

Air Displacement Plethysmography

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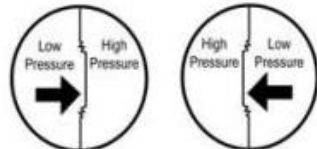
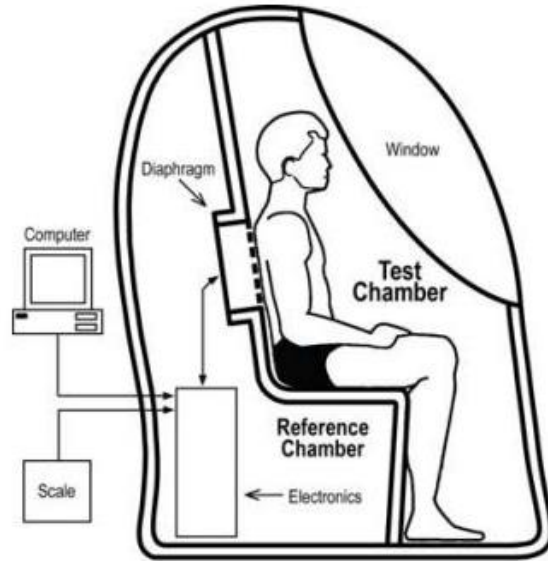
Air Displacement Plethysmography (ADP)

- ❖ Use of pressure-volume relationships in order to measure volume and density

Bod Pod (Life Measurement Instruments)



Components of Measurement



Moving diaphragm produces complementary pressure changes in the chambers.

- ❖ Test chamber
- ❖ Reference chamber
- ❖ Diaphragm
- ❖ Air circulation system

Relevant Gas Laws

❖ Boyle's Law: Isothermal Conditions

➤ $P_1/P_2 = V_2/V_1$

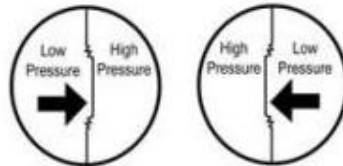
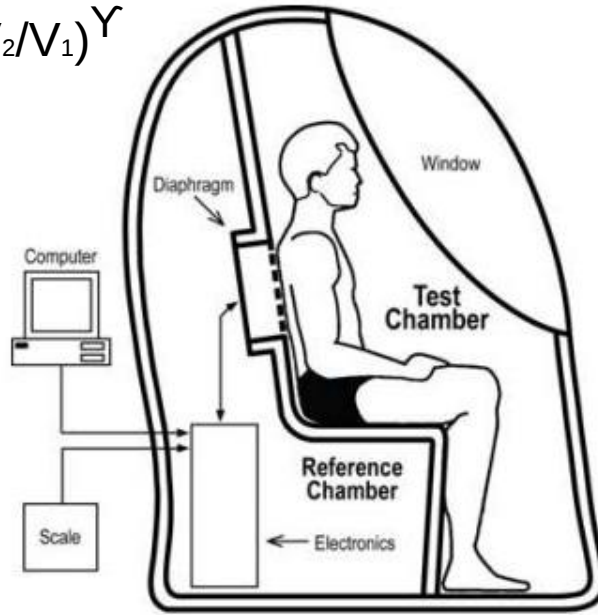
- P_1 =Pressure 1
- V_1 =Volume 1
- P_2 =Pressure 2
- V_2 =Volume 2

❖ Poisson's Law: Adiabatic Conditions

➤ $P_1/P_2 = (V_2/V_1)^\gamma$

- γ =specific heat of gas at constant pressure: constant volume
- P_1 =Pressure 1
- V_1 =Volume 1
- P_2 =Pressure 2

$$P_1/P_2=(V_2/V_1)^{\gamma}$$



Moving diaphragm produces complementary pressure changes in the chambers.

- ❖ Test chamber
 - ~450L
- ❖ Reference chamber
 - ~300L
- ❖ Diaphragm
 - Sinusoidal perturbations
 - Fourier coefficients
- ❖ Air circulation system

Measurement

❖ Two-point calibration process

- Empty (baseline): 50-l calibration cylinder
- $y=mx+b$

❖ Human measurement

- Clothing
- Hair
- Skin Area Artifact (SAA)
- Lung Volume (V_{TG})

$$SAA(l) = k(l/cm^2) * BSA(cm^2)$$

$$V_{TG}(l) = (m/1.4) - \text{dead space of breathing apparatus}$$

Corrected Body Volume

❖ Body volume (l) = Body volume_{raw} (l) - SAA (l) + 40% V_{TG} (l)

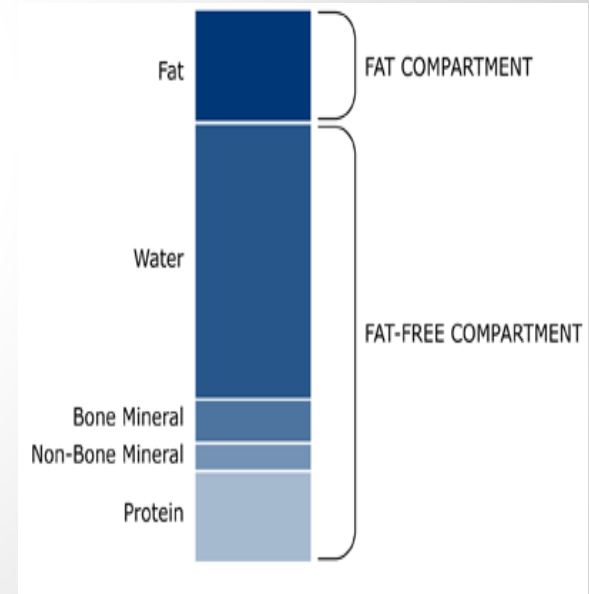
➤ SAA = Surface area artifact

➤ V_{TG} = Lung volume

❖ Density = Mass/Volume

➤ Siri Equation: Percent Fat = $495 / \text{Density} - 450$

➤ Lean Body Mass = 100 - Percent Fat



Relevant populations

- ❖ Children
- ❖ Elderly
- ❖ Infirm
- ❖ Disabled



Advantages/Disadvantages

❖ Advantages

- Speciality populations
- Accuracy
- Easy to operate
- Short measurement time (5-8 min/individual)

❖ Disadvantages

- Very expensive (\$30,000-\$40,000)
- Hydration status, muscle temperature can affect reading

Relevant Concept Question

- I. What relevant gas law was used in order to perfect the method of measurement behind air displacement plethysmography (ADP)?
- A. $P_1/P_2 = V_2/V_1$
 - B. $P_1V_1 = P_2V_2$
 - C. $P_1/P_2 = (V_2/V_1)$
 - D. $P_1/P_2 = (V_2/V_1)^{\gamma}$

References

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