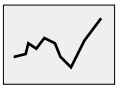


Trend

I have data on fat. Not just any fat, but my fat. I'm told that less is better, within certain ranges. It is not at all clear to me how to change body fat or whether to change body fat. But one thing I do know about is gadgets, I like gadgets and data. So one thing I am sure I can do is to convert body fat into is a high tech distraction replete with gadgets and data.

The gadget is a Futrex 1000. I press it into the skin (and fat) above my bicep. It returns a three digit number estimating body fat. According to directions,

> …human bodyfat absorbs light at specific wavelengths in the near-infrared portion of the spectrum. The Futrex 1000 emits these near-infrared wavelengths. Also, the Futrex-1000 contains an optical sensor to measure how much of this energy is absorbed by your bodyfat.
>
> The near-infrared absorption technology used inthe Futrex-1000 has been shown to be well within the accuracy of ±4.5%. Additionally, due to the smaller number of test variables, the repeatability of near-infrared is superior to all of the other bodyfat determination methods. …
>
> …Everyone's body responds to diet and exercise differently. For example, the "average person" who loses one pound of weight due to dieting, actually loses approximately 3/4 of a pound of fat and 1/4 pound of lean. However, if that same "average person" loses one pound of body weight due to exercise, he actually loses approximately 1 1/4 pound of fat and gains 1/4 pound of lean (muscle). Thus the benefit of exercise is obvious.
>
> You should be aware that when you start an exercise program there will not be an immediate reduction in your percent bodyfat. This is because the body will first lose water. As you continue your program, you will begin to lose bodyfat. It usually takes several weeks before noticeable loss in percent bodyfat occurs.

That tells me, among other things, that the measurement includes error. The

magnitude is, it tells me "within the accuracy of ±4.5%.

It also tells me that it is measuring something other than body fat. It hints at that in the little discourse on losing water. And, whether the directions told me so or not, with most "measurements" are not direct measurement of the thing they claim to measure: It is measuring absorption of light, not fat. That means that the numbers on its face are connected to the true (but unknown) facts for my body by a combination of theory and indirect physical links that connect infrared to fat. Every step in the process is an opening to sources of error. Every step in the process opens the door to other variables which can affect the measurement. These are the variables referred to in the famous caveat "all things being equal".

So, Wednesday, July 3 1:30 in the afternoon. I am going to reduce uncertainty by using repeated measurements. The ten estimates are

24.8%	25.6%	26.4%	24.2%	26.2%	26.1%	24.2%	23.4%	23.2%	25.8%

I'm not sure what the directions referred to as ±4.5%. Was that +4.5% of the observed value? Or was it 4.5% added or subtracted from the observed value? I don't know. But the range in these ten observations is 3.2%, from a low of 23.2% to a high of 26.4%. The mean is 25.0%. The standard deviation is 1.2%. Plus or minus two standard deviations would be plus or minus 2.4%, disconcertingly different from the 4.5% number specified in the directions.

That difference alerts me to another inevitable fact: I have to distinguish between variation around the mean (measured by the standard deviation), and variation of the mean (and the whole distribution) around the true value. One is the variation around the measurement, all things being equal. The other is the variation of the measurements induced by the fact that all things will not be equal from day to day.

