PHYSICAL FITNESS FOR DISABLED CHILDREN: A LITERATURE REVIEW

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INTRODUCTION:

Physical fitness is a crucial indicator of health in children and adolescents and can determine the health status in the later phases of an individual's life.Physical fitness has a multidimensional structure and can be assessed through its various health related components:body composition, cardio respiratory fitness, musculoskeletal fitness, motor fitness and flexibility. [1] Physical activity is defined as 'any bodily movement produced by skeletal muscles that results in energy expenditure' , while sedentary behaviour refers to any waking behaviour characterised by reduced physical movement and low energy expenditure in a sitting posture [2].

Children with cerebral palsy have more sedentary time and participate less in habitual physical activities than those without disabilities. Staying physically active with light physical activity is a beneficial way in the improvement of health for children with CP, especially for those with severe motor impairments where physical activity with moderate to vigorous intensity is considered a huge challenge.[3]

It is a challenge for children to meet the global recommendations of 60 minutes of moderate to vigorous physical activity per day for those with cerebral palsy (CP). Approximately 2-2.5/1000 children have CP where muscle tone, movement and motor skills are affected which is later on followed by intellectual, communication, and behavioural difficulties, epilepsy and pain.(4,5)

Children with intellectual disabilities (ID) exhibit many impairments in different domains of functioning such as- cognitive, social and adaptive behaviour.Lower levels of physical fitness is also reported at all stages of life.(Pitetti and Boneh, 1995, Skowroński et al., 2009, Van De Vliet et al., 2006). [6]

Since poor fitness seems to be the threatening factor for the increasing disabilities associated with children with IDD, aerobic physical exercise is found to improve fitness through specific motor performance ,that may have a positive health impact(7,8). Furthermore, physical fitness is necessary to perform daily ongoing activities of life and lower levels of strength and endurance will limit independence in adulthood .[9]

Children with Down Syndrome have delays in cognitive, speech, and communication as well as repeated and static patterns of physical inactivity that, over a long period of time, result in decreased health-related quality of life.Several barriers preventing them from participating in physical activities have been identified: the effect of common DS characteristics on maintaining an active lifestyle; competing family responsibilities; decreased physical and/or behavioural skills; lack of appropriate programmes serving children with DS . DS characteristics limit children's physical activity: foot posture, foot deformity, and poor footwear fit.[10]

Physical activities has been found to contribute in the improvement of autistic children. With bouts of physical activity, children with autism experienced decreases in negative behavior such as stereotypies and increased positive behaviors, such as time on task . More vigorous bouts of physical activity have further showed positive behavior change in comparison tolight or m oderate physical activity.(11,12,13)

For persons with Duchenne Muscular Dystrophy, there is uncertainity in the consideration of type, level and intensity of exercise found to be most beneficial.Regular submaximal exercise may help in the maintenance of muscoskeletal heath and prevention of complications like secondary disuse atrophy .Intensive eccentric muscle exercise as well as high-resistance exercises, may increase muscle damage and should be avoided . Lack of dystrophin may lead to contraction-induced injuries, impaired muscle tissue repair and the replacement of muscle fibres by fat and connective tissue.[14]

According to numerous literature,it was found that a single session of exercise can lead to drastic improvements in symptoms and cognitive functions related to Attention Deficit Hyperactivity Disorder.Studies emphasised on the effects of aerobic exercise such as cycling or running with moderate intensities and minimum durations of 20 min on executive and attentional functions.[15]

Exercise can have positive effects on self-esteem and self-confidence in children and youth whose development is typical. Children with disabilities tend to be weaker and more susceptible to early fatigue than their peers. [16] Therefore,physical activies should be implied on a larger basis at home environment,community settings,schools so as it will have a beneficial impact on children with disabilities

REVIEW OF LITERATURE

• Chrystiane VA Toscano et al.conducted a study on "Exercise improves the social and behavioral skills of children and adolescent with autism

spectrum disorders" The main aim was to examine the effects of physical activity on the primary clinical symptoms and associated comorbidities in children and adolescents with ASD. 229 children with ASD, ranging in age from 2.3-17.3 years (M = 7.8, SD = 3.2), into three groups: (a) exercise- intervention group, (b) control group from the same institution, and (c) control group from another institution were recruited.The exercise program was performed at moderate intensity in a 30 min section twice a week for 48 weeks. results showed that a 48-week exercise-intervention substantially decreased ASD social interaction problems, attention deficit, emotional reactivity, stereotypical verbal and motor behavior, and sleep disturbances. [17]

