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Comparison of the subjective sense of high or low metabolism and objectively measured resting metabolic rate

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Abstract

Objective To measure caloric intake, physical activity level and resting metabolic rate in participants having the subjective opinion of either having a high or low metabolic rate.

Methods Recruitment by local advertising of healthy subjects feeling that they have high or low metabolism i.e. either a tendency to easily stay lean ("high) or to very easily gain weight ("low") also when taking food intake in comparison with physical activity into account. Walking distance was estimated by pedometry, assessment of caloric intake was determined by food registration. Measurement of resting metabolic rate was performed in the fasting state.

Results We recruited 44 participants with a sense of "high" metabolism and 12 subjects in the contrasting group. Subjects with "high" metabolism were leaner ("high": 20.4±2.1 kg/m^2, "low": 27.8±7.5 kg/m^2, $p < 0.0001$) and reported a higher caloric intake than those with "low" metabolism ("high": 11435±2420 kJ/24h, "low": 8339±2679 kJ/24h, p= 0.001). Despite this there was no difference in the measured resting metabolic rate between the two groups ("high": 7230±1233 kJ/24h, "low": 7430±1422 kJ/24h, p= 0.6), nor was there any difference in physical activity measured by pedometry. Resting metabolic rate was negatively correlated with age and positively correlated with BMI in multivariate analyses of the total cohort.

Conclusion The sense of having a low or high metabolic rate is not related to actual resting metabolic rate.

Introduction

The prevalence of obesity is increasing world wide. In most cases the excess fat tissue is a natural consequence of a high intake of calories in combination with relatively low levels of physical activity. However, it is reasonable to assume that some individuals have a greater tendency to gain weight than others, and wise versa, that others are relatively protected against becoming obese due to genetic differences in basal metabolic rate and the response to excess caloric intake. Such potential differences between subjects can be found by prospectively evaluating the amount of increase in body weight following standardized hyper-alimentation. We have earlier conducted a study of fast food based hyper-alimentation and noticed a highly varying increase in body weight and change in body composition, partly dependent on gender [1,2]. In particular, we were intrigued by the notion that one participant who was certain he would not be able to increase in body weight by doubling the caloric intake in this fast food trial [1], actually reached the maximal 15% increase in body weight within 4 weeks. On the other hand, two subjects increased their basal metabolic rate to +30% within two weeks and hence gained very little weight, but seemed unaware of their relative predisposition to be protected against hyper-alimentation induced obesity. These few observations are in line with findings of individual differences of the increase in metabolic rate following increased caloric intake [3]. Furthermore, several rare genetic diseases are now known that lead to obesity and that are linked with differences in basal metabolic rate [4-7]. It is presently not known if differences in basal metabolic rate are commonly associated with the sense of being either relatively protected against obesity, or the opposite, to have a tendency to unduly easy increase body weight despite normal or even a high physical activity level.

We performed a study in which we advertised for healthy subjects that considered themselves to be either of two extremes: having a high metabolism and thus a tendency to stay lean, or the opposite, to very easily increase in weight without any subjective sense of overconsumption of calories. The aim of this observational study was to compare the opinion of the participants of having a “high” or “low” metabolism with actual measurement of resting metabolic rate, physical activity and reported caloric intake. Since many earlier surveys have investigated severely obese subjects [8-10] we focused the recruitment on subjects that had the opinion that they had a “high” metabolic rate.