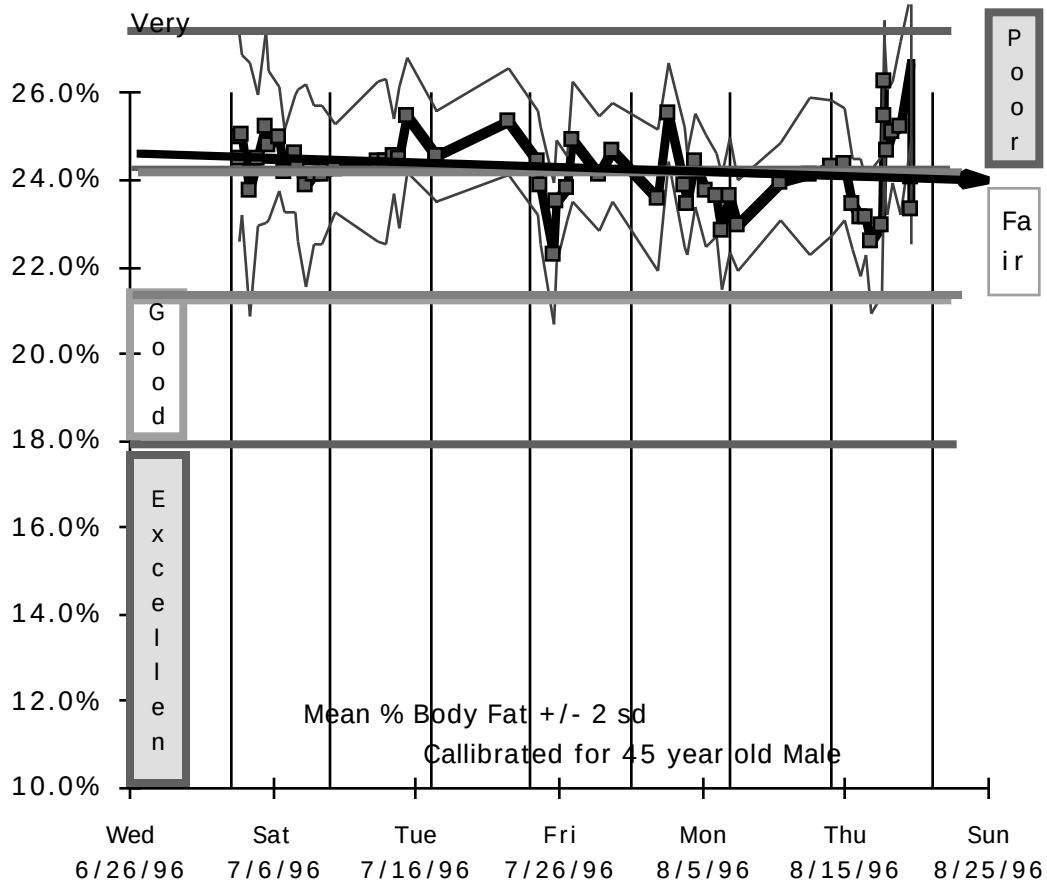
If the measurements themselves have 4.5% error built in (whatever that means) can I detect a trend within all this variation and all this error? With 5 or 6 weeks of data, 1 or 2% change is the most that would be credible since I have neither eliminated food nor dedicated myself exclusively to exercise.

Here is the graph and here are the data. They are not equally spaced in time. I did not always take ten measurements. And toward the end I took many measurements because I couldn't believe the numbers. The last measurements are close together because

I was trying to figure out what could possibly be going on that I would (appear to have) gained, in one instance, 3% during one hour. So I took multiple measurements, hoping to outweigh the bizarre values with others that would return to what had appeared normal. The result was the opposite, replicating the bizarre values.

So, is there a trend? How much? (The annotations, Very Poor, Poor, Fair, and so forth, are based on the instruction manual.

I presume that you can collect and analyze analogous data for a variety of physiological measures and indicators of performance.



