	Myrelid A; Bergman S; Elfvik Stromberg M; Jonsson B; Nyberg F; Gustafsson J; Anneren G	Acta Paediatrica **1.674**	2009	ENGLISH
3- LILACS/ SCIELO Brazil	Forca de Preensào e destreza manual na crianca com syndrome de Down	Priosti PA; Blascovi Assis; SM Cymrot R; Vianna DL; Caromano FA[22]	Fisioter pesg **0.944**	2013	PORTUGESE
4- SCOPUS Holland	The effect of early thyroxine treatment on developmentand growth at the age of 10.7 yrs: follow up of a randomised placebo-controlled trial in children with Down syndrome	Marchal JP; Murice Stam H; Ikelaarn NA; Klouwer FCC; Verhorstert KWJ; Witteveen ME; Houtzager BA; Grootenhuis MA; Trotsenburg ASV[23]	J clin endocrinol metab **6.209**	2014	ENGLISH
5-MEDLINE/ PUBMED/ SCOPUS USA	Motor control outcomes following nintendo wii, used by a child with Down syndrome	Berg P; Becker T; Martian A; Primrose KD; Wingen J[24]	Pediatric physical therapy **1.035**	2012	ENGLISH
6-SCOPUS/ PUBMED Canada	Neuropsychological late effects of treatment of acute leukemia in children with Down syndrome	Roncadin C; Hitzler J; Downie A; Montour-Proulx I; Alyman C; Cairney E; Spiegler BJ[25]	Pediatr blood cancer **2.386**	2015	ENGLISH
7-LILACS/ SCIELO/SCOUS Brazil	Avaliacao e intervencao no desenvolvimento motor de umacrianca com sindrome de Down	Santos APM; Weiss SLI; Almeida GMF[26]	Revista brasileira de educacao especial de Marilia **0.201**	2010	PORTUGESE
8-MEDLINE/ PUBMED/SCOPUS USA	Effect of congenital heart defects on language development in toddlers with Down syndrome	Visootsak J; Hess B; Bakeman R; Adamson LB[27]	Journal of intellectual disability research **1.788**	2012	ENGLISH

Table 1: Characterisation of final search.

Down syndrome, focusing on manual dexterity. English language predominance was observed, hindering reading access to therapists who do not work in research area, searching for additional knowledge.

Well distributed studies according to age range proposed by this literature review (Table 2); authors apply various types of evaluation instruments to characterise the population, but few studies make reference to the intervention.

In this table, from the eight selected items in this review, only two referred to intervention [21,22] Santos et al. [21] conducted a motor intervention with only one Down syndrome child. The intervention program comprised 32 sessions. From this total, only 5 sessions were specifically directed to fine motricity applying activities, as fitting parts and drawings. Since the intervention purpose was not specific to fine motricity/manual dexterity, the researchers divided the total