Subjects and methods

By local advertising in the Linköping area in Sweden, we recruited 44 subjects with high metabolism and 12 subjects with low metabolism. The advertising announced that we recruited healthy subjects being 20-50 years old that had a sense of being lean despite eating large amounts of food, or the opposite, subjects being overweight despite eating low amount of calories. Both categories were asked to also take physical activity into account in their judgment of caloric requirement. They were asked to fill out the SF36 questionnaire [11], and they were equipped with pedometers and scales to weigh and note the exact amount of food intake during three days. About a week later they returned to the clinic and resting metabolic rate was measured using a ventilated hood technique (Delta Trac, SensorMedics, Yorba Linda, CA, USA) [12] after an over night fast in the morning (i.e. a minimum of 10 hours without food or drinks except water). The mean value of one measurement per minute during the last six minutes of a 20 minute period was calculated, as previously described [13]. Blood was drawn in all subjects for analysis of thyroid hormone levels at this second visit. A specially designed software, Dietist XP, version 3.0 (Kost och Näringsdata AB, Bromma, Sweden) was used for analyzing caloric intake according to the food reports.

Statistics and power calculation

Statistical calculations were done with SPSS 18.0 software (SPSS Inc. Chicago, IL, USA). Linear correlations were calculated, except as stated in the text. Comparisons within and between groups were done with Student's paired and unpaired 2-tailed t-test or as stated in the results section. Mean (SD) is given unless otherwise stated. Statistical significance was considered at the 5% level ($p \leq 0.05$). The study had 99% power to detect a 10% difference in resting metabolic rate between the two groups based on earlier assessment of the precision of the measurement [13].

Ethics

The study was approved by the Ethics Committee of Linköping University and performed in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participating subjects.

Results

The 44 participants in the high metabolism group were leaner and reported a higher caloric intake than the 12 subjects who had a sense of low metabolism (see Table I that shows the participants characteristics). Despite this there was no difference in the measured resting metabolic rate between the two groups, nor was there any difference in physical activity measured by pedometers (see Table I and Figure 1). However, 9 subjects in the high metabolism group and one subject in the group with low metabolism did not correctly handle the pedometers and thus data were lost in these subjects. There was also no difference in the reported level of general physical activity between the groups (see Table II).