Date	Mean Percent Body Fat	Standard Deviation										
Wed 7/3/96 13:42	25.0%	1.2%	24.8%	25.6%	26.4%	24.2%	26.2%	26.1%	24.2%	23.4%	23.2%	25.8%
Wed 7/3/96 17:42	25.0%	0.9%	24.3%	25.5%	25.0%	24.1%	23.8%	25.2%	25.7%	26.7%	25.8%	24.3%
Thu 7/4/96 11:02	23.8%	1.5%	23.5%	23.0%	24.7%	22.6%	27.4%	22.5%	22.8%	23.6%	23.4%	24.2%
Thu 7/4/96 21:00	24.5%	0.8%	23.7%	23.5%	24.2%	24.8%	25.2%	23.9%	24.6%	23.8%	25.6%	25.4%
Fri 7/5/96 11:00	25.2%	1.1%	24.4%	23.5%	24.3%	25.6%	24.5%	24.8%	26.0%	26.9%	26.7%	25.4%
Fri 7/5/96 17:00	24.8%	0.9%	25.5%	25.9%	24.8%	25.0%	25.8%	24.5%	25.0%	23.7%	23.2%	24.5%
Sat 7/6/96 9:00	25.0%	0.6%	25.0%	25.3%	24.6%	25.9%	25.0%	25.5%	23.9%	25.1%	24.2%	25.1%
Sat 7/6/96 18:00	24.2%	0.5%	24.1%	23.4%	23.6%	24.4%	24.7%	24.9%	24.5%	24.3%	24.3%	23.8%
Sun 7/7/96 11:00	24.6%	0.7%	24.6%	25.7%	24.5%	23.8%	24.3%	23.9%		24.7%		25.5%
Sun 7/7/96 16:00	24.3%	0.9%	25.5%	24.6%	25.5%	23.4%	22.8%	24.5%	24.5%	23.6%	24.1%	24.7%
Mon 7/8/96 9:00	23.9%	1.2%	24.5%	22.9%	24.2%	24.0%	23.8%	21.9%	22.4%	25.4%	24.0%	25.4%
Mon 7/8/96 21:00	24.1%	0.8%	24.0%	25.2%	25.7%	24.0%	23.2%	23.2%	23.6%	23.8%	24.5%	24.0%
Tue 7/9/96 9:00	24.1%	0.8%	24.0%	25.2%	25.7%	24.0%	23.2%	23.2%	23.6%	23.8%	24.5%	24.0%
Wed 7/10/96 9:00	24.3%	0.5%	23.9%	24.5%	24.3%	24.1%	24.8%	23.1%	24.6%	24.7%	24.5%	24.0%
Sat 7/13/96 9:00	24.4%	0.9%	25.8%	24.2%	24.6%	22.9%	24.9%	24.2%	25.4%	23.4%	25.1%	23.7%
Sat 7/13/96 21:00	24.4%	1.0%	22.3%	24.1%	24.9%	24.3%	24.3%	24.5%	25.5%	25.6%	25.0%	23.8%
Sun 7/14/96 9:00	24.6%	0.4%	24.4%	25.3%	24.1%	24.7%	24.5%	25.0%	24.6%	23.8%	24.2%	24.8%
Sun 7/14/96 21:00	24.5%	0.8%	26.2%	23.7%	25.2%	24.5%	24.5%	23.3%	23.9%	24.9%	24.3%	24.6%
Mon 7/15/96 9:00	25.5%	0.6%	24.2%	26.2%	25.0%	24.4%	25.7%	25.5%	25.7%	25.9%	25.5%	25.0%
Wed 7/17/96 9:00	24.6%	0.5%	24.2%	24.5%	23.6%	24.7%	24.6%	25.4%	24.9%	24.7%	23.8%	24.5%
Wed 7/17/96 9:00	24.6%	0.5%	24.2%	24.5%	23.6%	24.7%	24.6%	25.4%	24.9%	24.7%	23.8%	24.5%
Mon 7/22/96 9:00	25.4%	0.6%	25.1%	25.2%	25.5%	25.8%	24.1%	25.6%				
Wed 7/24/96 10:00	24.4%	0.6%	24.1%	24.5%	24.3%	25.6%	23.9%	24.5%				
Wed 7/24/96 16:00	23.9%	0.7%	22.3%	24.1%	23.8%	24.0%	23.6%	24.0%				
Thu 7/25/96 16:00	22.3%	0.8%	20.5%	21.9%	22.1%	23.3%	22.6%	23.0%	21.8%	22.5%	21.6%	22.9%
Thu 7/25/96 21:00	23.5%	0.7%	24.5%	23.8%	23.2%	23.5%	24.0%	23.3%	21.8%	23.3%	23.5%	23.8%
Fri 7/26/96 12:00	23.8%	0.4%	24.2%	23.8%	22.9%	23.7%	24.2%	23.8%	23.7%	24.0%	23.9%	23.7%
Fri 7/26/96 20:00	24.9%	0.7%	25.0%	25.1%	25.4%	24.1%	23.2%	25.0%	25.5%	24.8%	24.4%	24.6%
Sun 7/28/96 18:00	24.2%	0.7%	23.3%	23.8%	23.3%	24.5%	24.3%	25.1%	24.0%	25.2%	23.8%	24.6%
Mon 7/29/96 18:00	24.7%	0.6%	23.8%	24.7%	24.5%	24.8%	25.4%	24.7%	24.6%	24.4%	24.2%	25.8%
Thu 8/1/96 23:00	23.6%	0.8%	25.5%	23.4%	24.6%	23.6%	23.5%	22.7%	24.0%	24.5%	23.3%	23.4%
Fri 8/2/96 15:00	25.6%	0.6%	25.6%	24.8%	25.9%	24.4%	26.1%	25.5%	25.8%	25.2%	26.0%	24.9%
Sat 8/3/96 18:00	23.9%	0.7%	24.5%	23.3%	23.1%	24.3%	25.4%	23.2%	23.8%	23.9%	23.6%	24.1%

