Metabolic Equations for Estimating Gross VO_2 (ACSM 2000)

Exercise mode Gross VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$)	Resting VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$)	Comments
Walking $VO_2 = (S^a \times 0.1) + (S \times G^b \times 1.8)$	**+ 3.5**	1. For speeds of 50-100 m/min^{-1} (1.9-3.7 mph) 2. 0.1 $ml \cdot kg^{-1} \cdot m^{-1} = O_2$ cost of walking horizontally 3. 1.8 $ml \cdot kg^{-1} \cdot m^{-1} = O_2$ cost of walking on incline (% grade of treadmill)
Running $VO_2 = (S^a \times 0.2) + (S \times G^b \times 0.9)$	**+3.5**	1. For speeds >134 $m \cdot min^{-1}$ (>5.0 mph) 2. If truly jogging (not walking), this equations can also be used for speeds of 80-134 $m \cdot min^{-1}$ (3-5 mph) 3. 0.2 $ml \cdot kg^{-1} \cdot m^{-1} = O_2$ cost of running horizontally 4. 0.9 $ml \cdot kg^{-1} \cdot m^{-1} = O_2$ cost of running on incline (% grade of treadmill)
Leg ergometry $VO_2 = (W^c/M^d \times 10.8) + 3.5$	**+3.5**	1. For work rates between 50 and 200 W (300-1200 $kgm \cdot min^{-1}$) 2. $kgm \cdot min^{-1}$ = kg x m/rev x rev/min 3. Monark and Bodyguard = 6 m/rev; Tunturi = 3 m/rev 4. 10.8 $ml \cdot kg^{-1} \cdot W^{-1} = O_2$ cost of cycling against external load (resistance) 5. 3.5 $ml \cdot kg^{-1} \cdot min^{-1} = O_2$ cost of cycling with zero load
Arm ergometry $VO_2 = (W^c/M^d \times 18.0) +$ none	**+3.5**	1. For work rates between 25 and 125 W (150-750 $kgm \cdot min^{-1}$) 2. $kgm \cdot min^{-1}$ = kg x m/rev x rev/min 3. 18.0 $ml \cdot kg^{-1} \cdot W^{-1} = O_2$ cost of cycling against external load (resistance) 4. None = due to small mass of arm musculature, no special term for unloaded (zero load) cycling is needed
Stepping $VO_2 = (F^e \times 0.2) + (F \times ht^f \times 1.8 \times 1.33)$	**+3.5**	1. Appropriate for stepping rates between 12 and 30 steps/min and step heights between 0.04 m (1.6 in.) and 0.40 m (15.7 in.) 2. 0.2 $ml \cdot kg^{-1} \cdot m^{-1} = O_2$ cost of moving horizontally 3. 1.8 $ml \cdot kg^{-1} \cdot m^{-1} = O_2$ cost of stepping up (bench height) 4. 1.33 includes positive component of stepping up (1.0) + negative component of stepping down (0.33)

[a] S= speed of treadmill in $m \cdot min^{-1}$; 1 mph = 26.8 $m \cdot min^{-1}$.
[b] G= grade (% incline) of treadmill in decimal form; e.g., 10% = 0.10.
[c] W= power output in watts; 1 W = 6 $kgm \cdot min^{-1}$.
[d] M= body mass in kilograms; 1 kg = 2.2 lb.
[e] F= frequency of stepping in steps per minute.
[f] ht= bench height in meters; 1 in. = 0.0254 m.