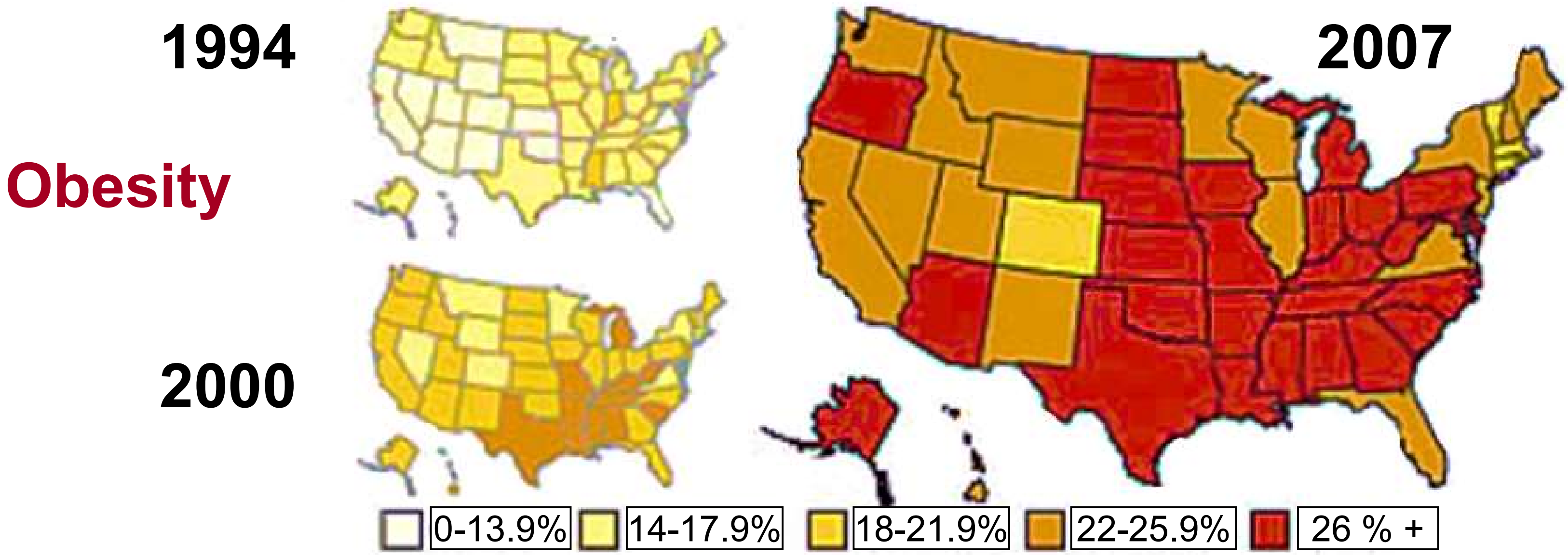
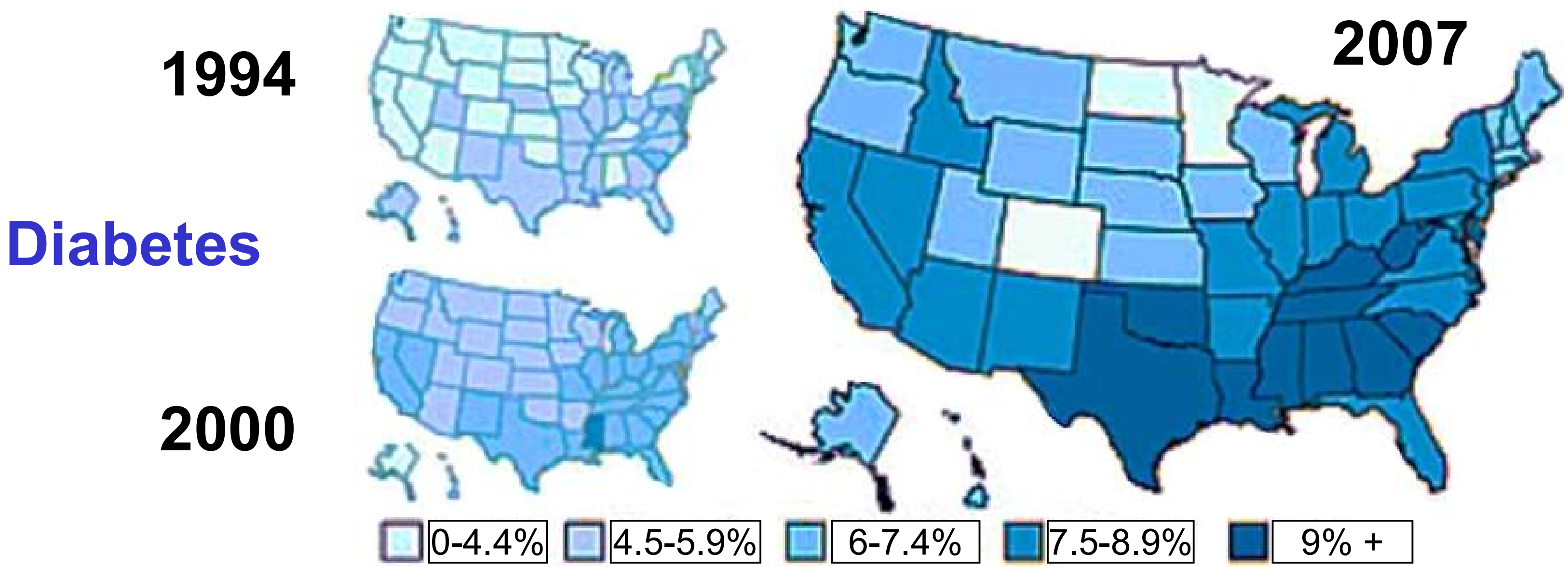
Obesity & diabetes changes in America 1994 - 2007





