

Equations for Calculating Body Segment Parameters

Mass:

$$m_i = P_i \times m_{total\ body} \quad m_i \text{ is the mass of segment } i$$

$$\sum_{i=1}^n P_i = 1.000 \quad P_i \text{ is the mass proportion of segment } i \text{ and } n \text{ is the number of body segments}$$

$$m_{total\ body} = \sum_{i=1}^n m_i \quad m_{total\ body} \text{ is mass of the total body}$$

Centre of Mass:

$$R_{proximal} + R_{distal} = 1.000 \quad R_{proximal} \text{ and } R_{distal} \text{ are the distances between the proximal and distal ends, respectively, to a segment's centre of gravity as proportions of the segment's length}$$

$$r_{proximal} = R_{proximal} \times length \quad r_{proximal} \text{ is the distance from the centre of gravity to the proximal end of the segment*}$$

$$s_{cg} = s_{proximal} + R_{proximal} (s_{distal} - s_{proximal}) \quad s_{cg} \text{ represents the location of the centre of gravity in either x, y or z directions, } s_{proximal} \text{ and } s_{distal} \text{ are the locations of the segments proximal and distal ends, respectively, in x, y or z directions*}$$

$$s_{limb} = \frac{\sum_{i=1}^L P_i s_{cg_i}}{\sum_{i=1}^L P_i} \quad s_{limb} \text{ is the location of the centre of gravity of a limb and } L \text{ is the number of segments in the limb}$$

$$s_{total\ body} = \sum_{i=1}^n P_i s_{cg_i} \quad s_{total\ body} \text{ is the location of the total body centre of gravity in x, y or z direction}$$

Radius of Gyration:

$$K_{proximal} = \sqrt{K_{cg}^2 + R_{proximal}^2} \quad K_{proximal} \text{ is the length of the radius of gyration of a segment about its proximal end as a proportion of the segment's length*}$$

$$K_{cg} = \sqrt{K_{proximal}^2 - R_{proximal}^2}$$

K_{cg} is length of radius of gyration of a segment about its centre of gravity as a proportion of the segment's length

$$k_{proximal} = K_{proximal} \times length$$

$k_{proximal}$ is length to radius of gyration of a segment about its proximal end*

Moment of Inertia:

$$I_{proximal} = m k_{cg}^2 + m r_{proximal}^2$$

$I_{proximal}$ is moment of inertia of a segment about its proximal end of segment*

$$I_{cg} = m (K_{cg} \times length)^2$$

I_{cg} is moment of inertia of a segment about its centre of gravity

$$I_{proximal} = m (K_{cg} \times length)^2 + m (R_{proximal} \times length)^2*$$

$$I_{total\ body} = \sum_{i=1}^n I_{cg_i} + \sum_{i=1}^n m_i r_i^2$$

$I_{total\ body}$ is the total body moment of inertia where r_i is the distance between the total body centre of gravity and segment i 's centre of gravity

* The equation for the distal end is constructed by replacing *proximal* with *distal* and *vice versa*.