



Efforts To Improve the Motor Development of Children with Down Syndrome: Narrative Review

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ABSTRAK

Background: In children with Down syndrome, the patterns of gross and fine motor development follow the same patterns as in normal children, but developmental milestones are achieved at a later time. There are several reasons why children with Down syndrome experience delayed motor development, including cognitive factors, hypotonia, reduced muscle strength, loose joints and ligaments, and hand structure factors. Objective: To determine effective interventions in improving the development of children with Down syndrome. Research Method: Narrative review. Research Results: A review of 15 articles found that the use of trampolines, virtual reality, treadmill exercises, isokinetics, vibration, surfing, traditional Indian dance, computer-based phonics, vestibular stimulation, improvement of numerical skills, the use of picture card media, traditional games such as jamuran and engklek, and sensory integration with busy books can improve the development of children with Down syndrome. Conclusion: There are effects and benefits from the provision of each intervention in various countries on improving the development of children with Down syndrome.

Keywords: Down syndrome, development, children

1. INTRODUCTION

One of the most common causes of intellectual disability due to genetic abnormalities is Down syndrome (Corona-Rivera et al., 2019). DS is a condition of cell division (non-disjunction) during embryonic development, where the embryo receives an extra chromosome 21, either partially or entirely. The three main cytogenetic mechanisms that can cause DS are complete trisomy 21, mosaic trisomy 21, and translocation trisomy 21 (Olagunju & Masud, 2021). In most cases, 95% of DS is caused by complete trisomy 21, where all cells of the affected individual have an extra chromosome 21 (Olagunju & Masud, 2021).

The prevalence of SD worldwide according to the Centers for Disease Control and Prevention (CDC) is approximately 6,000 babies born with SD each year, or about 1 in every 700 babies born (CDC, 2023). In Indonesia, the Ministry of Health reports that the number of children born with SD is increasing. Based on the results of a basic health survey in 2010, the number of SD cases in children aged 24-59 months was 0.12% (Kemenkes RI, 2010), Three years later, in 2013, the number rose to 0.13% (Kemenkes RI, 2013), , and in 2018, there was a reported increase in cases to 0.21% (Kemenkes RI, 2018). Thus, there has also been an increase in the number of children with developmental disorders, as developmental disorders are a

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characteristic of children with SD (Irwanto, 2019).

The population with SD exhibits abnormal muscle coordination, difficulty processing sensory information, and functional limitations. Upper extremity dysfunction in this population (muscle weakness and hypotonia, slow reflexes, abnormal biomechanics, sensory deficits) has a negative impact on daily activity performance, independence, and quality of life (Lopes et al., 2017).

In children with SD, the patterns of gross and fine motor development follow the same patterns as in typically developing children, but developmental milestones are achieved at a later age. There are several reasons why children with SD experience delayed motor development, including cognitive factors, hypotonia, reduced muscle strength, loose joints and ligaments, and hand structure factors (Irwanto, 2019).

Children with SD have more impaired fine motor skills than gross motor skills, with problems in accuracy and time to complete tasks that require bilateral coordination. Impaired fine motor skills can cripple SD children, especially in cognitive development. These functional skills are necessary for writing and capturing information from letters (Irwanto, 2019).

Therefore, monitoring the motor development of elementary school children is very important to be done as early as possible so that appropriate care and stimulation can be provided. This narrative review was compiled to find effective interventions related to the development of elementary school children in various countries.

2. RESEARCH METHOD

The method used was a narrative review. To find relevant articles, the author used two databases, PubMed and Google Scholar, with the keywords Down Syndrome, Development, Children.

