TITLE

Human Energy Metabolism can be expressed quantitatively:

Energy Intake, EI, is the amount of calories ingested (Clin, 2012). Energy Stored, ES “reflects net changes in the body mass of carbohydrate, protein and fat” (Clin, 2012). Energy Expendture, EE can be subdivided into three parts

Resting Energy Expenditure (REE) is the rate of energy at rest, influenced by body size and composition. Thermic Effect of Food (TEF) represents “digestion and processing of ingested food” (Clin, 2012). Activity Energy Expenditure (AEE), is ‘Energy Expenditure Rate during activity’ (Clin, 2012). Both equations can be combined:

For body weight maintenance EI should be equal to EE. “Any imbalance between the intake and utilization of these macronutrients will lead to an alteration in body composition” (Clin, 2012). Quantitatively we can interpret ES to represent this alteration. We obtain ES > 0 when EI > EE, and ES < 0 when EI < EE. Positive balance for prolonged period of time causes measurable weight gain ( Galgani and Revussin, 2008). In this investigation we are going to consider whether positive energy balance results in higher Body Mass Index (BMI), Waist to Hip Ratio (WHR) and Body Fat percentage (BF%) in males and females. In this experiment TEF was excluded due to limitations in availability of equipment required. As discussed by Reed and Hill (1996) ventilated-hood indirect calorimetry system is needed to calculate the accurate Resting Metabolic Rate in first place, so that the rest of the procedures are valid. For collecting other data cheap, quick, easy and non-invasive methods were used.

Methods

1. Calculation of Energy Intake

Each of the 50 participants involved (48 females and 12 males) kept a food diary for a 48-hour period (Figure 1.1). The average of the total energy content (kcal) form two days was calculated.

1. Energy Expenditure

Each participant kept an activity diary for a 48 hour period (Figure 1.2). The average from two days was calculated. Height of each individual was measured using the stadiometer. Each participant stand bare feet in a natural position and the height was noted. Resting Energy Expenditure (REE) was measured using a spirometer for five minutes placing a mouthpiece removed from a Milton fluid in the mouth and clipping the nose. Each subject was breathing from spirometer for 5 minutes. Each individual was told to relax breath in from the spirometer at the start and exhale into the spirometer at the end of time. Oxygen volume inhaled was subtracted from the initial volume of oxygen present in the spirometer. Then each litre of oxygen inhaled was converted into kcal of energy knowing that each litre produces 4.8 kcal of energy. Therefore by knowing the average number of calories used per minute, results were scaled into the 24 hour period of time to obtain REE. This allowed to calculate the Total Energy Expenditure (TEE) by multiplying REE with daily activity factor.

1. Energy Stored

Weight and BF% were measured using a laboratory scale (Tanita) incorporated with Bioelectric Impedance Analysis. One kilogram was subtracted from the weight for additional clothing. From the data gathered, Body Mass Index (BMI) was calculated (Figure 1.3). Then WHR was measured by noting the narrowest point on the torso and the greatest circumference at the buttocks using a tape-measure. Those two values where then divided respectively.

Results

Energy Balance is treated as the **independent variable** throughout this analysis, as it is a direct cause of body composition changes.

WHR, BMI

The following variables are analysed as

To enable powerful statistical analysis

For each person Energy Balance (E\_B) was calculated by subtracting energy output from energy intake. The following 3 graphs were produced separately for males and females: BMI against E\_B (fig. 1 and 2), body fat percentage BF\_% against E\_B (fig. 3, 4), and WHR against E\_B (fig. 5, 6). For each graph the line of best fit was used to investigate correlation in the sample.

In graph 1 (females one) there is a negative association between BMI and energy intake ( The higher the energy Intake, the lower the BM) The trend is the same for males, however in females it is slightly more negative.