• Olaf Verschuren, BSc, PT et al. conducted a study on "Exercise Training Program in Children and Adolescents With Cerebral Palsy Objective" in the year 2007 to evaluate the effects of an 8-month training program with standardized exercises on aerobic and anaerobic capacity in children and adolescents with cerebral palsy. Pragmatic randomized controlled clinical trial with blinded outcome evaluation between July 2005 and October 2006. Participants were recruited from 4 schools for special education in the Netherlands. A total of 86 children with cerebral palsy (aged 7-18 years) classified at Gross Motor Function Classification System level I or II. Participants were randomly assigned to either the training group (n = 32) or the control group (n = 33). The training group met twice per week for 45 minutes to circuit train in a group format that focused on aerobic and anaerobic exercises.Main Outcome Measures **o**f Aerobic capacity was assessed by the 10-m shuttle run test, and anaerobic capacity was assessed by the Muscle Power Sprint Test. Secondary outcome measures included agility, muscle strength, self-competence, gross motor function, participation level, and health-related quality of life.The results concluded a significant training effect was found for aerobic ($P < .001$) and anaerobic capacity ($P = .004$). A significant effect was also found for agility ($P < .001$), muscle strength ($P < .001$), and athletic competence ($P = .005$). An exercise training program improves physical fitness, participation level, and quality of life in children with cerebral palsy .[18]

• Che-Wei-Hsu in 2019 conducted a study on "Effects of Therapeutic Exercise Intensity on Cerebral Palsy Outcomes:A systematic Review with Meta-Regression of Randomized Clinical Trials" to assess the effects of intensive exercise-based therapy on improvement in gross motor function in children with CP. Three databases were searched for randomized clinical trials evaluating the effects of therapeutic exercise training by using Gross Motor Function Measurement (GMFM) 66 and 88 among children with CP. Studies that used interventions in addition to therapeutic exercise were excluded from the present meta-analysis. Exercise intensity was defined using the number of training hours per day and duration of intervention (in weeks). The effects of the number of daily training hours and program duration on GMFM improvement were evaluated using meta-regression.The study concluded that intensive physical exercise improved CP outcomes in the intervention and standard therapy groups. The duration of therapeutic intervention improved CP outcomes among the children who received the therapeutic intervention, while an increase in the number of daily training hours improved in CP outcomes in the children who received standard therapy.[19]

• Hsiu-Ching Lin et al. conducted a study on Strength and agility training in adolescents with Down syndrome: A randomized controlled trial.The purpose of this study was to investigate the effects of a proposed strength and agility training program of adolescents with Down syndrome. Ninety-two adolescents were recruited and evenly randomized to two intervention groups (exercise group vs. control group). The exercise training program consisted of a 5-min treadmill exercise and one 20-min virtual-reality based activity administered three times a week for 6 weeks. Pre- and post-test measures were taken for muscle strength and agility performance. The exercise group had significant improvements in agility ($p = 0.02$, $d = 0.80$) and muscle strength of all muscle group (all p's < 0.05, $d = 0.51–0.89$) assessed in comparison to the control group after the 6-week intervention. Knee muscle groups including both flexors and extensors had the greatest gains among all the muscles measured. A short-term exercise training program used in this study is capable of improving muscle strength and agility performance of adolescents with DS.[20]

• In a study by Chenchen Xu et al the adapted rhythmic gymnastics (ARG) program was designed for children with IDD and is aimed at testing the effects of the exercise program on children's physical fitness. Participants were recruited from two special needs schools in Beijing of China. Twenty-two children with IDD were assigned to an ARG experimental group or a traditional control group. The experimental group

took part in a 16-week ARG program consisting of three 50 min sessions each week. And children's body composition, aerobic capacity, and musculoskeletal functioning were measured by the Brockport Physical Fitness Test (BPFT) before and after the program. The study concluded between-group analysis revealed great improvements for the experimental group in abdominal strength (curl-up test: p = 0:025 < 0:05) and upper limb strength (dumbbell press test: p = 0:038 < 0:05). Compared to the pretest, most of the physical fitness parameters improved significantly in the experimental group except BMI, and flexibility of the experimental group children showed a substantial increase. Conclusions: Most of the physical fitness parameters of children with IDD in the experimental group improved significantly, especially on abdominal strength and upper limb muscle strength when comparing to the control group.[21]

