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Current Market Body Fat Analyzers

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Introduction

There are several different methods that are currently used on the commercial market to analyze body fat content. The methods that will be examined will be bioelectrical impedance analysis (or BIA), air displacement, calipers and hydrostatic weighing as listed in [1]. The accuracy of the methods is directly related to the cost of each. Air displacement and hydrostatic weighing both are accurate to within 3% of total fat percentage and on average cost upwards of 100-200 dollars per analysis session according to [2]. Calipers are accurate to within 5% of total fat percentage [3], while BIA is accurate anywhere between 5-15% depending on the person using the device [4].

Air Displacement

Air displacement, commercially known as a Bod-Pod, uses a tank or container with a known volume of air to measure fat percentage. A user will enter the container, and the pod measures the total air displacement, weight, and then cycles through multiple air pressures to determine an average composition. Points of error in this setup come from lung displacement changing through breathing during the test and places of error in the weight scales [5]. Single sessions of the test on average cost between 100-200 dollars, which forces availability into a very niche market.

Hydrostatic Weighing

Hydrostatic weighing is also a measurement of displacement much like air displacement except it is much more complicated to run, but gives more reliable results. A tank of water is used to measure displacement when a patient enters the water and then exhales, removing as much air as possible from their body according to [6]. Combined with a scale, the fat percentage is accurate within 3% [2]. The procedure is usually upwards of 200 dollars per session and requires a large amount of space.

Bioelectrical Impedance Analysis

Bioelectrical impedance analysis uses a timed pulse from one location on the body, usually an arm or leg, and records the time to reach a receiving probe. The signal is usually 500 uA or less to make sure that there is no noticeable shock to an individual. Most devices run a small signal AC voltage at 50 kHz to reduce absorption in the body [7]. The signal time is affected by the amount of fat encountered when crossing the body. Muscle and skin have high water content, making them very good signal conductors, with fat slowing the signal down due to extremely low water content. Each machine, whether handheld or scale type, then uses height and weight calculations to estimate fat content. On average this form of estimation yields error rates anywhere from 5-15% [4]. This method is extremely cheap to implement with most devices costing under 40 dollars. Tracking day to day or week to week progress with a BIA machine is very difficult due to the 5-15% error rate. Sources for these errors include partial body estimation, clenching or relaxing muscles, and differences in body composition. Partial body estimation occurs when ankle to ankle or wrist to wrist devices are used. These probes only measure either upper or lower body fat content, leaving estimation error for the unknown portion of the body. Clenching or relaxing muscles affects the time since altering the signal path during multiple tests adds error [8]. The equations within the device add another source of error by using general models for an average person, which makes bone and muscle density skew results depending on how dense or frail the tissue path [8].

Calipers

Calipers are the simplest method to analyze body fat. The folds of skin on the body are measured using the calipers and then summed to determine total fat. With around 5% error [3], calipers are a commonly used and inexpensive method to determine body fat. The only complication with calipers is that they require another individual to properly measure skin folds [9]. The only difference between calipers and the previous methods is it removes any digital error from the percentage equations, but instead adds human error with readout estimation.

Conclusion

Between all of the different methods, accuracy, price, and lack of mobility are all positively related. The cheaper the product becomes the lower the accuracy and the heavier the machine. This relationship becomes the determining factor in a customer’s choice. Since accuracy, price, and mobility cannot all be met, compromises in the market have to be examined.

References

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