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## **Gross motor delay**

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Gross motor skills encompass a broad array of large muscle movements spanning from rudimentary skills like rolling and sitting to highly specialized skills such as the serve and forehand in tennis. For the purposes of this review, we will focus on a subset of gross motor skills called fundamental motor skill (FMS) that are considered the building blocks to later physical activity and sports performance. FMS include locomotor skills like running and jumping and object control skills such as throwing and catching, along with non-locomotor skills such as balance. The identification of gross motor delay with regard to FMS occurs when a child fails to achieve important developmental milestones, often lagging two years or more behind the typical age-based norm for that skill. The purpose of this chapter is to provide a brief overview of FMS and describe gross motor delay in a variety of populations, concluding with recommendations for practice.

## **Importance of fundament motor skills**

FMS form a critical set of skills that should be developed in the early childhood years. FMS are considered the “base camp” to the mountain of motor development and provide children with a skill repertoire they can apply to a wide variety of sports, games, and physical activities throughout the lifespan. FMS do not “naturally” develop and must be taught and reinforced through structured physical activity as part of physical education, sport, and play. If children fail to develop and learn proficient levels of FMS competence during the early years, they will be less likely to engage in physical activities. Moreover, young children with FMS delays may ultimately drop out of physical activity by adolescence putting them at a greater risk of unhealthy weight. Therefore, it is critical children develop FMS competence at an early age in order to set them onto a positive developmental trajectory with an active lifestyle. There is a growing body of evidence that supports this view suggesting motor competence in the preschool and elementary years is predictive of physical activity across childhood and adolescence. Limited opportunities for children to practice FMS during the early years is often associated with gross motor delay and an increased likelihood for sedentary behaviors.

## **Gross motor delay in disadvantaged children**

Children from socioeconomically disadvantaged environments consistently demonstrate gross motor and FMS delay regardless of race/ethnicity and geographic location. Interestingly, there are gender differences in gross motor delay with boys having better object control skills than girls (both are still delayed), but with no gender differences in locomotor skills. Parents of children with gross motor delay speak to the significant barriers that exist in their disadvantaged communities for timely motor development. Lack of safe places to play outside, and high levels of sedentary behavior at home due to many hours of screen time (e.g. video games, television),

are often associated with gross motor delay. Fortunately, children from disadvantaged settings often receive gross motor intervention through Head Start and school programs that can be successful in remediating gross motor and FMS delays.

### **Gross motor delay in children with developmental coordination disorder**

A subgroup of children who experience delay with gross motor skills for reasons that are beyond lack of instruction and exposure may have a condition known as developmental dyspraxia or Developmental Coordination Disorder (DCD). DCD affects 5-6% of school-aged children with more boys than girls being affected (ratio of 2:1 to 5:1 depending on who is studied). Identification of DCD occurs when children demonstrate a delay in motor skills, or difficulty coordinating movements that results in a child being unable to adequately perform daily life activities. By definition, the gross motor delay in children with DCD is not solely attributed to any specific neurological or intellectual condition. Signs of DCD can present as early as the first six months of life with delay in suckling and swallowing, as well as motor milestones like pull to stand and walking. As children age, DCD signs shift to a clumsy appearance, a tendency to trip over his/her own feet, difficulty balancing, and gross motor delay in FMS. Skills that involve multiple limb coordination and rhythm such as skipping are particularly problematic. Although children with DCD have normal or above average intelligence, the challenges they face in gross motor skills can impact other domains such as academic progress, socio-emotional development, and interaction with peers. Often, children with DCD will demonstrate fine motor delay as well as gross motor delay. Children with DCD do not simply outgrow their motor difficulties and early motor skill programs are key to assisting children with DCD to remain on a positive developmental trajectory and help reduce the physical, emotional and social consequences that are often associated with this disorder.

### **Gross motor delay in children with intellectual disability and Down syndrome**

Children with intellectual disability (ID) and/or Down syndrome (DS) present significant delay in their gross motor skills, especially their FMS. The degree of delay is often associated with the extent of their ID. That is children with a more severe ID will have greater gross motor delay. Similar to children who are socially disadvantaged, boys with ID often outperform girls with ID in FMS. In a number of studies children with mild ID scored significantly lower on FMS than children with Borderline ID, this has been particularly true for locomotor skills. An interesting finding between FMS and sports participation is that children with ID who perform better in object control skills participated in more organized sport.

Children with DS also demonstrate the same findings as children with ID. Children with DS have hypotonia (low muscle tone) and hyper-mobility in joints such as the hip joint. The combination of low tone and substantial laxity makes it difficult for children with DS to stand, often resulting in walking as much as a year later than their typically developing peers. As a result, many children with ID/DS require adapted physical education (APE) services in addition to physical education with their typical peers in order to work on their gross motor delay.