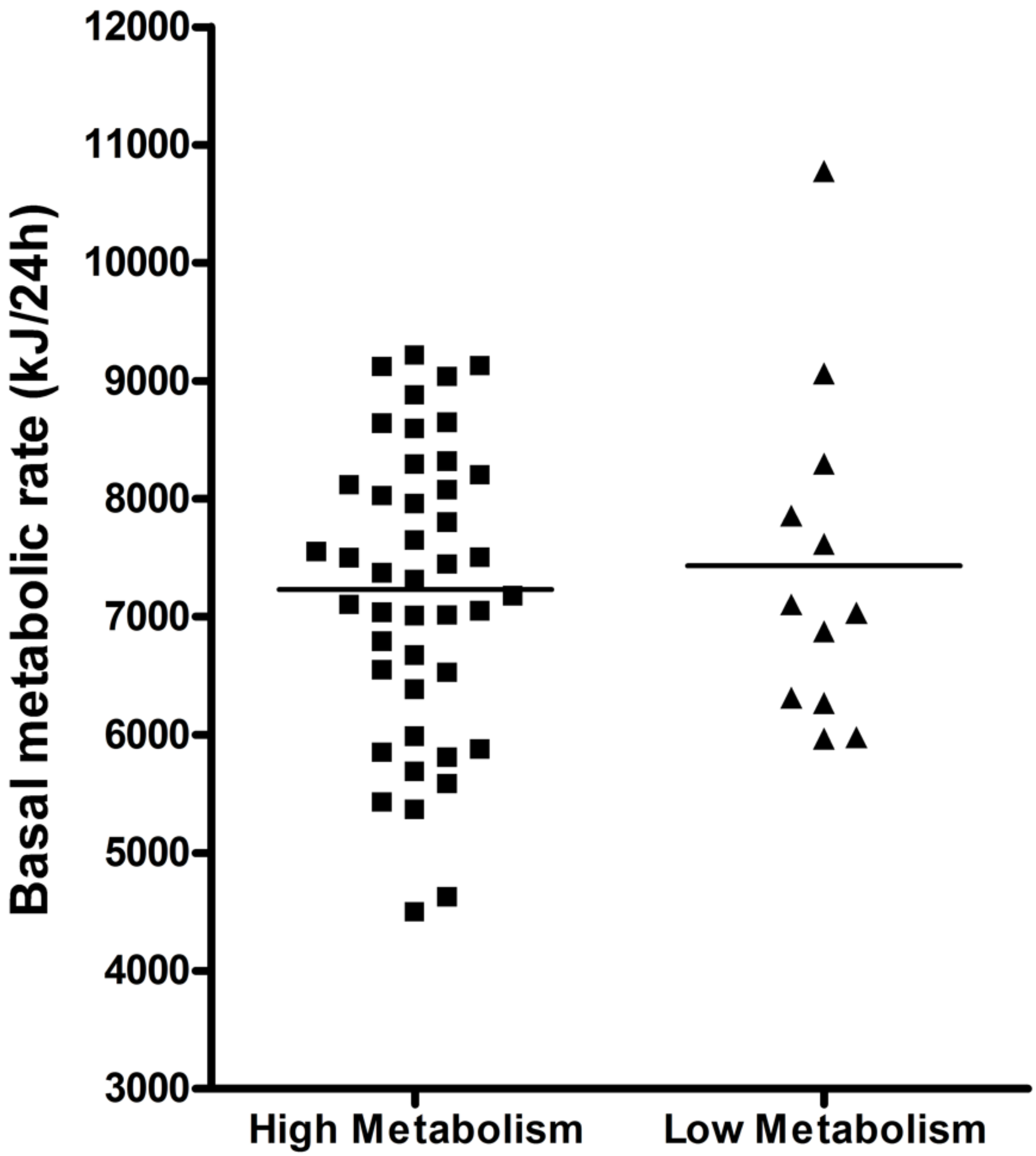

Figure 1.
Fasting level of resting metabolic rate of the participating subjects.
High metabolism: participants that subjectively evaluated their metabolism as being high, n= 44.
Low metabolism: participants that subjectively evaluated their metabolism as being low, n= 12.
The measured resting metabolic rate (y-axis) was similar in both groups (high metabolism: 7230±1233 kJ/24h, low metabolism: 7430±1422 kJ/24h, p= 0.6).

There was a positive correlation between body-mass-index (BMI) and resting metabolic rate when analyzed in the total material ($r = 0.52$, $p < 0.0001$). The level of thyroid hormone, serum T4, was positively correlated to the level of the resting metabolic rate when analyzed in the total material ($r = 0.32$, $p = 0.02$). A linear regression model with resting metabolic rate as the dependent variable and gender, steps/day by pedometer, smoking, age, BMI, reported caloric intake and reported level of physical activity as independent variables, gave an R-value for the total model of 0.91 ($p < 0.0001$). Individual variables that were related significantly to BMR in this model were gender (men= 1, women= 2, standardized Beta -0.7, $p < 0.0001$), age (standardized Beta -0.19, $p = 0.04$) and BMI (standardized Beta 0.56, $p < 0.0001$). A corresponding model with reported energy intake as dependent variable and gender, steps/day, smoking, age, BMI, resting metabolic rate and level of physical activity as independent variables gave an R-value of 0.53 with a statistically non-significant p-value of 0.09. Among the entered independent variables in this equation, only BMI was related to energy intake (standardized Beta -0.58, $p = 0.03$). In a non-adjusted linear regression analysis reported caloric intake was also negatively correlated with BMI in the total material ($r = -0.32$, $p = 0.02$).

Analysis of results of SF36 showed that the score for “bodily pain” differed between the two groups, with the group with “high” metabolism achieving the highest score (87.7 ± 14 vs. 67.8 ± 24, $p = 0.001$).

