How to Measure Muscle and Fat in Children?

09/09/2021
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Key Points:

- **Assessment of body composition is critical in pediatric populations for multiple reasons including:**
    - **Understanding growth and development**

    - **Quantification of interventions for the epidemic of childhood obesity**

    - **Following medical treatments that alter body composition (radiation, chemotherapy) and assessment of adaptations to interventions that alter muscle, bone, or fat mass.**

Childhood obesity is an important issue because it can lead to risks for other health issues later in life. According to the Centers for Disease Control in years 2017-2018, the prevalence of obesity was 19.3% and affected about 14.4 million children and adolescents, and obesity prevalence was 13.4% among 2- to 5-year-olds, 20.3% among 6- to 11-year-olds, and 21.2% among 12- to 19-year-olds. Thus, the childhood obesity epidemic is a serious problem in the United States. Understanding body composition (or how the body can be divided into different components such as fat, muscle and bone) is important in this regard to be able to assess the effectiveness of interventions for obesity.[1]

Bioelectrical impedance analysis (BIA) is one method for the estimation of body composition. It estimates various components of our body through the use of electrical currents. A small, undetectable current is sent through the body. The device recognizes and analyzes how fast the current travels through the different tissues in our body. It then uses these data and principles of physics to measure the current and resistance to current flow. The measured values are put into various equations, to estimate the amount of each type of tissue (fat free (such as muscle and organs) and fat mass) in our body.[2,3,4,5,6]

Body composition is an important component to understanding overall health and wellness of an individual. Body composition is best understood in terms of different compartmental models. The first type of model is called a 1-Compartment model, which contains information such as whole-body weight and whole-body height, from which we can calculate BMI, or body mass index. The second type of model is called a 2-Compartment model, in which the body is divided into two compartments: fat mass (contains fat), and fat-free mass (contains muscle, bone, organs, etc.), The third type of model is called a 3-Compartment model, in which the body is divided into fat mass, lean mass (muscle, organs), and bone. The fourth type of model is called a 4-Compartment model, in which the body is divided into fat mass, lean mass (muscle, organs), bone, and water. This 4-Compartment model is the highest order model available and divides the body into the most different components.[7]

Dr. Jody Clasey from the University of Kentucky is an expert in pediatric body composition assessment and has a spent her career researching body composition in children as young as two, across various clinical populations. She and her research team developed a new bioelectrical impedance analysis equation to estimate the body composition of young children. It was validated with the use of dual energy x-ray absorptiometry (DXA) as the criterion measure, which is also known as the gold standard method of measuring body composition. This new equation she developed showed good agreement with the DXA machines, meaning that with the use of this equation, BIA can be a valid method of determining body composition.[6]

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$$DXA\ FFM\ (kg) = (-7{,}655 + 297\ (Ht) + 125\ (BM) - 17.4\ (Imp))/1{,}000$$

Figure 1: Tanita MC-780U BIA machine (left), Hologic A DXA scanner (right), and new BIA equation[6] (top; FFM: fat free mass; Ht: height; BM: body mass; Imp: impedance).

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