Number-Title	Type of study	Objectives	Subjects	Instruments/ Action held
1- Clumsiness in fine motor tasks: evidence from the quantitative drawing evaluation of children with Down syndrome[20]	qualitative; descriptive; case-control	Characterise fine motor skills of participants with Down syndrome, during a Denver Test design task.	Population of 14- 18 years; group with Down syndrome (23) and typical group (13).	SMART-D BTS; Italy / measure in 3D) and an integrated video system (Vixta, BTS, Italy). Child sitting in front of a table making copies with the dominant hand; three drawings were presented
2- Late effects of early growth hormone treatment for Down syndrome[21]	qualitative; descriptive; case-control	Investigate the late effects of early treatment with GH on growth and psychomotor development in Down syndrome.	Population of 17 and 20; 12 treated subjects; 10 control subjects; both groups diagnosed with Down syndrome.	The subjects were weighed; standing height, sitting height; distance between the fingertips (open arms at shoulder height); head circumference; cognitive ability (Leiter-R); WISC III; BOT-2;
3- Grip strength and manual dexterity in children with Down syndrome[22]	qualitative; descriptive; case-control	Analyse the correlation between gripping strength and dexterity in children with DS comprising ages 7-9; Analyse gripping strength and manual dexterity variables in relation to ages 7, 8 and 9, for females and males.	Population from 7 to 9 years old; 26 children with Down syndrome and 30 control children.	Jamar dynamometer; Box and Blocks Test.
4- The effect of early thyroxine treatment on development and growth at the age of 10.7 years: follow-up of a randomised placebo- controlled trial in children with Down syndrome[23]	qualitative; descriptive;	To determine the effects of long term treatment with previous T4 on the development and growth of children with Down syndrome in neonatal, normal or high TSH concentration.	Average age population of 8.7 years; 181 children were divided into two groups; 64 treated with T4 and 59 with placebo; all of them with Down syndrome.	Questionnaires to determine whether the child attended rehabilitation centers after 26 months of age; plasma TSH measurement; assessed signs of puberty; Snijders-Oomen Nonverbal Intelligence Test; Bayley Scales of Infant Development-II (BSID-II) if necessary; Movement Assessment Battery for Children 2 (M-ABC2); Vineland Adaptive Behaviour Scale (VABS); Beery VMI fifth edition; height, weight and head circumference.
5- Motor control outcomes following nintendo wii, used by a child with Down syndrome[24]	qualitative; case study	Analyse the motor results from 8-week intervention with Nintendo Wii upon a child diagnosed with Down syndrome (DS).	A 12-year-old with Down syndrome.	Evaluated visual perception (TVT-3), self-efficacy (SPC), and self-perception (PPA); manual coordination (BOT-2), body coordination (BOT-2), strength and agility (BOT-2), balance (Biodex Balance System BioSway), body composition (Bodystat Quadscan 4000). Intervention: 8 weeks; 4 times a week, lasting 20 minutes; parents were asked to keep a diary of the sessions; every two weeks a researcher made contact with parents for clarifying doubts; after the intervention period the parents returned to the lab to perform the same pre intervention.
6-Neuropsychological late effects of treatment for acute leukemia in children with Down syndrome[25]	qualitative; descriptive; case-control	Investigate the neuropsychological outcomes in children with DS suffering from acute lymphoblastic leukemia (ALL) or acute myeloid leukemia (AML), compared to children with DS without cancer history	Population from 4 to 17; three groups: DS ALL; DS AML and control.	It was evaluated the intelligence (Stanford-Binet Intelligence Scales), academic participation (Woodcock-Johnson III Tests of Achievement); language (Peabody Picture Vocabulary Test III); visuomotor (Wide Range Assessment of Visual-Motor Abilities) and adaptive behaviour (Scales of Independent Behaviour Revised).
7- Evaluation and intervention of motor development of a child with Down syndrome[26]	descriptive; case study	Analyse the motor development of a child with Down syndrome and check the effects of a specific motor intervention program.	A 7 year- old- child	Biopsychosocial questionnaire; motor development scale (ROSA NETO, 2002), held at pre and post intervention. Intervention: 32 sessions, 2 times a week, lasting 50 minutes each; activities carried out ludically comprised fine and global motor skills, balance, body scheme, spatial and temporal organisation and laterality.
8- Effect of congenital heart malformations upon language development in toddlers with Down syndrome[27]	qualitative; descriptive; case-control	Check the impact of heart congenital malformations on language development in children with DS	Population from 2 to 4 years; 29 children with DS, divided into two groups: DS plus congenital heart disease and DS without congenital heart disease.	MacArthur Communication Development Inventory (CDI); Mullen Scales of Early Learning; Communication Play Protocol;

Table 2: Characterisation of the articles according to the type of study, objectives and methodology.

number of interventions and distributed among seven different motor development components assessed in the study with the child.

Berg et al. [22] performed an intervention with different Nintendo games Wii® with a Down syndrome child, during 8 weeks. Different from the intervention protocol of the study by Santos et al. [21], applied in the researchers University laboratory, the proposed intervention by Berg et al. [22] was performed in the child's home, without rehabilitation professionals, since the study aimed at determining the motor intervention effects in a Down syndrome child, regarding a family encouragement situation.

The researchers taught the basic commands of Nintendo Wii® to the child and instructed the parents for encouraging the child play the games at least for 20 min, four times a week, during 8 weeks; they should write down in a diary, the child´s routine while using the Virtual Reality. As observed, the child remained more time playing Bowling and Baseball, representing respectively 56% and 22% of the total time spent by the child, during the intervention period. These games mainly stimulate manual dexterity.

