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Orthotic Intervention for Children with Down Syndrome: A Review Based on the ICF Model

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INTRODUCTION

Down Syndrome (DS) is the most common genetic disorder in the United States. Children with DS typically experience cognitive and physical delays, and participate in fewer social activities than typically developing peers. Foot and ankle orthoses are commonly prescribed for this population to improve joint alignment and stability, decrease future injury risk, and address gross motor skills such as walking, running, and jumping. The International Classification of Health and Disability (ICF) model is a useful framework through which to investigate the impact of orthoses on three domains of health: body structure and function, activity and participation. While research suggests that orthoses positively affect the body structure and function and activity domains of the ICF, little research directly examines the impact of orthotic intervention on participation in children with DS. Evidence does, however, support the interdependence of the ICF domains, indicating that orthoses that address body structure and function and activity are likely to have a positive impact on participation.

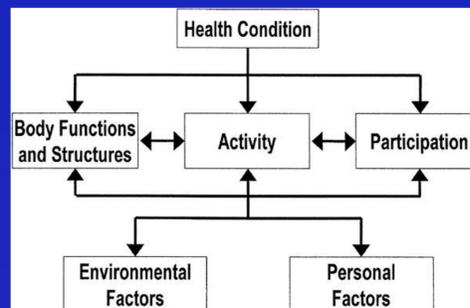


Figure 1.

DOWN SYNDROME AND THE ICF

Body Structure and Function:

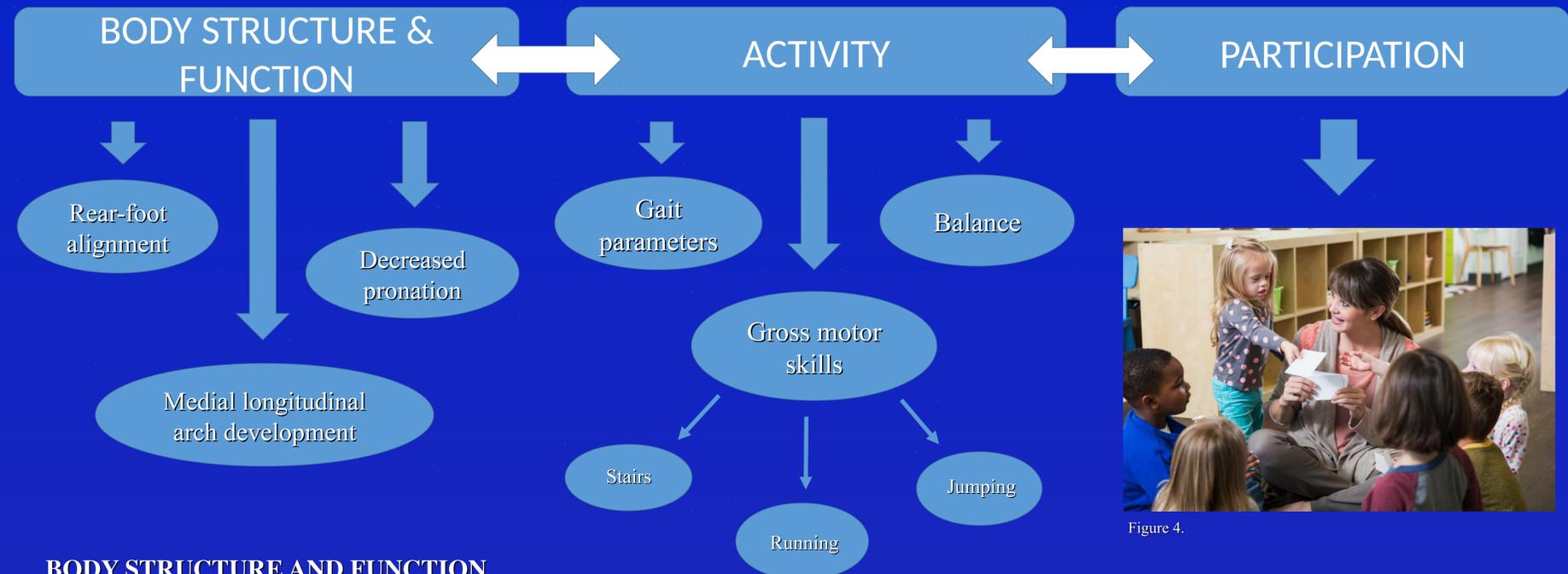
In addition to hypotonia and ligamentous laxity, common body structure and function impairments of the foot and ankle include pes planus, excess calcaneal eversion, increased internal tibial rotation, and bony abnormalities such as hallux valgus. Furthermore, children with DS demonstrate abnormal loading with excessive pronation and increased midfoot weight bearing during stance and gait.