Limitations:

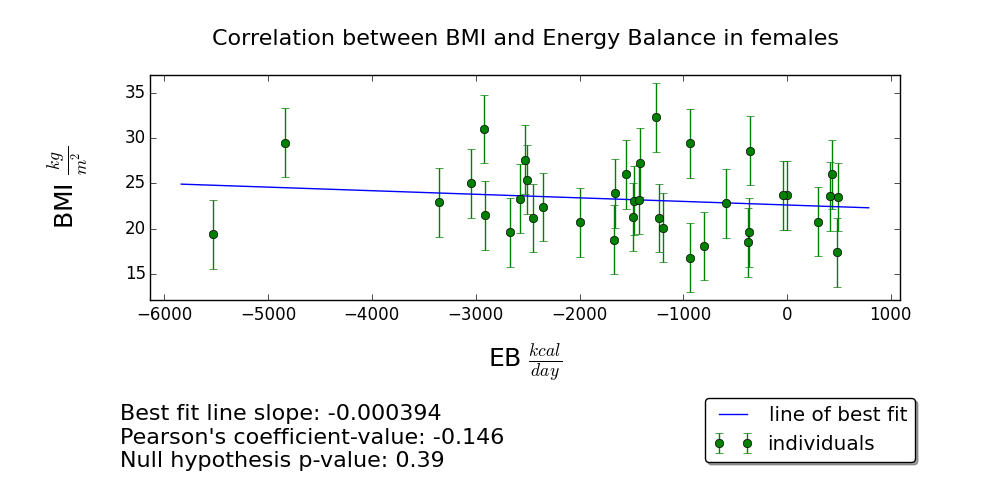
There are certain procedures which may have lead to errors. To make the experiment statistically more valid, higher number of participants should have been used as well as equal number of males and females. A 48 hour period might not be an accurate source of the exact diet and activity of a person. Additionaly, data provided might not have been honest due to the fact that subjects knew in what way their data was being analysed. One of the ways to improve accuracy could be to ask subjects to keep food and activity diaries for a month without any additional information provided about the experiment. One of the biggest errors was the measure of REE, because it was done in a laboratory and for a short period of time. To improve this, each individual could rest for 30 minutes before the test was done, should consume the last meal 2 hours before the test, do the test in a quiet room and should not move their arms and legs during. Body fat percentage and weight of each participant was measured in clothes, which influenced values relying on those. To improve the accuracy for both of those all participants should be naked and on an empty stomach in the morning in case of water and food influence. Equal number of males is needed to increase accuracy for male results (mention graphs) REPETITION?

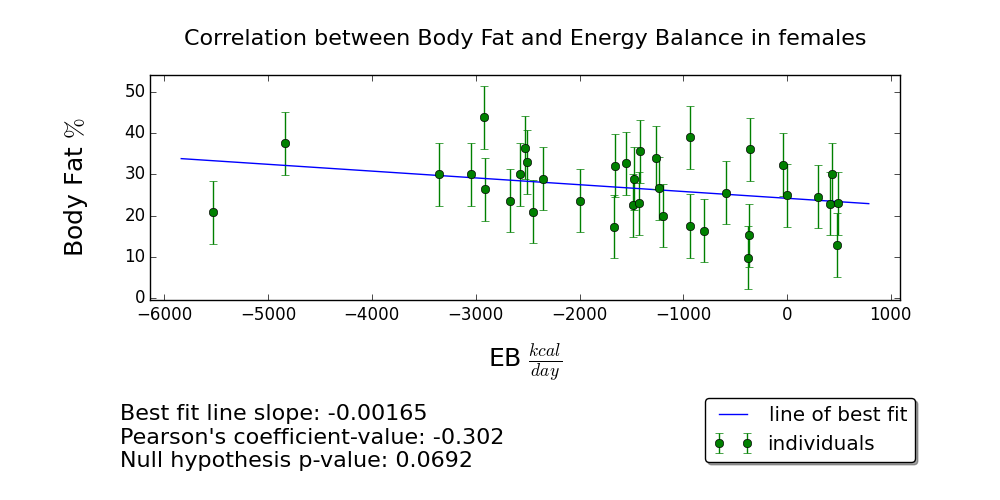
|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Food/drink consumed | Portion small/medium/large | Amount (g) | Energy Content (kcal/100) | Total Energy Content (kcal) |
| Breakfast |  |  |  |  |  |
| Lunch |  |  |  |  |  |
| Tea |  |  |  |  |  |
| Supper |  |  |  |  |  |
| Extra Snacks |  |  |  |  |  |
| TOTAL FOR 24 HOURS (kcal) | | | | | |