The eight articles presented in this review applied some tools to evaluate children motor development. Only three are meant to accurately measure fine motor/manual dexterity [23,24] apply the SMART-D BTS Ttaly/measure in 3D, which assesses the child sitting at a table making copies of three drawings with the dominant hand, presented via an integrated video system; [20] apply the Box and Blocks, whose goal aims to transport, during one minute, small wooden cubes, inside a box from one edge to the other; [25] apply MABC-2; an instrument which aims to investigate the child's motor difficulty level and Bayley; a standardised scale assessing motor and mental abilities of children, composed by three sub-scales, detecting developmental delays, including fine and broad motor subscale.

The remaining 5 articles [26-29] present instruments aiming to evaluate intelligence, balance, language, bio psychosocial and visual perception; but all of them include some fine motor assessment skills in their study, as BOT-2, a Motor Proficiency Test used by Berg et al. [22], aiming to measure fine motor skills of children and adolescents.

From all selected articles, only two applied MABC-2 and BOT-2 scales, considered as gold standard for fine motor evaluation/manual dexterity. The other articles applied scales emphasizing assessment of cognition, balance and language, but all of them presented some tests related to fine motricity/manual dexterity, secondarily in their assessments.

The table below presents the main results of the study and conclusions. Many of these results comprise people with Down syndrome.

Important results of the eight selected articles were observed (Table 3). These data show that children and adolescents with Down syndrome do not show significant motor delays facing the typical population, as well as the influence of treatment with growth hormone or T4 can influence on the acquisition of motor skills of children and adolescents with Down syndrome. On the other hand, few results have been observed directly related to manual dexterity skills of these children and adolescents. For instance, the study of Roncadin et al. [26] encompasses manual dexterity in the article as a measurable skill, but in their results and conclusion, data of other skills are presented, such as communication and visual-motor skills. The other articles also follow this pattern of results and conclusions, that is, they cite the manual dexterity in the article, but not to present important results for the study. As observed in Table 2, the instruments proposed by the authors are not suitable for measuring such skill, which impairs the results of the articles. Only three articles intended to evaluate manual dexterity [23-25] with appropriate tools, and the results are relevant to their objectives and methodology.

Discussion

The results in Table 1 highlight limitations in reference to quotations from studies on manual dexterity of children with Down syndrome, especially in motor rehabilitation area.

In addition, findings show that publications on the theme still present secondarily the evaluation of manual dexterity in children with Down syndrome, as other clinical aspects of the development and/or child health are considered as primary topics, among the studies. This fact justifies the publication in journals comprising other scopes and higher impact factors.

In general, only two intervention studies did not aim to create a specific protocol for gains on manual dexterity of children with Down syndrome. This fact shows what is often observed in the clinical area, as the motor rehabilitation aimed for manual dexterity does not have sufficient relevance visibility when aiming motor gains in children with developmental delays, as in case of Down syndrome.

In this regard, the literature presents significant limitations in fine motor/manual dexterity of these children, which would justify immediate interventions directed to such limitations [4,29]

An alternative for achieving greater relevance in manual dexterity consists on the evaluation of the same, firstly featuring its profile, as an important guidance for future interventions. This is demonstrated in most studies reviewed here, as six of the eight articles refer to this subject. From these 6 articles, 2 [20,24] aimed to characterize the manual dexterity evaluation, to identify motor alterations which might interfere on daily life activities and school tasks of children with Down syndrome, aiming interventions in motor rehabilitation area.

Other studies comprising characterization/evaluation of manual dexterity focused on establishing this variable relationship with clinical conditions, such as treatment with growth hormone [26] and treatment with Thyroxine [20]. Also with pathologies treatments for these children, as in case of acute leukemia [23] and congenital cardiac abnormalities [24]

Such studies, specific for clinical health conditions of children with Down syndrome, demonstrate that manual dexterity evaluation and fine motor skills also constitute parameters to assess these children health status. Those studies also enable the evolution follow-up of many treatments for common diseases associated with genetic conditions, such as Down syndrome [28].