Activity:

Children with Down Syndrome are commonly delayed in their ability to achieve motor milestones. Approximately half of children with DS are unable to run, jump, or navigate stairs by 5 years of age. Children with DS typically exhibit postural instability and gait deviations such as decreased step length, slow gait speed, diminished push-off, and increased double-limb stance time.

Participation:

Children with DS have decreased participation levels in a variety of life situations. They perform fewer family and self-care tasks at home and demonstrate lower levels of school participation. In addition, a third of children with DS have no friends and the majority participate in one or no hobbies or sports.



BODY STRUCTURE AND FUNCTION

For children with hypotonia and ligamentous laxity, orthotic intervention can improve the structural alignment of the rearfoot, elevate the medial longitudinal arch and alter body weight distribution through the foot. While wearing orthoses, children with DS demonstrate improved talar and calcaneal alignment with decreased calcaneal eversion, increased supination in stance and decreased pronation during gait.^{7,10} Orthotic intervention also facilitates more even weight distribution across the forefoot, midfoot, and rearfoot.¹² Furthermore, research indicates that orthotic intervention combined with physical therapy can lead to greater barefoot supination and elevation of the medial longitudinal arch, indicating that orthoses may alter foot structure and function overtime.¹² Orthoses may also play a role in decreasing the risk of future musculoskeletal impairments by decreasing abnormal tissue stress in the foot and at other joints up the kinetic chain. For example, some authors report that orthoses can reduce excess tibial internal rotation, genu valgum and genu recurvatum.³ In this way, orthoses may foster increased functional independence and participation by reducing the likelihood of future injury and disability.



Figure 2.



Figure 3.

ACTIVITY

Research indicates that children with Down Syndrome demonstrate significant improvements in balance and gross motor skills, as measured by the BOTMP balance subtest, GMFM and PDMS, with the use of orthotic intervention.^{3,7} These outcome measures test skills such as single leg stance balance, walking on a balance beam, running, jumping and stairs. Research also indicates that orthotic intervention positively affects gait parameters such as step length, gait velocity and single leg stance phase ratio, as well as gait consistency.^{5,10} Improvement in postural stability, gross motor skills and gait parameters contribute to increased movement efficiency, decreased metabolic demand and the development of complex movement strategies.¹ In addition, the development of motor skills such as walking, running and jumping has been linked to cognitive and social development, indicating that motor ability has an impact on participation.⁴

PARTICIPATION

Research investigating the effect of orthoses on participation for children with DS is lacking. However, evidence does support the interdependence of the ICF domains, suggesting that interventions aimed at body structure and function or activity likely impact participation. Parents and individuals with DS have identified foot impairments and hypotonia as barriers to function and participation.² Similarly, foot deformities and ill-fitting footwear are associated with disability during school and play activities in children with DS.⁶ In addition, motor ability and greater functional independence in children with DS are predictors of social function, self-care, sports participation and friendships.^{8,11} While these relationships are not causal, they suggest that orthoses which positively affect the body structure and function and activity domains are likely to also positively impact the participation domain.

RELEVANCE AND FUTURE RESEARCH

Participation is an essential component of human health and drives both cognitive and physical development.⁴ Understanding the impact of orthoses on the three ICF domains, including participation, will help health-care providers and parents recognize which children with DS will most benefit from orthotic intervention. Further research regarding the most effective type of orthoses, timing of orthotic intervention, specific indications for use, and the long-term impact of orthoses on injury prevention is needed to clarify the role of orthotic intervention for children with DS. Existing studies often exhibit low methodological quality. Therefore, future high quality randomized control trials are needed to substantiate current research, address deficits in the existing body of literature, and directly address the effect of orthotic intervention on participation.