Simple Health Network

Providing Simple Solutions to Complex Problems

Body Impedance Analysis

Bioelectrical impedance analysis (BIA) measures the flow or the impedance to the flow of an electric current through the tissues of the body. Electrodes are placed on the hands, wrists, feet and ankles and a very low electrical current (undetectable by patients) is passed through the body from one electrode to the other. This is a non-invasive test that takes less than 5 minutes to perform and provides valuable information to assess many areas of health and associated health risks.

While there are several categories of information captured by this simple test, including your Body Mass Index (BMI = your ratio of body fat to lean muscle), your levels of hydration inside the cells (ICW) and between the cells (ECW), the overall health of the cell membrane (capacitance and resistance), and most importantly, the phase angle of the cell. The measurement of the phase angle is a very accurate assessment of the general health of tissues throughout your body.

This information helps you, as a patient, narrow down the sources of any health issues or potential health risks and with quick and inexpensive follow ups track your progress.

Detailed Test Information:

Impedance is low in lean tissue, where intracellular fluid and electrolytes are primarily contained, but high in fat tissue. Impedance is thus proportional to body water volume (TBW). In practice, a small constant current, typically 800 uA at a fixed frequency, usually 50 kHz, is passed between electrodes spanning the body and the voltage drop between electrodes provides a measure of impedance. Prediction equations, previously generated by correlating impedance measures against an independent estimate of TBW, may be used subsequently to convert a measured impedance to a corresponding estimate of TBW. Lean body mass is then calculated from this estimate using an assumed hydration fraction for lean tissue. Fat mass is calculated as the difference between body weight and lean body mass.

The impedance of a biological tissue comprises two components, the resistance and the reactance. The conductive characteristics of body fluids provide the resistive component, whereas the cell membranes, acting as imperfect capacitors, contribute a frequency dependent reactive component. Impedance

measurements made over a range of low to high (1 MHz) frequencies therefore allow development of prediction equations relating impedance measures at low frequencies to extracellular fluid volume and at high frequencies to total body fluid volume. This is known as multi-frequency bioelectrical impedance analysis (MFBIA).

BMI:

BMI stands for “Body Mass Index”, a ratio of height to weight. Measurements do vary with each individual, and is somewhat based on body fat. Those who are overweight will have a higher BMI than those who are not overweight. BMI does not account for gender, large or small frames, or increased muscle mass.

Therefore, BMI is not accurate when used on body builders, pregnant or lactating women, growing children or in frail/sedentary elderly individuals. Normal BMI is 18.5 to 24.9 and this range is consistent with good health. 25.0 to 29.9 indicate the person is overweight. 30.0 + indicates obesity. A high BMI, especially 30.0 + indicates increased risk for: hypertension, cardiovascular disease, dyslipidemia, adult-onset diabetes (type II), sleep apnea, osteoarthritis, and female infertility. A low BMI, below 18.5 indicates malnutrition.

BMI Category Health risks based on BMI

19-24 Minimal
25-26 Low
27-29 Moderate
30-34 High
35-39 Very High
40+ Extreme

If your BMI is high, you may have an increased risk of developing certain diseases, including:

* Hypertension
* Cardiovascular Disease
* Dyslipidemia
* Adult-Onset Diabetes (Type II)
* Sleep Apnea
* Osteoarthritis
* Female Infertility

BMI is a better predictor of disease risk than body weight alone.

Phase Angle:

Phase angle is based on total body resistance and reactance and is independent of height, weight and body fat. Lower phase angles appear to be consistent with either cell death or a breakdown of the cell membrane. Higher phase angles appear to be consistent with large quantities of intact cell membranes and body cell mass. All living substances have a phase angle. In fresh uncooked vegetables phase angle can exceed 45 degrees. In cooked vegetables phase angle is zero because they are dead. Phase Angle measures the overall health and strength of the cell membrane and in some cases may be used to determine disease progression/regression.

Phase angle increases as a result of optimal health due to exercise and good nutrition. Low phase angle is related to cell death, damage, stress, higher morbidity and higher mortality. Low phase angles may be due to HIV/AIDS, some cancers, abusive life style, poor diet, chronic alcoholism, and/or old age (80-100). High phase angle is associated with higher cell mass, less morbidity and less mortality. The higher the phase angle, the better.

Phase Angle (degrees) Health Risk Based on Phase Angle

Above 10.4 Extremely Healthy
8.5-10.3 Optimal Health
7.2-8.4 Average
5.9-7.1 Below Average
4.7-5.8 Low Energy
Below 4.6 Warning

Phase Angle is a predictor of outcome and indicates the course of disease progression; it increases as the result of optimal health based on good nutrition and consistent exercise. As we get older our phase angle will decrease and will be approximately 4 or less when we die. Physically fit adolescents may have a phase angle greater than 10. This effect is a result of cell integrity due to age.

Low phase angles are consistent with:
* Malnutrition
* HIV/AIDS infection
* Cancer (most types)
* Abusive life style
* Chronic Alcoholism
* Old Age (80 - 100 years)

Good fitness and life style is the key to maintaining a healthy phase angle. Phase angle is a good indicator of disease progression although it is not used to diagnose a specific disease. It may be thought of as a thermometer with a broad range of normal. It may also be used to monitor the practice of good health which would include healthy diets, the use of nutritional supplements, and exercise.