Energy Metabolism Estimation

Resting Metabolic Rate (RMR) = 1 MET = 3.5 ml O_2 / kg body wt / min
1 Liter O_2 = 5 Kcal
1 lb adipose tissue (fat) = 3500 Kcal
1 kg = 2.2 lbs.
1 mph = 26.8 meters / min
1 kgm = 9.807 joules
1 watt = 6.1 kgm/min
Speed in min. / mile = 60 / speed in MPH

Example:

1. **Estimate the daily energy requirements of a 176 lbs. Man (RMR)**

2. **How much weight would the man lose in one week if he reduced his caloric intake by 250 kcal / day and burned an extra 250 kcal / day by running on a treadmill (assume all metabolic hormone influences are negligible and that he does indeed have fat to lose)?**

$$\frac{\frac{3.5\ \text{ml}}{\text{kg}}}{\text{min}} \times \frac{176\ \text{lbs}}{1} \times \frac{1\ \text{kg}}{2.2\ \text{lbs}} \times \frac{1\ \text{liter}}{1000\ \text{ml}} \times \frac{60\ \text{min}}{1\ \text{hr}} \times \frac{24\ \text{hr}}{1\ \text{day}} \times \frac{5\ \text{kcal}}{1\ \text{liter}} = \frac{2016\ \text{kcal}}{1\ \text{day}}$$

$$\frac{500\ \text{kcal}}{\text{day}} \times \frac{7\ \text{days}}{1\ \text{week}} \times \frac{1\ \text{lbs. fat}}{3500\ \text{kcal}} = \frac{1\ \text{lb. fat}}{\text{week}}$$

Estimation Equations For Exercise Metabolism

Walking - speeds 50 to 100 m/min : 1.9 to 3.7 mph

Horizontal Component: VO_2 ml/kg/min = SPEED m/min x .1 ml/kg/min/m/min

Vertical Component: VO_2 ml/kg/min = SPEED m/min x %GRADE x 1.8 ml/kg/min/m/min

Resting Component: VO_2 ml/kg/min = 3.5 ml/kg/min

Total VO_2 (ml/kg/min) = sum of the resting, horizontal and vertical components

Relative VO_2 = (SPEED x .1) + (SPEED x GRADE x 1.8) + 3.5

Running - speeds > 134 m/min : > 5 mph or between 3 and 5 mph if truly running

Horizontal Component: VO_2 ml/kg/min = SPEED m/min x .2 ml/kg/min/m/min

Vertical Component: VO_2 ml/kg/min = SPEED m/min x %GRADE x .9 ml/kg/min/m/min

Resting Component: VO_2 ml/kg/min = 3.5 ml/kg/min

Total VO_2 (ml/kg/min) = sum of the resting, horizontal and vertical components

Relative VO_2 = (SPEED x .2) + (SPEED x GRADE x .9) + 3.5

Cycle Ergometry

(unloaded cycling) *(resting component)*

$$VO_2 \text{ ml/kg/min} = \frac{(1.8 \text{ ml/kgm} \times \text{WORK RATE kgm/min})}{\text{BODY WEIGHT (kg)}} + (3.5 \text{ ml/kg/min}) + (3.5 \text{ ml/kg/min})$$

WORK RATE = Resistance (kg) x Pedal Revolution Circumference (m/rev) x RPM (rev/min)

Pedal Revolution Circumference: Monarch - 6 m/rev Tunturi - 3 m/rev

Relative VO_2 = { [1.8 x (R x PRC x RPM)] / BW } + 7

Metabolic Calculation Example

You have been assigned to supervise exercise for a new post-CABG cardiac patient who weighs 210 lbs. And has a peak $\dot{V}O_2$ of 6 METS. At what speed would you set the treadmill at a 5% grade for a workout at 50% of his peak $\dot{V}O_2$?