Discussion

Despite our aim to find subjects with presumed “high” or “low” metabolic rate we were unable to document differences in resting metabolic rate between our two groups. This was not due to the fact that subjects did not concert with the inclusion criteria, since a clear difference in both body weight and in caloric intakes was indeed found, with subjects in the presumed high metabolism group being leaner and subjects in the presumed low metabolism group reporting a low caloric intake. As can be seen in Figure 1 the lack of differences between the two groups was not explained by outliers in the level of resting metabolic rate, since there was an apparent similarity in the distribution of this measured variable in the two groups. Indeed, several subjects in the “high” metabolism group had lower resting metabolic rate than those with the lowest metabolic rate in the contrasting group. Furthermore, the participant with the highest recorded resting metabolic rate was found in the group of subjects with presumed “low” metabolism.

The apparent difference between the subjective sense and measured level of resting metabolic rate could not be accounted for by the level of physical activity in our study. Both measured walking distance and reported level of physical activity was similar in both groups. The similarity in metabolism between the two groups was also apparent regarding levels of thyroid stimulating hormone and serum T4, and none of the investigated subjects showed laboratory signs of overt thyroid disease.

The level of the resting metabolic rate in the total cohort was positively correlated with BMI and negatively correlated with age, which is in line with many earlier studies [14-16]. Reported energy intake, however, was more difficult to capture in a statistical model containing several variables that could be assumed to be associated with this variable. The model was not in itself statistically significant but BMI, when considered separately, or in the model, was negatively correlated with reported energy intake. Indeed, reported intake of caloric intake has been found to be negatively associated with BMI also in earlier studies [17,18].

In conclusion, despite recruiting two groups representing presumed extremes in appreciation of metabolic rate, we found no differences in the measured resting metabolic rate. Apparently, in the selected cohorts that we investigated, the sense of having low or high metabolic rate is not correlated with objective findings. Our study unfortunately also shows that recruitment of subjects by advertising that might be relatively protected to become obese due to high resting metabolic rate, is apparently an inefficient way to find such individuals.

Competing interests There are no competing interests for any of the authors in relation to this manuscript.

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Table I.

Characteristics of study participants.

Figures are means (SD).

	Subjects considering themselves to have low metabolism	Subjects considering themselves to have high metabolism	P-value between groups
Total number	12	44	
Men/women	5/7	29/15	0.2
Age (years)	29.6 (12)	25.7 (4.4)	0.07
Smoking	0 (0%)	3 (6.8%)	0.07
Body mass index (kg/m^2)	27.8 (7.5)	20.4 (2.1)	<0.0001
Energy intake[a] (kJ/24h)	8339 (2679)	11435 (2420)	0.001
Fat intake (g/day)	72.3 (27)	92.5 (27)	0.031
Carbohydrate intake (g/day)	237 (102)	334 (74)	0.001
Protein intake (g/day)	83.2 (32)	104 (30)	0.046
Resting metabolic rate (kJ/24h)	7430 (1422)	7230 (1233)	0.6
Thyroid stimulating hormone (U/L)	1.9 (0.55)	1.9 (0.95)	0.9
Serum T4 (pmol/L)	13.8 (2.0)	14.2 (2.2)	0.6
Steps/day[b]	7127 (2786)	6168 (2148)	0.2

[a]Data on food intake was missing in four subjects in the “high” metabolism group and in one subject in the “low” metabolism group. [b]Data on pedometry was missing in nine subjects in the “high” metabolism group and in one subject in the “low” metabolism group

Table II.

Reported level of exercise in the two groups.

Figures are means (SD). The difference in the mean score between the groups was not statistically significant ($p= 0.35$).

Weekly exercise	Subjects considering themselves to have low metabolism	Subjects considering themselves to have high metabolism
None	1 (8.3%)	4 (9.1%)
Irregularly	1 (8.3%)	9 (20.5%)
One time/week	1 (8.3%)	5 (11.4%)
Two times/week	4 (33.3%)	13 (29.5%)
> two times/week	5 (41.7%)	13 (29.5%)
Mean score (based on levels above, 1-5)	3.9 (1.3)	3.5 (1.4)