Tabel 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
1. Full-text articles	1. Articles in the form of publication manuscripts
2. Articles in English and Indonesian	2. Articles with English titles but written in other languages such as Spanish and others
3. Articles with respondents who are children with Down syndrome	
4. Articles discussing the development of children with Down syndrome	
5. Articles published in the last 10 years (2014–2024)	

3. RESULTS AND DISCUSSION

The results of a review of 15 articles show that Down syndrome (DS) is a genetic (congenital) abnormality on chromosome 21 that can affect intelligence, certain physical characteristics, and other health conditions. In general, the characteristics of children with DS are similar to those of the Mongolian race. This syndrome was first described in 1866 by British physician John Langdown Down, who conducted research on a group of individuals living at Earlswood Asylum for Idiots in Surrey, England (dr. Ellyana Sungkar, 2023)

Children with SD experience delays in growth and functional abilities compared to their peers. Therefore, developmental milestones for children with SD have their own limitations. The developmental problems experienced by children with SD, such as communication disorders, mobility disorders, and difficulties with daily activities such as bathing, eating, and others, can have an impact on their participation in society, from school to work. Therefore, early and appropriate treatment is necessary so that they can live their lives independently (dr. Ellyana Sungkar, 2023).

Enhancing the development of children with SD can be achieved through stimulation. A

study in Saudi Arabia investigated the effects of a 3-month trampoline-based Stretch-Shortening Cycle (SSC) exercise program on muscle strength and postural control in children with SD. Thirty-two children with SD aged 7–9 years of both genders were included in the study. The results of the study showed increased strength in the hip extensors ($p=0.034$) and adductors ($p=0.015$), knee extensor ($p=0.028$) and flexor ($p=0.01$), as well as dorsiflexor ($p=0.033$) and plantar flexor ($p=0.007$) muscles significantly increased in the SSC group compared to the control group (Azab et al., 2022).

Additionally, isokinetic training was also studied in Saudi Arabia to determine the effect of isokinetic training on muscle strength and postural balance in elementary school children. This study involved 31 elementary school children aged 9 to 12 years who were randomly divided into two groups. The results showed that each group demonstrated a significant improvement in postural balance and peak torque of the knee flexors and extensors ($P < 0.05$) (Mohamed A. Eid, Aly, Huneif, & Ismail, 2017).

In Egypt, the authors identified three interventions related to motor development in elementary school children: mechanical vestibular stimulation, core stability training versus treadmill training, and vibration training. All three showed significant improvements in balance, stability index, and muscle strength after training. However, core stability training and treadmill training must be applied in conjunction with a physical therapy program for better results (Alsakhawi & Elshafey, 2019; Mohamed Ahmed Eid, 2015; Nahla, El-Sayed, Ragaa, & El Ghafar, 2022).

Furthermore, in Chile, the intervention was based on exercises using the Nintendo Wii along with the Wii Balance Board to determine its effect on motor development and postural control in elementary school children. Sixteen children with DS aged 6-12 years were involved in this study. The results showed that children who participated in the five-week virtual reality intervention using the Nintendo Wii and Wii Balance Board significantly improved their postural control with eyes closed ($p < 0.010$) (Gómez Álvarez et al., 2018).

The effectiveness of surfing intervention was also studied in Rhode Island. 71 children with disabilities such as autism spectrum disorder, Down syndrome, global developmental delay, and cerebral palsy. The results showed significant improvements in core strength ($p = 0.00$), upper body strength ($p = 0.00$), flexibility ($p = 0.01$), and cardiorespiratory endurance ($p = 0.00$) in the surfing group. However, there was no significant difference in overall fitness levels between the surfing group and the unstructured pool play group. Body composition measurements in the surfing group showed a significant decrease in total body fat percentage ($p = 0.016$) and fat-free mass ($p = 0.008$) and a significant increase in bone mineral density ($p = 0.004$) before and after surfing therapy (Clapham, Lamont, Shim, Lateef, & Armitano, 2020).