The selected articles of this review describe manual dexterity as above, however the assessments applied for the studies were not properly selected, which leads us to question the concept of the term manual dexterity, to the authors of the articles.

Difficulty in dominant hand/fine motor skills are characterised by problems concerning gripping, unstable tracing, impulsive movements, difficulty in performing activities such as fitting parts and writing [30].

Conclusion

It can be concluded that there are few studies on manual dexterity comprising children and adolescents with Down syndrome, mainly

Number-Title	Main results	Conclusions
1- Clumsiness in fine motor tasks: evidence from the quantitative drawing evaluation of children with Down syndrome[20]	The kinematic parameters of the upper limb movement did not show statistically significant difference between the groups; Circle drawing: the drawing duration was shorter for DS, maximum speed was higher for DS, precision of drawing similar in both groups; Drawing of the Cross: the drawing duration was shorter for DS, the horizontal line of the DS drawing was smaller; the vertical line had similar sizes for both groups; top speed was higher for DS; greater inaccuracy of the DS drawing and the center of intersection lines are more decentralised for DS; Drawing of the square: vertical sides are a little higher on drawings for DS, and SD is more likely to draw rectangles than squares. The distance between table- head was shorter for SD regarding circle and cross drawings, compared to the distance of the square drawing;	The kinematic parameters of the upper limb did not present significant differences; the accuracy of the drawings was lower, and higher speed for DS. This indicates that cognitive aspects interfere on drawing task performance. Children with DS have more evident psycho-motor retardation than the biomechanical aspects related to difficulty of representing, programing and activating correct motor sequences, manifesting motor clumsiness and lower levels of accuracy in drawings.
2- Late effects of early growth hormone treatment for Down syndrome[21]	Weight and height of the groups did not differ; larger head circumference in the treated group; differences were found in body measurements of height and scale; there was no statistically significant difference in IQ; however the WISC-III and LEITER, the group treated with GH had higher results in their subtests. For BOT-2 all the evaluated obtained low performance, with the agility and strength susbtest, the treated group showed better performance than the control group	Even with little motor change, GH treatment is important on a population which already presents motor delay. Greater head circumference and higher results in cognitive subtests demonstrate the importance of early treatment with GH.
3- Força de preensão e destreza manual na criança com síndrome de Down[22]	There was a linear relationship between dominant hand gripping strength and manual dexterity of the dominant hand for control children, and this relationship was not found in DS children; the average gripping strength was different for ages 7,8, and 9, particularly between 7 and 9 for control children; for manual dexterity there was no difference between the ages of control children; the dominant average manual dexterity of control children is higher than the average manual dexterity of children with DS; average gripping strength and manual dexterity in DS showed no difference between ages; there was no difference between strength and manual dexterity for both groups, concerning gender.	Regarding the investigated age range, the strength and dexterity performance evaluation did not differ for boys and girls. It was also observed correlation between manual strength and dexterity and evolution was observed as age increased.
4- The effect of early thyroxine treatment on development and growth at the age of 10.7 years: follow-up of a randomised placebo- controlled trial in children with Down syndrome[23]	Hypothyroidism was present in both groups; the group treated with T4 showed mental age higher than the placebo group; better fine motor skills was observed in group T4; head circumference and increased stature in T4; between the T4 and placebo group, the children with higher / equal to 5 mIU / L of TSH showed better results for motor, mental development, communication and coordination of motor skills.	Treatment up to two years old with T4 does not seem to influence the motor and mental development of children with DS; checked in the period of puberty, treatment with T4 appears to result into better growth development, especially in children with high concentrations of TSH in the plasma during the neonatal period.
5- Motor control outcomes following nintendo wii, used by a child with Down syndrome[24]	The child played Wii for 68 minutes, during a week, with 4 different types of games. The child showed improvements in manual dexterity, coordination of the upper limbs, balance and running speed and agility in scores for BOT-2 scales. Strength and bilateral coordination did not show any improvement, and there was improvement in postural control.	The repeated practice of Wii, bowling, baseball, boxing and snowboarding by the child Showed some improvement in coordination of the upper limbs, manual dexterity, balance and postural control.
6-Neuropsychological late effects of treatment for acute leukemia in children with Down syndrome[25]	The groups differed in verbal intelligence and the control group had a higher score; there were no differences between groups for reading ability; DS ALL group had lower score in speech; DS ALL group had difficulties in completing the subscales of academic participation; both DS groups had low scores for receptive vocabulary; DS ALL group had very low scores compared to the control for expressive vocabulary; DS A LL had low score for visual motor skill and low adaptive behaviour.	It was demonstrated that the study of neuropsychological late effects of treatment of leucemia in children with developmental disabilities is feasible. However, despite the care for subjects selection and assessments carried out, participants with ALL are less likely to complete measurements of visual motor and academic skills. Development of new and appropriate neuropsychological assessment tools for children with developmental disabilities is important for future researches.
7- Avaliação e intervenção no desenvolvimento motor de uma criança com síndrome de Down[26]	The chronological age of the child was increased by 4 months post intervention; the negative age was altered from 46 to 42; the general motor age had an increase of 8 months; the general motor quotient pre and post-test, rated as much lower in temporal organisation / language (IM6) and fine motor skills (IM1) showed greater impairment; in the areas of global motricity (IM2), balance (IM3) and spatial organisation (IM5) there have been major improvements after the interventions. In body schema (IM 4) there were no changes, as well as for fine motor skills. Laterality, which does not appear in the chart, was defined as complete right- handed, on both moments.	The areas which presented greatest difficulties, were fine motor skills and language; the psychomotor interventions realised in this period altered positively the child's development line, mainly in global motricity, balance and spatial organisation.
8- Effect of congenital heart malformations upon language development in toddlers with Down syndrome[27]	Parents reported significantly shorter vocabulary on the CDI for children with DS+CHD; expressive(P=0.12) and receptive language (P=0.19), scores were relatively lower for the DS+CHD group compared with DS-CHD; visual (P=0.88) and fine motor (P=0.84) scores were not affected; children with CHD spent less time in symbol-infused joint engagement: a situation in which they use language as well as focus on shared objects. Total joint engagement and nonlanguage dependant forms of joint engagement did not differ.	Our findings are relevant with regard to the delineation and interventional implications of distinct language outcomes in children with DS+CHD. Important is the impact of CHD on the infusion of symbols during joint engagement episodes comprising parent–child interactions. Findings concerning the total amount of joint engagement and the amount of the coordinated or supported forms of joint engagement were not associated with CHD, suggesting that the preverbal attentional support for communication is not as vulnerable in DS, as the expansion of this attentional structure which occurs as language is acquired.