Sat 8/3/96 21:00	23.5%	0.6%	24.0%	23.9%	22.3%	23.2%	24.3%	23.5%	22.9%	23.4%	23.6%	23.0%
Sun 8/4/96 13:00	24.5%	0.5%	24.2%	25.1%	24.2%	25.5%	25.0%	23.7%	24.2%	24.2%	24.7%	24.7%
Mon 8/5/96 8:00	23.8%	0.6%	24.3%	23.4%	22.9%	24.1%	23.6%	22.8%	24.3%	23.1%	24.6%	23.9%
Mon 8/5/96 22:00	23.7%	0.5%	23.7%	22.9%	23.7%	24.6%	23.3%	23.6%	23.5%	23.1%	23.9%	23.9%
Tue 8/6/96 10:00	22.8%	0.7%	23.0%	23.9%	22.1%	22.3%	22.1%	23.3%	22.0%	23.6%	22.8%	22.8%
Tue 8/6/96 22:00	23.7%	0.7%	23.2%	23.6%	24.1%	22.2%	22.5%	23.9%	23.8%	24.0%	22.9%	23.7%
Wed 8/7/96 10:00	23.0%	0.5%	22.8%	24.2%	22.8%	22.1%	22.9%	23.2%	23.0%	22.6%	23.0%	23.1%
Sat 8/10/96 13:00	24.0%	0.5%	24.6%	24.1%	23.4%	24.5%	24.2%	24.0%	23.4%	23.6%	23.4%	23.9%
Mon 8/12/96 13:00	24.1%	0.9%	24.2%	25.0%	23.9%	23.6%	22.0%	24.4%	24.4%	25.4%	23.9%	24.0%
Tue 8/13/96 22:00	24.3%	0.8%	24.0%	25.4%	23.5%	25.3%	25.3%	24.0%	24.3%	23.4%	25.3%	24.3%
Wed 8/14/96 22:00	24.4%	0.6%	23.8%	24.4%	24.3%	25.7%	25.4%	24.5%	25.1%	24.0%	24.1%	24.0%
Thu 8/15/96 10:00	23.5%	0.5%	23.6%	22.9%	23.2%	24.0%	23.6%	23.7%	23.3%	23.2%	24.5%	22.7%
Thu 8/15/96 23:50	23.2%	0.7%	23.1%	23.1%	23.2%	22.9%	23.5%	24.7%	22.4%	23.8%	22.4%	23.6%
Fri 8/16/96 11:50	23.2%	0.4%	23.2%	23.6%	23.5%	23.2%	22.8%	22.8%	23.4%	23.1%	23.1%	22.1%
Fri 8/16/96 19:00	22.6%	0.8%	23.2%	23.6%	24.3%	21.8%	23.5%	22.6%	22.1%	22.6%	22.2%	22.0%
Sat 8/17/96 11:00	23.0%	0.8%	22.8%	23.9%	21.6%	24.2%	23.4%	24.0%	23.1%	22.4%	22.8%	22.6%
Sat 8/17/96 18:00	26.3%	0.7%	25.8%	26.5%	26.5%	27.5%	26.1%	27.2%	25.4%	25.8%	25.7%	26.7%
Sat 8/17/96 19:30	25.5%	0.9%	24.1%	25.2%	26.2%	26.4%	25.6%	25.5%	26.4%	24.4%	24.3%	25.4%
Sat 8/17/96 20:00	24.7%	0.7%	23.6%	24.8%	24.0%	24.3%	26.0%	24.5%	23.8%	25.2%	24.8%	24.9%
Sun 8/18/96 9:00	25.1%	0.6%	25.6%	25.1%	26.1%	26.1%	26.3%	25.1%	25.1%	25.1%	24.7%	24.7%
Sun 8/18/96 21:00	25.2%	1.0%	23.3%	25.2%	22.9%	24.7%	25.5%	25.2%	25.5%	25.3%	25.4%	23.6%
Mon 8/19/96 12:40	26.7%	0.9%	26.7%	27.7%	25.9%							
Mon 8/19/96 12:40	23.3%	0.4%	24.0%	23.5%	23.1%	23.1%	23.2%	24.1%	23.5%	23.4%	23.1%	22.9%

be 7 or 8 pounds in 5 or 6 weeks. I would know if something would be quite dramatic if it occured

. and if, as I can almost guarantee, I have not lost fat on that order of magnitude during the first month or two, can I even detect a trend in the measurements of that time. (I presume a drop from 25% bodyfat on July 3 to 20% body fat in the middle of August would be quite noticeable: If it were pure loss, without increase in muscle, that would