METS to $\dot{V}O_2$ conversion

$$\frac{6\ \text{METs}}{1} \times \frac{3.5\ \frac{\text{ml}}{\text{kg}}/\text{min}}{1\ \text{MET}} = 21\ \frac{\text{ml}}{\text{kg}}/\text{min} \quad \left(\times .5 = 10.5\ \frac{\text{ml}}{\text{kg}}/\text{min}\right)$$

$$10.5\ \frac{\text{ml}}{\text{kg}}/\text{min} = (\text{speed} \times .1) + (\text{speed} \times .05 \times 1.8) + (3.5)$$

$$10.5 = (.19 \times \text{speed}) + (3.5)$$

$$\text{speed} = 36.8\ \text{meters / min}$$

$$= 1.4\ \text{mph}$$

Substitution into and then solving the equation

Metabolic Calculation Example

You have been directed to change the patient's workout in the previous question from a treadmill to a monarch cycle ergometer. His peak $\dot{V}O_2$ was 6 METS and he weighed 210 lbs. At what resistance would you set a Monarch bike at 60 rpm for a workout at 50% of his peak $\dot{V}O_2$? How many calories would the patient burn in a 30 minute workout at this workload?

Body Weight Conversion

$$\frac{210\ \text{lbs}}{1} \quad \frac{1\ \text{kg}}{2.2\ \text{lbs}} = 95.5\ \text{kg}$$

Substitution into and then solving the equation for kg of resistance

$$\frac{10.5\ \text{ml}/\text{kg}}{\text{min}} = \left[\frac{1.8 \times (6 \times 60 \times \text{kg})}{95.5}\right] + 7$$

$$10.5 = \text{kg}(6.79) + 7$$

$$.52 = \text{kg}$$

Caloric expenditure calculation

$$1002.75\ \frac{\text{ml}}{\text{min}} \cong \frac{1\ \text{liter}\ O_2}{\text{min}} \times \frac{5\ \text{kcal}}{\text{liter}\ O_2} \times 30\ \text{min} = 150\ \text{kcal}$$

Derivations of the Fick Equation

$$\dot{V}O_2 \; \frac{\text{ml } O_2}{\text{min}} = \dot{Q} \; \frac{\text{L blood}}{\text{min}} \times AVO_2D \; \frac{\text{ml } O_2}{\text{L blood}}$$

$$\dot{V}O_2 \; \frac{\text{ml } O_2}{\text{min}} = HR \; \frac{\text{beats}}{\text{min}} \times SV \; \frac{\text{L blood}}{\text{beat}} \times AVO_2D \; \frac{\text{ml } O_2}{\text{L blood}}$$