- Chien Yu Pan et al. In 2014 conducted a study on "Effects of Physical Activity Intervention on Motor Proficiency and Physical Fitness in Children With ADHD: An Exploratory Study. "The objective of this study explored how a 12-week simulated developmental horse-riding program (SDHRP) combined with fitness training influenced the motor proficiency and physical fitness of children with ADHD. Twelve children with ADHD received the intervention, whereas 12 children with ADHD and 24 typically developing (TD) children did not. The fitness levels and motor skills of the participants were assessed using standardized tests before and after the 12-week training program. Results showed significant improvements in the motor proficiency, cardiovascular fitness, and flexibility of the ADHD training group following the intervention.The study Concluded that children with ADHD exhibit low levels of motor proficiency and cardiovascular fitness; thus, using the combined 12-week SDHRP and fitness training positively affected children with ADHD. [22]

- Donovan J. Lott et al.2020 conducted a study on "Safety, feasibility, and efficacy of strengthening exercise in Duchenne muscular dystrophy" to explore the safety, feasibility, and efficacy of a mild–moderate resistance isometric leg exercise program in ambulatory boys with Duchenne muscular dystrophy (DMD).A dose escalation paradigm with varying intensity and frequency of leg isometric exercise to determine the dose response and safety in 10 boys was done. Secondly, safety and feasibility of a 12-wk in-home, remotely supervised, mild–moderate intensity strengthening program in eight boys was examined. Safety measures included T_2 MRI, creatine kinase levels, and pain. Peak strength and function (time to ascend/descend four stairs) were also measured.Results showed that Dose-escalation revealed no signs of muscle damage. Seven of the eight boys completed the 12-wk in-home program with a compliance of 84.9%, no signs of muscle damage, and improvements in strength (knee extensors $P < .01$; knee flexors $P < .05$) and function (descending steps $P < .05$).The study concluded that an in-home, mild–moderate intensity leg exercise program is safe with potential to positively impact both strength and function in ambulatory boys with DMD.[23]

- In a study conducted by Nathalie Topin et al. "Dose-dependent effect of individualized respiratory muscle training in children with Duchenne muscular dystrophy" in 2002, the aim of this study was to evaluate the effects of low intensity, home inspiratory muscle training on respiratory muscle endurance in children with Duchenne muscular dystrophy, using a double-blind protocol. Eight trained children (mean age 14.7+/-4.5 years) and eight control children (mean age, 12.6+/-1.8 years) were studied. For 6 weeks, children breathed twice a day for 10 min through a valve with either 30% (training group) or less than 5% (control group) of their maximum inspiratory pressure (P(imax)). The results showed (1) a 46% improvement in the time limit after training in the training group and no change in the control group and (2) a significant correlation between the total time of respiratory muscle training and the percentage of endurance improvement in the training group. It was concluded that specific training improves respiratory muscle endurance in Duchenne muscular dystrophy and the effectiveness of training appears to be dependent on the quantity of training.[24]

- Andreea Maria Rosca et al.2022 conducted a study on "Physical Activity Design for Balance Rehabilitation in Children with Autism Spectrum Disorder" to analyze postural stability evolution after physical therapy exercises based on balance training. The study included 28 children with ASD (average age 8 years, average weight 32.18 kg). The rehabilitation program involved performing balance exercises twice a week for three months. Subject assessment was carried out using the RSScan platform. The parameters were the surface of the confidence ellipse (A) and the length of the

curve (L) described by the pressure center, which were evaluated before and after the rehabilitation program. Following data processing, a significant decrease in the surface of the confidence ellipse by 92% was observed from EV1 to EV2. Additionally, a decrease of 42% in the curve length was observed from EV1 to EV2. A t test applied to the ellipse surface showed a $p = 0.021$ and a Cohen's coefficient of 0.8 (very large effect size). A t test applied to the length L showed $p = 0.029$ and Cohen's coefficient of 1.27 mm. Thus, the results show a significant improvement in the two parameters. The application of the program based on physical exercise led to an improvement in the balance of children with autism under complex evaluation conditions.[25]