In India, 36 children with SD aged 6-10 years were enrolled to test the effects of traditional Indian dances such as Bharatanatyam, Kuchipudi, and Kathak on motor skills and balance in children with SD compared to neuromuscular training. After six weeks of training, there were significant group differences in changes in the Test of Gross Motor Development-2 (TGMD-2) scores [experimental: 30.47 vs. control: 11.1], the TGMD-2 locomotor subset [experimental: 11.1 vs. control: 4.35] and FSST [experimental: 4.29 vs. control: 2.41], but not on the pediatric balance scale [experimental: 3.59 vs. control: 3.76]. Traditional Indian dance significantly improved the locomotor skills of children with SD compared to neuromuscular training. Both dance and neuromuscular training had an impact on balance capacity (Raghupathy, Divya, & Karthikbabu, 2022).

In 2019, researchers in Australia conducted a definitive randomized trial to evaluate the effectiveness of customized footwear in increasing physical activity among children and adolescents with SD. However, future trials need to ensure that the footwear intervention used fits the participants' feet correctly. This requires special fitting of footwear compared to that used in this study, as the results showed that customized footwear was no better than the

participants' regular footwear (Hassan et al., 2021).

GG (GraphoGame) is a computer-based reading program designed to support phonemic awareness in children with dyslexia and is a learning tool for synthetic phonics instruction. Seventeen elementary school children (aged 5-16 years) were involved in a study in Sweden to explore children's independence and adaptation needs when working with computers. Additionally, the study investigated the potential impact on phonological processing, letter knowledge, word decoding, and reading strategies in children with mild intellectual disabilities and children with moderate to severe intellectual disabilities. The results showed that, at the individual level, some children with mild to severe intellectual disabilities demonstrated improved ability to interpret trained words. After one period of GG, an increase in alphabetically translated words was found. These findings suggest that computer-based phonics may be beneficial for children with SD in their educational environment (Nakeva von Mentzer, Kalnak, & Jennische, 2021).

Subsequently, Italian researchers developed a basic skills training program for elementary school children that included lexical, semantic, and pre-syntactic processes, as well as numeracy skills. One group consisting of 15 children was trained in numeracy skills twice a week for 2 months, for approximately 30 minutes per session. The control group, consisting of 9 children, did not participate in any training sessions. After training, children in the intervention group performed better on numerical tests, while children in the control group did not. These results show that this training program is feasible and effective for elementary school children (Lanfranchi, Aventaggiato, Jerman, & Vianello, 2015).

For Indonesia, regarding elementary school child development interventions, the author found four interventions, namely picture cards, traditional jamuran and engklek games, and sensory integration therapy through busy books. All four have their own advantages for the motor, social, and numeracy development of elementary school children. The jamuran game improves social interaction and motor

skills. Engklek games improve the ability to jump with one and two feet, throw objects, and the ability to tiptoe and run fast. The use of picture cards is useful for increasing the vocabulary of elementary school children. Busy books help elementary school children in counting with the help of objects that pop up and make sounds (Cahyati Ngaisah et al., 2023; Fawaid Birriy, Indahwati, & Nurhasan, 2020; Martati, Candra Dewi Sagala, & Karmila, 2022; Rahayu, Rasmitadila, & Makarim, 2018; Solicha & Suyadi, 2021).

CONCLUSION

Based on the review results, it can be concluded that interventions using trampolines, virtual reality, treadmill exercises, isokinetic exercises, vibration, surfing, traditional Indian dance, computer-based phonics, vestibular stimulation, numerical skill improvement, the use of picture word cards, traditional games such as jamuran and engklek, and sensory integration with busy books can improve the motor development of children with SD. Except for customized footwear intervention, the researchers stated that this study needs to be further investigated to evaluate the efficacy of customized footwear in increasing physical activity in children with SD.

RECOMMENDATIONS

It is hoped that this narrative review on efforts to improve the development of children with Down syndrome will be useful for health practitioners, researchers, and parents and families involved in the care of children with this condition. Health professionals and therapists should always seek interventions supported by strong empirical evidence to support the development of children with Down syndrome. In addition to the interventions already described, the role of family and environment is also very important for the development of children with Down syndrome.

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