### **Gross motor delay in children with cerebral palsy**

Cerebral palsy is a condition caused by brain injury and/or malformation that affects girls slightly more than boys (1.2:1 ratio). Cerebral palsy may occur before, during, or immediately after birth affecting every 2.5 out of 1000 births with higher incidence in premature deliveries. Cerebral palsy can affect intellectual and motor development differently based upon the size and location of the cerebral injury. For example, lesions in the cerebellum may cause ataxia (uncontrolled movements), hypotonia (low muscle tone), and significant delay in attaining motor milestones. In contrast, upper motor neuron injury in the brain stem or the cerebral cortex may

result in spasticity or hypertonia (extensive muscle contraction). Spasticity severely affects flexibility, walking gait, grasping/releasing, and overall motor development.

There are multiple systems that classify the severity of motor impairment affecting children with cerebral palsy. The two most prevalent systems are the Gross Motor Functioning Classification System (GMFCS) and the anatomic classification system. The GMFCS focuses upon movements that can be voluntarily initiated and contains five levels (I-V) with class I containing the highest motor function (moving without assistance) and class V the most limited independent function (transport in a motorized wheelchair). The anatomic classification system focuses more on physical presentation than self-initiated movement capabilities. The four classifications of the anatomic system are diplegia (typically lower limbs affected more than upper), hemiplegia (one side of the body), quadriplegia (all limbs), and paraplegia (only the lower limbs). The different classification systems demonstrate the potential array of motor impairment for children with cerebral palsy. Early motor skill interventions (physical/occupational therapy, APE), along with specific medical or surgical treatments to reduce spasticity, are essential to maximize their motor function.

### **Assessment of gross motor delay**

Most research conducted on gross motor delay has used one of the following assessments: Movement Assessment Battery for Children-2 (M-ABC-2), Test of Gross Motor Development-2 (TGMD-2) and Bruininks-Oseretsky Test of Motor Proficiency-2 (BOT-2). The M-ABC-2 measures three subscales of gross motor delay including ball skills, manual dexterity, and static/dynamic balance across three age bands (3-6, 7-10, 11-16 years). This assessment has been used in much of the work on DCD and some of the work on ID. The TGMD-2 measures locomotor and object control skills of children aged 3 to 10 years. The advantage of the TGMD-2

is the focus on qualitative aspects of motor skills (e.g., use of hands during ball catch; contralateral step during throw). The TGMD-2 has been used extensively to identify development delay in FMS and is generally used to qualify children for APE services. It should be noted that a third version of the test is being developed. The BOT-2 is also frequently used in research to measure both gross and fine motor skills. The BOT-2 has eight subscales (Fine Motor Precision, Fine Motor Integration, Manual Dexterity, Bilateral Coordination, Balance, Running Speed and Agility, Upper-Limb Coordination, Strength). The short form of the BOT-2 is often applied in practice since the complete form of the test is time consuming. All of these tests are norm-referenced and are considered valid and reliable measures of gross motor delay in the populations described.

### **Fundamental motor skill intervention**

Children who present gross motor delay can benefit from receiving motor skill programs that provided structured and developmentally appropriate activities, especially in the early years, which is considered a sensitive period for motor development. In the early childhood and elementary years, motor skill interventions should focus on developing competency in FMS and applying those FMS to simple sports and games with their peers. FMS interventions should preferably take place in physical education where children with gross motor delay interact with their typically developing peers. However, for some groups of children additional pull-out to work on target FMS will be necessary and valuable to help minimize gross motor delay. Evidenced-based FMS intervention programs have identified pedagogical strategies that are effective for children with intellectual disability, Down syndrome, cerebral palsy and other developmental disabilities. These pedagogical strategies include clear directions and consistent teaching cues (e.g. “hands ready, reach for the ball” in catching), specific feedback aligned to the



performance of the skill (e.g., “I like the way you step and throw, next time step with opposition”), carefully designed instructional tasks that align to the current performance of the child, sufficient opportunities to practice, high quality demonstrations, and careful sequencing of tasks. It is important to understand the strengths and weaknesses of each individual with gross motor delay. The research evidence suggests that engaging children in structured FMS activities in at least 60 minutes per week can improve/remediate gross motor delay. One principle is clear for this population: the earlier the therapeutic intervention is started, the better the likelihood of remediating the gross motor delay. Thus, all children should be screened for gross motor delay at an early age (preferably by the age of 3 years) and should be adequately supported through well-designed intervention programs.

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