

Bod Pod Overview 2010

OVERVIEW:

The Bod Pod is a Body Composition Tracking System (an Air Displacement Plethysmograph). It calculates whole-body density (densitometry) to determine body composition. Body composition refers to the amount of fat and fat-free mass (protein, water, bone, glycogen, mineral) in the human body. The Bod Pod works under the same principles as hydrostatic (“underwater”) weighing, except instead of measuring the volume of water being displaced, it measures the volume of air in the chambers. The Bod Pod also offers information on Resting Metabolic Rate (RMR) and Total Energy Expenditure (TEE). The entire measurement/calculation process takes about 5 minutes.

HOW IT WORKS:

The Bod Pod System uses Air Displacement Plethysmography for determining fat and fat-free mass. The test measures the subject’s mass (weight) using an electronic scale (outside of the chamber), and volume, which is determined by sitting inside the Bod Pod chamber. From these two measurements, the subject’s body composition (density) is calculated.

Densitometry

$$\mathbf{D \text{ (density)} = Mass \text{ (scale)} / Volume \text{ (BOD POD)}}$$

The Bod Pod consists of two chambers:

- Test Chamber (front) – where subject sits
- Reference Chamber (rear)

The chambers have a common wall separating the two. The common wall has an oscillating diaphragm, called a speaker, which is mounted on the machine. During the brief data collection period of the volume measurement, the chamber door is secured by a series of electromagnets and a gasket. At this point, the speaker oscillates, which causes fluctuations of the volume inside the chamber. The pressure response to these volume changes is measured. How?

First the interior volume of the empty Bod Pod chamber is measured. Next, a subject is placed in the chamber and the volume of the front chamber is measured again.

For example: If the volume of the empty chamber is 400 liters, and the volume of the chamber is 350 liters with the subject inside, the body volume of the subject would be 50 liters (400 L – 350 L = 50 L).

Now that we have the **volume** of the subject, and the **mass** of the subject (by weighing the subject on the scale), the **density** is determined.

* In order to determine an unknown volume, the Bod Pod uses the relationship between pressure and volume.

Under isothermal conditions (Boyle's Law), the temperature of air remains constant as its volume changes. This means that the amount of air compressed will decrease its volume in proportion to the increasing pressure.

$$P_1 / P_2 = V_2 / V_1$$

The air in our lungs, skin, clothing and hair behave isothermally.

Under adiabatic conditions (Poisson's Law), the temperature of air does not remain constant as its volume changes.

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

γ = ratio of specific heat of gas at constant pressure and constant volume. (value is approximately 1.4).

The majority of the air in the chambers behaves adiabatically.

Air under isothermal conditions is easier to compress. This means, that for a given change in volume, the pressure of air under isothermal conditions would change 40% less (40% more compressible) than under adiabatic conditions.

Since the majority of the air in the chambers behaves adiabatically, Poisson's Law is used to determine a raw estimate of the subject's volume, and the actual volume is determined afterwards by accounting for the isothermal conditions (air in lungs, surface of subject, etc.).

Thoracic Gas Volume (TGV): Since air in the lungs behaves isothermally, the volume of air in the lungs is measured and added to the raw body volume measurement to account for discrepancy. During testing, the subject breathes normally.

During testing, TGV can either be:

Measured

Retrieved- taken from previous test

Predicted- using standard prediction equations based on gender, age and height.

Entered

(We use **Predicted** unless the subject is an athlete. For an athlete we use **Measured**).

It is NOT possible to derive this information from other sources and input into the Bod Pod software using the equation provided.

PROTOCOL/REQUIREMENTS:

Clothing: Subjects must wear minimal tight fitting clothing in order to determine most accurate results.

Men: Form-fitting Speedo or spandex type swim suit or single-layer compression shorts (no padding).

Women: Form-fitting Speedo or spandex type swim suit or single-layer compression shorts (no padding) and single layer jogging bra (no padding).

Swim Cap (lycra only, no rubber caps).

No jewelry, socks, shoes, eyeglasses or any other accessories.

Subjects must refrain from eating and exercise two hours prior to testing.

Subjects should know their height prior to test.

Subject should remain quiet, still and relaxed during testing.

In case of an emergency, subject has access to a green emergency button located inside of the chamber by subject's left leg.

LOCATION of the Bod Pod is also important for accurate results.

- Do not place Bod Pod near a heater, air conditioner, or fan.
- Do not place Bod Pod in direct sunlight.
- Room temperature should be between 70 °F -80 °F.
- Room humidity should be between 20-70%.
- Do not place Bod Pod near a door. Keep door shut during testing.
- Do not place Bod Pod near an open window, fan or heating, cooling ducts.
- Avoid acoustic noise.
- Avoid people passing by.
- Do not touch Bod Pod during testing.
- Adjust scale-make sure it is stable and level.

