Dempster's Body Segment Parameter Data for 2-D Studies[1]

Segment name	Endpoints (proximal to distal)	Seg. mass /total mass (P)	Centre of mass /segment length ($R_{proximal}$)	(R_{distal})	Radius of gyration /segment length (K_{cg})	($K_{proximal}$)	(K_{distal})
Hand	wrist axis to knuckle II third finger	0.0060	0.506	0.494	0.298	0.587	0.577
Forearm	elbow axis to ulnar styloid	0.0160	0.430	0.570	0.303	0.526	0.647
Upper arm	glenohumeral joint to elbow axis	0.0280	0.436	0.564	0.322	0.542	0.645
Forearm & hand	elbow axis to ulnar styloid	0.0220	0.682	0.318	0.468	0.827	0.565
Upper extremity	glenohumeral joint to elbow axis	0.0500	0.530	0.470	0.368	0.645	0.596
Foot	lateral malleolus to head metatarsal II	0.0145	0.500	0.500	0.475	0.690	0.690
Leg	femoral condyles to medial malleolus	0.0465	0.433	0.567	0.302	0.528	0.643
Thigh	greater trochanter to femoral condyles	0.1000	0.433	0.567	0.323	0.540	0.653
Leg & foot	femoral condyles to medial malleolus	0.0610	0.606	0.394	0.416	0.735	0.572
Lower extremity	greater trochanter to medial malleolus	0.1610	0.447	0.553	0.326	0.560	0.650
Head	C7-T1 to ear canal	0.0810	1.000	0.000	0.495	1.116	0.495
Shoulder	sternoclavicular joint to glenohumeral joint	0.0158	0.712	0.288			
Thorax	C7-T1 to T12-L1	0.2160	0.820	0.180			
Abdomen	T12-L1 to L4-L5	0.1390	0.440	0.560			
Pelvis	L4-L5 to trochanter	0.1420	0.105	0.895			
Thorax & abdomen	C7-T1 to L4-L5	0.3550	0.630	0.370			
Abdomen & pelvis	T12-L1 to greater trochanter	0.2810	0.270	0.730			
Trunk	greater trochanter to glenohumeral joint	0.4970	0.495	0.505	0.406	0.640	0.648
Trunk & head	greater trochanter to glenohumeral joint	0.5780	0.660	0.340	0.503	0.830	0.607
Head, arms & trunk	greater trochanter to glenohumeral joint	0.6780	0.626	0.374	0.496	0.798	0.621
Head, arms & trunk	greater trochanter to midrib	0.6780	1.142	-0.142	0.903	1.456	0.914

[1] Adapted from D.A.Winter, *Biomechanics and Motor Control of Human Movement*, Second edition. John Wiley & Sons, Inc., Toronto, 1990.

Equations:

$$\sum_{i=1}^{n} P_i = 1.000$$

where n is the number of body segments and i is the segment number and P_i is the segment mass proportion

$$m_{total\ body} = \sum_{i=1}^{n} m_i$$

m_i is mass of a segment

$$R_{proximal} + R_{distal} = 1.000$$

R is distance to centre of gravity as proportion of segment length

$$r_{proximal} = R_{proximal} \times length$$

$r_{proximal}$ is distance from centre of gravity to proximal end

$$s_{cg} = s_{proximal} + R_{proximal}\,(s_{distal} - s_{proximal})$$

s represents position in x, y or z directions

$$s_{limb} = \frac{\sum_{i=1}^{L} P_i\, s_{cg_i}}{\sum_{i=1}^{L} P_i}$$

where L is the number of segments in the limb

$$s_{total\ body} = \sum_{i=1}^{n} P_i\, s_{cg_i}$$

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

$k_{proximal}$ is radius of gyration for axes through the proximal end and $K_{proximal}$ is the radius of gyration as a proportion of the segment length

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

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

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

I_{cg} is moment of inertia about an axis through the centre of gravity

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

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

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

where r_i is the distance between the total body centre of gravity and each segment's centre of gravity