Table 3: Characterisation of the items according to their results and conclusion.

studies concerning intervention/treatment, indicating that studies aiming these objectives are necessary for this population.

When reading the articles, the employment of inadequate instruments to assess manual dexterity was observed, considering that the evaluation of manual dexterity is not the research focus, but other skills of these children and adolescents, such as: cognition, vocabulary, writing, growth rate, among others. However the use of specific instruments is needed to measure this skill.

In face of the exposed, it is questioned if the term/concept "manual dexterity" is being properly applied among the authors/researchers of the selected items, or if there is still some doubt in relation to the employment of this nomenclature.

It can be concluded that children with Down syndrome present motor impairments pertinent for continued studies on this population, mainly studies based on appropriate motor interventions for these children, as well as the construction of standardized scales for population with Down syndrome.

Concluding remarks and future perspectives

Using the keywords: "Dexterity manual, fine motor skills, fine hand skills, fine motor coordination, Down syndrome, evaluation" we found low number of publications on the subject of this review, may have been used the words in a wide way, we suggest that studies with more specific keywords in relation to "evaluation" will be used, such as Purdue Pegboard, Minnesota (CMDT) manual dexterity test, Box and Blocks test, as well as other specific tests to measure followed manual ability of other keywords thus allowing search more directed towards the evaluation of this ability in population with Down syndrome.

However, we saw the importance of further studies with this population to broaden the knowledge on this topic and to strengthen the proper treatment of children and adolescents with Down syndrome. This study makes a positive contribution to the literature, presenting relevant blank for future scientific research.

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Conflict of Interest

The authors declare no conflict of interest.

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