• In a study conducted by Ke Long Cai et al.in 2020 entitled "Mini-Basketball Training Program Improves Physical Fitness and Social Communication in Preschool Children with Autism Spectrum Disorders"to examine the effects of a 12-week mini-basketball training program (MBTP) on physical fitness and social communication in preschool children with autism spectrum disorders (ASD). The study applied a quasi-experimental design. Fifty-nine preschool children aged 3-6 years with ASD were assigned to either a MBTP group (n = 30) or a control group (n = 29). Participants in the MBTP group received a scheduled mini-basketball training program (5 sessions per week, forty minutes per session) for twelve consecutive weeks, while the control group was instructed to maintain their daily activities. The physical fitness test and the parent-reported Social Responsiveness Scale Second Edition (SRS-2) test were performed before and after the intervention. Results indicated that the 12-week MBTP facilitated performance in the physical fitness test, particularly in speed-agility and muscular strength abilities. Additionally, children in the MBTP group demonstrated improvement in SRS-2 performance in social awareness, social cognition, social communication, and autistic mannerisms, whereas no such changes were found in the control group. It was concluded that the 12-week MBTP could improve physical fitness and social communication in preschool children with ASD, and thus the use of physical exercise intervention as a therapeutic tool for preschoolers with ASD is recommended.[26]

• ILKER YILMAZ et al.conducted a study in 2004 determine the effects of water exercises and swimming on motor performance and physical fitness, and to observe the behavior of an autistic subject as he becomes familiar with the pool, and to observe the development of beginner swimming skills in children with autism. The subject was 9-years-old.The physical tests used were six minute walkingtest, balance,thrust test,grip strength, muscle strength and running test.For flexibility, sit and reach test, body lateral flexion test (right-left) and body hyperextension tests were used.Results showed that after the 10 weeks swimming training; the balance, speed, agility and power scores increased. Also, the hand grip, upper and lower extremity muscle strength, flexibility and cardiorespiratuar endurance increased. y, the amount of stereotypical autistic movements (spinning, swinging and delayed echolalia) decreased after hydrotherapy.[27]

• Brunton et al.,conducted a study in 2010 to describe the types of exercise participation of adolescents with cerebral palsy;(2)the weekly duration of stretching, strengthening, and cardiovascular exercise; (3) how the level of activity compares with national health guidelines; and (4) the change in participation over 4 years. Participants included 126 males and 104 females who reported physical activities in the previous week.A significant main effect of GMFCS level was detected forlight and moderate exercise. A significant interaction of GMFCS level and sex was found for stretching; females stretched more. An average of 9.4% and 11.4% of our sample participated in weekly levels of moderate and vigorous exercise, respectively.[28]

Karen J Dodd et al.conducted a study in 2003 to evaluate the effects of a home-based, six-week strength-training programme on lower limb strength and physical activity of 21 young people (11 females, 10 males; mean age 13 years 1 month, SD 3 years 1 month; range 8 to 18 years) with spastic diplegic cerebral palsy (CP) with independent ambulation, with or without gait aids; (Gross Motor Function Classification System levels I to III). The study design was a randomized clinical trial. Results showed that a relatively short clinically feasible home-based training programme can lead to lasting changes in the strength of key lower-limb muscles that may impact on the daily function of young people with CP.[29]

A.C.J. Balemans et al.2015 conducted a study to investigate the associations among changes in physical fitness, walking-related physical activity levels, and fatigue in children with CP. This

study was a secondary analysis of a randomized controlled trial. Twenty-four children with bilateral spastic CP and 22 with unilateral spastic CP, aged 7 to 13 years, all walking, participated in this study. In children with bilateral CP, all fitness parameters showed a positive, significant association with walking- related PAL, whereas no associations between physical fitness and walking-related PAL were seen in children with unilateral CP.[30]

