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Air Displacement Plethysmography (ADP)

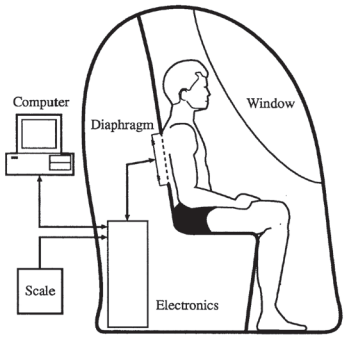
Body Composition

The BOD POD

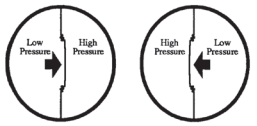
The BOD POD is an Air Displacement Plethysmograph (ADP) that uses whole-body densitometry to determine body composition (fat vs. lean). Similar in principle to underwater weighing, the BOD POD measures body mass (weight) using a very precise scale, and volume by sitting inside the BOD POD. Body density can then be calculated:

Density = Mass/Volume

Once the overall density of the body is determined, the relative proportions of body fat and lean body mass are calculated.



General arrangement of chambers, subject, and diaphragm.



Moving diaphragm produces complementary pressure changes in the chambers.

The BOD POD differs from underwater weighing in that the BOD POD uses air instead of water to measure body volume, based on the physical relationship between pressure and volume. The relationship allows for the derivation of an unknown volume by directly measuring pressure.

During a measurement, the BOD POD produces very small volume changes inside the chamber and measures the pressure response to these small volume changes. To accomplish this, the interior volume of the empty BOD POD chamber is first determined, then the volume when the subject is seated inside the BOD POD is also determined. By subtraction, the subject's volume is obtained. For example, if the interior air volume of the empty chamber is 400 liters, volume of the chamber is reduced to 350 liters with the subject inside, then the body volume is 50 liters.

The BOD POD consists of two chambers. The molded seat inside the BOD POD divides the unit into front (test) and rear (reference) chambers and provides a common wall between these two chambers. A diaphragm mounted on the common wall is oscillated during testing by computer control. During data collection, the BOD POD door is closed by a series of electromagnets and a gasket, and the diaphragm effectively moves back and forth between the two chambers. When the volume is increased in one of the chambers, it is decreased by the same amount in the other chamber, and vice versa. The pressure in each of the two chambers responds immediately to this volume change, and the magnitude of the pressure changes indicates the relative size of each of the chambers. The pressure change is roughly ±0.5 cm H_2O, and is rarely noticeable to the subject (comparable to the change in pressure while moving from the first floor to the second floor in an elevator).

During the body volume measurement, the subject breathes normally, known as relaxed tidal breathing, unlike underwater weighing which typically requires maximal exhalation to residual volume. Thus, the relevant measurement of lung volume for the BOD POD is not residual volume, but the average lung volume during normal tidal breathing (average thoracic gas volume). This is a much easier measurement to obtain and no difficult maneuvers are required.

To achieve optimal accuracy, the volume of air in the lungs must be determined. This may be done either by directly measuring the average thoracic lung volume or by using an estimated value based on standard prediction equations. The effect of skin surface area is also estimated. This information is then used to make corrections to the body volume measurement for obtaining final body composition measurement results.

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