STARTING THE BOD POD APPLICATION:

- The Bod Pod needs to warm up 30 minutes prior to the starting a test.
- Quality Control Procedures need to be conducted once each day in which subjects will be tested.
- Scale should be calibrated every two weeks or anytime the scale has been moved.
- Exit the system by using Windows Start > Shutdown method.

QUALITY CONTROL PROCEDURES:

Failure to conduct QC might result in inaccurate body composition test results.

**A 50-liter calibration volume is used to ensure the accuracy of volume measurements.*

System Warm-Up: Let system warm up for 30 minutes.

Analyze Hardware: If any steps in the activity fail, repeat the test.

Passing: No Problems Detected

Failing: Possible Problems Detected... followed by list of errors.

**If system fails twice, call LMI Customer Service for assistance.*

Autotest(optional): Assess stability of Bod Pod and environment. If steps fail, repeat test.

Passing: slope ± 30 ml and SD < 60 ml.

**If fails, perform two more tests; if fails again, call Customer Service.*

Test System: Assess Bod Pod volume performance.

Passing: volume ± 100 ml of actual volume, SD ≤ 75 ml.

**If more than one two tests fail call Customer Service.*

Scale Calibration: If scale has been moved or two weeks have passed, calibrate scale.

Passing: 20.00kg displayed on screen.

Failing: Less than 20.00kg.

**If two tests fail, call Customer Service.*

PROCEDURE:

Once QC is conducted, subject can begin to be tested.

- 1) Subject information is entered:
 - a) Body density is dependent upon race, gender and age. The following calibrations are selected for use according to the following:

Siri: General, non-black population

Schuttle: Black males
Ortiz: Black females
Brozek: Lean and obese individuals
Lohman: Children ≤ 17 yrs.

b) Select Thoracic Gas Volume (TGV)

- Measured
- Retrieved- taken from previous test
- Predicted- standard prediction equations based on gender, age and height.
- Entered

(We use **Predicted** unless the subject is an athlete. For an athlete we use **Measured**).

* If **Measured** is picked, instruct client as follows:

*“This portion of the test will measure the amount of air in your lungs. After I close the chamber door, a 20 second equilibration period will take place. (**Practice this 2-3 times before putting athlete into the chamber.**)*

*During this time, hold the breathing tube in your right hand and follow the hand signals displayed. When you see the technician hold up 1 finger, insert the breathing tube into your mouth and plug nose. Continue to breathe normally. At a certain point between 4th and 6th breath into the tube, when you see the technician hold up 2 fingers, puff gently 3 times with the same force you would used to fog up your eyeglasses before cleaning them. You will be halfway through an exhalation and will feel the airway close so you will be breathing against some resistance. During the puffing, make sure to keep a tight seal between your mouth and the tube. **DO NOT BLOW HARD**. At the end of the third puff, the TGV measurement is complete.”*

Results:

Airway Pressure Value- max airway pressure during puffing. If results indicate HIGH, subject puffed to hard. Repeat test and ask subject to puff lighter.

Merit Value-if results indicate HIGH, subject did not maintain a tight seal around the tube. Repeat test.

If both pass, and the TGV value is out of range of the average population, the test will be asked to be repeated.

- 2) Subject weight is measured.
- 3) Begin Volume Measurement:
 - a. Subject enters Bod Pod.
 - b. Volume Measurement: Subject is asked to breathe normally. 2-3 volume measurements are taken, the average is taken. The chamber door must be opened between measurements to assure accuracy.
 - c. TGV: If predicted, nothing needs to be done.

- d. If measured, subject is instructed to “HUFF: into the breathing tube as shown on the screen. Subject must hold his/her nose and completely cover the mouth end of the tube, making sure air does not escape between the tube and the subject’s mouth.
- 4) Review/Print Test Results: Results are displayed and can be reviewed.

MAINTENANCE:

The Bod Pod chamber should be cleaned on a weekly basis with an all-purpose cleaner, and wiped down with a wet cloth afterwards. The magnets on the Bod Pod need to be cleaned once a month with an alcohol swab. The window should be cleaned with a window cleaner.

Cover the oscillating diaphragm (Speaker) vents during cleaning and avoid the magnet keepers located around the Bod Pod door. Cover the air holes located at the top right hand corner of the seat back during cleaning to avoid damage to the Bod Pod.