A. Matute-Llorente conducted a study in 2013 to determine if adolescents with and without Down syndrome (DS) accomplish the physical activity (PA) guidelines and to evaluate relationships between PA and cardiorespiratory variables. 42 adolescents (27 with DS) participated in this study. PA was measured using accelerometers. Walking-graded treadmill protocol with a breath-bybreath gas analyzer was employed to assess cardiorespiratory fitness.The study concluded that adolescents with DS spent less time in edentary PA, moderate PA (MPA), vigorous PA (VPA) and moderate to vigorous PA (MVPA) than those without DS. Engaging more time in MPA was associated with greater cardiorespiratory fitness in adolescents with Down syndrome.[31]

Julia Vry et al.conducted a study in 2014 To evaluate safety of whole-body vibration training in ambulatory children with Duchenne muscular dystrophy (DMD) and spinal muscular atrophy (SMA). 14 children with DMD and 8 with SMA underwent an 8- week vibration training programme on a Galileo MedM® at home (3 × 3 min twice a day, 5 days a week).Results showed that all children showed good clinical tolerance. In boys with DMD, creatine kinase increased by 56% after the first day of training and returned to baseline after 8 weeks of continuous whole-body vibration training.[32]

Daphna Vilozni et al conducted a study on " Computerized respiratory muscle training in children with Duchenne muscular dystrophy"where 5-week regimen of respiratory muscle training in 15 patients with Duchenne muscular dystrophy (DMD) at various stages of the disease.The result concluded that computerized respiratory games may be applied for breathing exercises and may improve respiratory performance in recently immobilized children with DMD who have moderate impairment of LFT.[33]

Jose Pedro Ferreira et al.did a study in 2018 to determine the effects of a Physical Exercise Program (PEP-Aut) on Autistic Children's Stereotyped Behavior, Metabolic and Physical Activity Profiles, Physical Fitness, and Health-Related Quality of Life.The study was conducted in two phases-Phase 1: a cross-sectional study, consisting of 12 weeks, with the assessment of 145 ASD children. Phase 2: an intervention with exercise that take place over 48 weeks, including 40 weeks of PE (PEP-Aut) and 8 weeks of assessment .The study concluded that it will provide critical information on the efficacy of exercise for children with ASD and help guide design and delivery of future programs.[34]

"Effects of a trampoline exercise intervention on motor performance and balance ability of children with intellectual disabilities",a study conducted by Paraskevi Giagazoglou et al aimed to assess the effect of a 12-week trampoline exercise intervention program on motor and balance ability of school aged children with intellectual disability.The study concluded that trampoline intervention resulted insignificant improvements of participants' performance in all motor and balance tests.[35]

Matthew B. Pontifex et al.2013 conducted a study to examine the effect of a single bout of moderate-intensity aerobic exercise on preadolescent children with attention-deficit/hyperactivity disorder. The ADHD group comprised 20 children (6 females) aged 8-10 years. The findings indicate that single bouts of moderately intense aerobic exercise may have positive results for neurocognitive function and inhibitory control in children with ADHD.[36]

SL No	Author	Disability	Intervention	Conclusion
1	Chrystiane VA Toscano et al(2022)	Autism	48-week physical exercise-intervention program	Decreased ASD social interaction problems, attention deficit, emotional reactivity, stereotypical verbal and motor behavior, and sleep disturbances.
2	Olaf Verschuren et al.2007	Cerebral palsy	8-month training program with standardized exercises on aerobic and anaerobic	Exercise training program improves physical fitness, participation level, and quality of life in children with cerebral