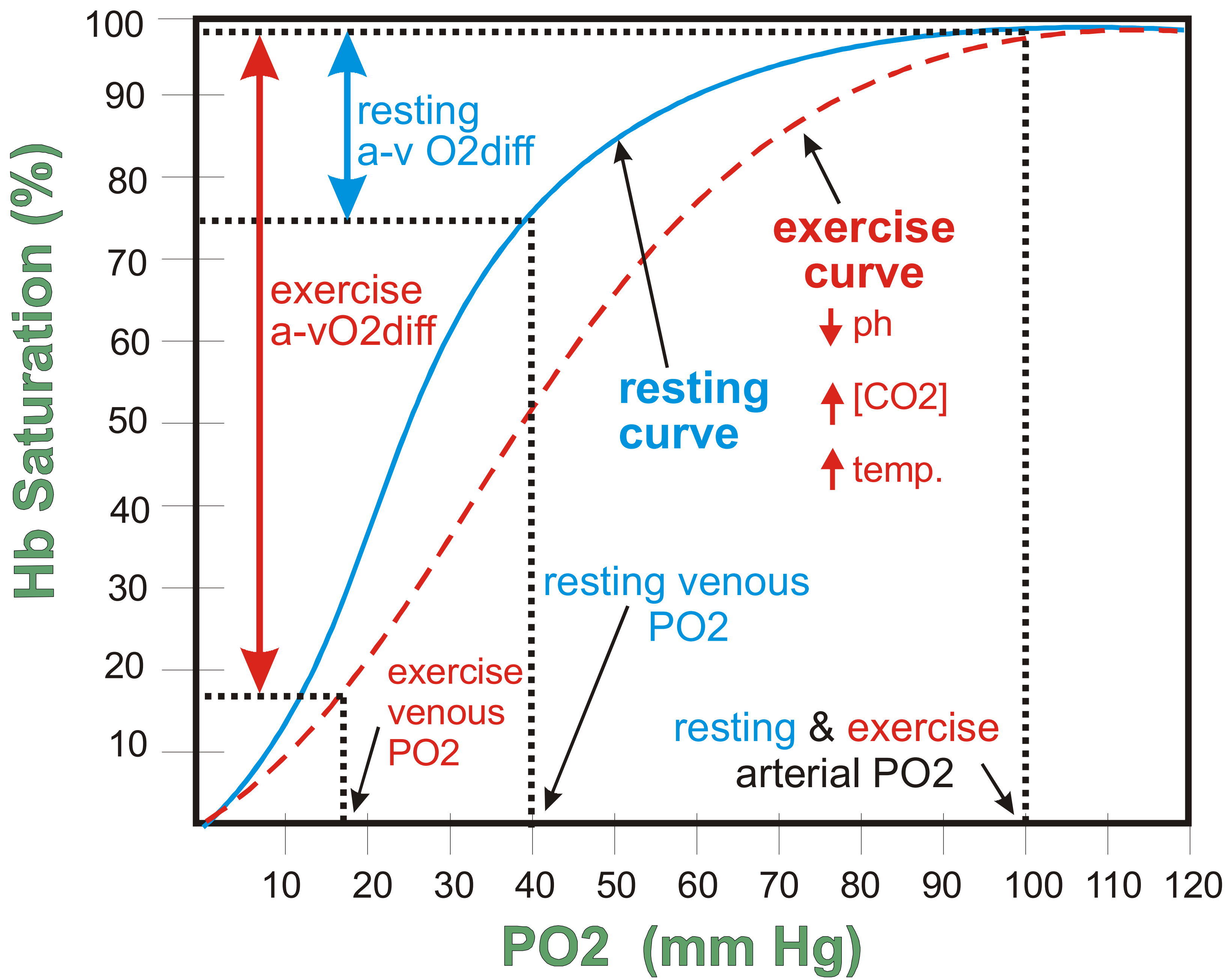
$$AVO_2D \; \frac{\text{ml O2}}{\text{L blood}}$$

$$\left(CaO_2 \; \frac{\text{ml } O_2}{\text{L blood}} - CvO_2 \; \frac{\text{ml } O_2}{\text{L blood}} \right)$$

$$\left(1.34 \; \frac{\text{ml } O_2}{\text{g Hb}} \times [Hb] \; \frac{\text{g Hb}}{\text{100 ml blood}} \times SaO_2 \; \%O_2 \text{ sat} \times 10 \right) - \left(1.34 \; \frac{\text{ml } O_2}{\text{g Hb}} \times [Hb] \; \frac{\text{g Hb}}{\text{100 ml blood}} \times SvO_2 \; \%O_2 \text{ sat} \times 10 \right)$$

the unit on the “10” in the above equation is : $\dfrac{\text{ml } O_2\text{/liter of blood}}{\text{ml } O_2\text{/100 ml of blood}}$

Rest & Exercise Oxyhemoglobin (De) Saturation Curves



Metabolic Calculation Example

A pulmonary patients is being intra-arterially monitored for AVO2Diff which was found to be 4.228 ml%. His [Hb] is 16 g%, his current arterial O2 sat 85%, and his current venous O2 sat is 70%. Assuming his venous sat does not change, what must his arterial O2 sat be to raise his AVO2Diff to around normal levels (about 6 ml%)?

$$\left(1.34 \ \frac{ml\ O_2}{g\ Hb} \times [Hb] \ \frac{g\ Hb}{100\ ml\ blood} \times SaO_2 \ \%O_2\ sat \times 10\right) - \left(1.34 \ \frac{ml\ O_2}{g\ Hb} \times [Hb] \ \frac{g\ Hb}{100\ ml\ blood} \times SvO_2 \ \%O_2\ sat \times 10\right) = 4.228\ ml\%$$

(or 42.28 ml / L)

$$\left(1.34 \times [16] \times SaO_2 \times 10\right) - \left(1.34 \times [16] \times .70 \times 10\right) = 60\ ml / L$$

214 (SaO2) = 210.08

(SaO2) = .982 or 98%