Capacitance:

All living things are made of cells. Cells are membrane bounded compartments filled with a concentrated solution of chemicals and salts. Groups of cells perform specialized functions and are linked by an intricate communications system. The cell membrane maintains an ion concentration gradient between the intracellular and extracellular spaces. This gradient creates an electrical potential difference across the membrane which is essential to cell survival. Electrical gradients are necessary to support movement of oxygen, carbon dioxide, and nutrients.

Therefore, the cell membrane has electrically insulating qualities or capacitance. Electrical capacitance will increase or decrease depending on the health and the number of cells.

Damage to the cell membrane, and its functions, is as lethal to the cell as direct damage to the nucleus itself.

The cell membrane functions as a permeable barrier separating the intracellular (cytoplasm) and extracellular components. The lipid membrane is transversed by proteins, which are soluble in water thus making pores through which water, ions and other chemicals can enter and exit the cell. Capacitance is the capacity of the cell to support movement of oxygen, carbon dioxide, and nutrients in and outside of the cell.

Electrical impulses are pertinent for a cell to support movement; therefore, capacitance is the measurement of that electrical impulse. Capacitance is also a measure of cell membrane health and it does fluctuate due to changes in health and disease. Higher capacitance indicates a healthier state, whereas, a lower capacitance indicates a degenerative state.

Capacitance (Pico Farads) Cell Health Assessment*

Above 1313 Extremely healthy
1003-1312 Optimal Health
795-1002 Average
589-794 Below average
382-588 Low health
Below 381 Warning

*Based on capacitance scores BIA prediction equations have been developed that use parallel resistance and reactance as predictors of extracellular mass and body cell mass. Comparisons to K40, DEXA and D20 were very similar ($r > 0.9$) and as a result are sufficient to be used in clinical practice such as muscle wasting disorders seen in AIDS patients.

Parallel capacitance is somewhat like phase angle, whereas it is not affected by weight or body fat. It is a measure of cell membrane health in all living substances and can change dramatically depending on disease or good health. A body builder, for example, would have a high parallel capacitance and low resistance, or more cell volume, because he/she is extremely muscular and fit. A malnourished AIDS patient would have a low parallel capacitance.

BMR:

Energy is the most fundamental need of biological systems. Without it, the basic biological processes of life cannot occur. Survival depends on consistently finding the right fuel in the appropriate quantity to sustain the biochemical reactions of energy metabolism. The body extracts and uses energy through the process of metabolism.

Metabolism occurs in two distinct and interdependent phases: 1.) catabolism, in which the body breaks down food into its component parts and harvests the energy stored in its atomic bonds, and 2.) anabolism, in which those component parts and energy are used to build new tissues and conduct basic life functions. Metabolic Rate (BMR) is the amount of energy your body requires every day to perform its most basic function including:

1. Breathing
2. Digesting
3. Heart beating
4. Muscles activity
5. Transportation of fluids and tissue
6. Circulation of blood

BMR is a representation of the amount of energy you would require if you laid in bed all day without ever moving a single muscle. Since most of us do a bit more than that, a daily activity level must also be factored in. This ranges from everyday activities to working out strenuously every day.

BMR is only a way to estimate how fast you burn calories. The slower your metabolism, the more difficult it will be to lose weight. If you burn your daily calorie intake, you will maintain your current weight. Burning more than your daily intake causes weight loss.

There are many factors that vary your metabolism. However, exercise and daily activity level are keys to increasing your BMR. There can be major nutritional consequences to the decline of the BMR in advanced age. Decreased caloric requirements may lead to decreased food intake. Sufficiently low caloric intake can lead to deficient intake of essential nutrients.

The more lean tissue, specifically body cell mass, the higher your BMR.

Basal Metabolic Rate (BMR) Energy Level

Above 2124 Extreme energy
1809-2123 High Energy
1597-1808 Average energy
1387-1596 Below average
1176-1386 Low average
below 1175 Warning

BMR varies between the sexes. Lean body mass is a major determinant, and women tend to have less lean muscle mass. As a result, their BMR is lower than that of otherwise comparable males.

BMR peaks during infancy, then it declines rapidly through childhood and adolescence. It continues to fall slowly with increasing age and decline further with old age due largely to a loss of muscle mass. This is not inevitable, however, as weight-bearing exercise will prevent or reverse muscle loss among the elderly.

ECW (Extra Cellular Water)

ECW (Extra Cellular Water) - Represents all of the fluid that exists outside of cellular structures and circulates throughout the body carrying sodium, chloride, bicarbonate ions and nutrients. ECW exists and flows within lymph tissues, blood vessels, the gastrointestinal tract, intestines, interstitial spaces, and also in the spinal fluid. Normal ECW for males is 40% of total body water and 50% for women. High ECW indicates edema (water retention). Low ECW indicates dehydration.

ICW (Intracellular Water)

ICW (Intracellular Water) - Represents all the fluid that is contained inside the cellular membrane. ICW accounts for approximately two-thirds of total body water and also is composed of more K+ ions than extracellular water. Muscle and organ cells contain more ICW fluid than do fat cells; therefore, if a patient’s muscle mass increases, you can expect an increase in intracellular water.