			capacity	palsy
3	Che-Wei-Hsu et al.2019	Cerebral palsy	Therapeutic exercise training by using Gross Motor Function Measurement (GMFM)	intensive physical exercise improved CP outcomes in the intervention and standard therapy groups.
4	Hsiu-Ching Lin et al.2012	Downs syndrome	Exercise training program consisted of a 5-min treadmill exercise and one 20-min virtual-reality based activity administered three times a week for 6 weeks.	Exercise training program used in this study is capable of improving muscle strength and agility performance of adolescents with DS.
5	Chenchen Xu et al.2020	Intellectual Developmental Disability	16-week ARG program consisting of three 50 min sessions each week.	physical fitness parameters of children with IDD in the experimental group improved significantly, especially on abdominal strength and upper limb muscle strength
6	Chien Yu Pan et al. 2014	Attention Deficit Hyperactivity Disorder	12-week simulated developmental horse-riding program (SDHRP) combined with fitness training	the combined 12-week SDHRP and fitness training positively affected children with ADHD**.**
7	Donovan J. Lott et al.2020	Duchenne Muscular Dystrophy	A dose escalation paradigm with varying intensity and frequency of leg isometric exercise	In-home, mild–moderate intensity leg exercise program positively impact both strength and function in ambulatory boys with DMD.
8	Nathalie Topin et al.2002	Duchenne Muscular Dystrophy	low intensity, home inspiratory muscle training on respiratory muscle endurance	training improves respiratory muscle endurance in Duchenne muscular dystrophy .
9	Andreea Maria Rosca et al.2022	Autism Spectrum Disorder	The rehabilitation program involved performing balance exercises twice a week for three months.	The application of the program based on physical exercise led to an improvement in the balance of children with autism under complex evaluation conditions.
10	Ke Long Cai et al. 2020	Autism spectrum disorders	12-week mini-basketball training program (MBTP) on physical fitness and social communication in preschool children with autism spectrum disorders (ASD).	The 12-week MBTP could improve physical fitness and social communication in preschool children with ASD
11.	ILKER YILMAZ et al.2004	Autism	water exercises and swimming	after the 10 weeks swimming training; amount of stereotypical autistic movements (spinning, swinging and delayed echolalia) decreased after hydrotherapy.
12	Brunton et al.2010	Cerebral Palsy	stretching, strengthening,and cardiovascular exercises	A significant main effect of GMFCS level was detected for light and moderate exercise. A significant interaction of GMFCS level and sex was found for stretching; females stretched more
13	Karen J Dodd et al 2003	Cerebral Palsy	home-based, six-week strength-training programme on lower limb strength and physical activity	relatively short clinically feasible home-based training programme can lead to lasting changes in the strength of key lower-limb muscles that may impact on the daily function of young people with CP.
14	A.C.J. Balemans et al 2015	Cerebral Palsy	physical fitness training focusing on gross motor	children with bilateral CP, all fitness parameters showed a

			activities, anaerobic fitness and muscle strength, counseling, and home-based physical therapy	positive, significant association with walking-related physical activity levels
15	A. Matute-Llorente et al.2013	Downs Syndrome	Walking-graded treadmill protocol with a breath-bybreath gas analyzer was employed to assess cardiorespiratory fitness.	Engaging more time in Physical activities was associated with greater cardiorespiratory fitness in adolescents with Down syndrome.
16	Julia Vry et al.2014	Duchenne Muscular Dystrophy	8-week vibration training programme	In boys with DMD, creatine kinase increased by 56% after the first day of training and returned to baseline after 8 weeks of continuous whole-body vibration training.
17.	Daphna Vilozni et al.1994	Duchenne muscular dystrophy	5-week regimen of respiratory muscle training	improved respiratory performance in recently immobilized children with DMD who have moderate impairment of LFT.
18.	Jose Pedro Ferreira et al 2018	Autism	Physical Exercise Program (PEP-Aut)	efficacy of exercise for children with ASD
19.	Paraskevi Giagazoglou et al.2013	Intellectual developmental disability	trampoline exercise intervention	trampoline intervention resulted in significant improvements of participants' performance in all motor and balance tests.
20.	Matthew B. Pontifex et al.2013	Attention Deficit Hyperactivity Disorder	moderate-intensity aerobic exercise	moderately intense aerobic exercise may have positive results for neurocognitive function and inhibitory control in children with ADHD

Conclusion

A limited number of fitness programs are available for children with disabilities. Children with disabilities often are unable to participate in community activities or prefer not to participate because it is difficult for them to keep up with peers who are developing typically.Wellness promotion and prevention of secondary conditions are the roles of a physical therapist because therapists work closely with children with disabilities, knowledge about the safety and feasibility of fitness programs for children with disabilities is important.

Development of modules and programs for physical activity and play applications in schools, special education schools, rehabilitation centers for children who have disabilities, and to put into practice regularly under the guidance of specialist and trainers are expected to contribute positively to children's development. Moreover, it is of utmost importance that the children are directed to exercise by increasing their families' consciousness level together with the exercises for the development of physical fitness of children with specific difficulties.

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