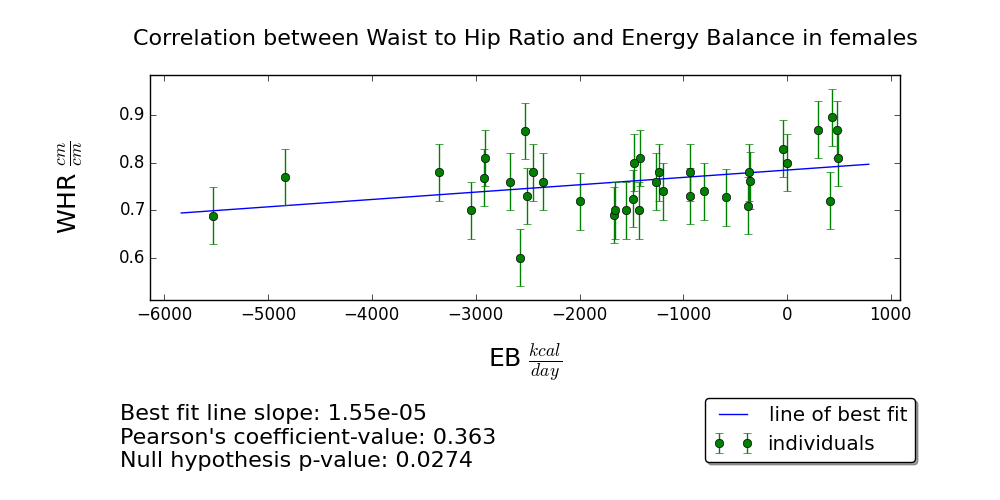
Figure 1.1 Food Diary for a 24 hour period

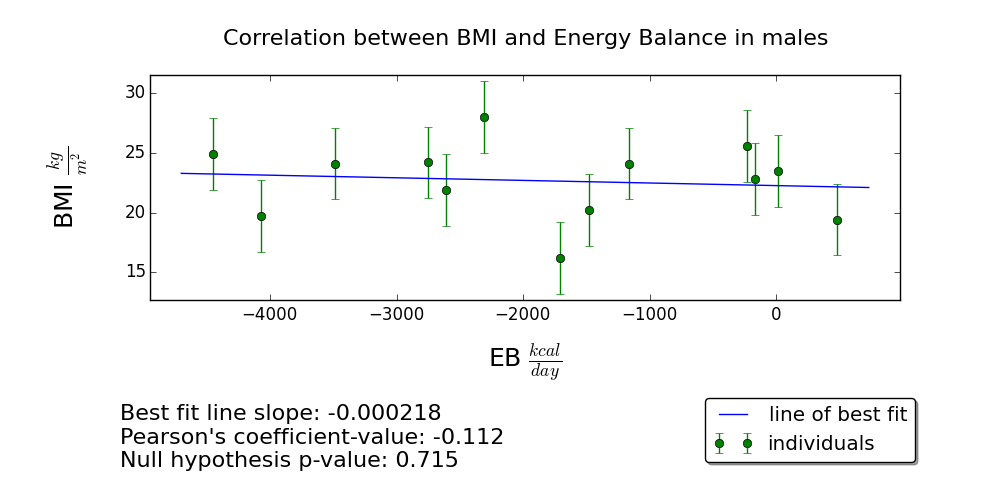
|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Hours | Time of day | Activity | Duration (hours) | Activity factor | Duration  X  Activity factor |
| 1 |  |  |  |  |  |
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| 23 |  |  |  |  |  |
| 24 |  |  |  |  |  |
| TOTAL | | | | |  |
| AVERAGE DAILY ACTIVITY FACTOR (total/24) | | | | |  |

Figure 1.3 Body Mass Index equation.









References:

1. Hall, K. D., Heymsfield, S. B., Kemnitz, J. W., Klein S., Schoeller, D. A. & Speakman, J. R. (2012) Energy balance and its components: implications for body weight regulation. The American Journal of Clinical Nutrition. 95(4). p. 989-994.
2. Galgani, J. & Ravussin, E. (2008) Energy metabolism, fuel selection and body weight regulation. International Journal of Obesity. 32. p. S109–S119.
3. Reed, G. W. & Hill J. O. (1996) Measuring the thermic effect of food. American Journal of Clinical Nutrition 63(2). p. 164-9.