Original Research as Short Communication

Differences in Basal Energy Expenditure and Obesity

Jean-Pierre Flatt

Abstract

FLATT, JEAN-PIERRE. Differences in basal energy expenditure and obesity. *Obesity.* 2007;15:2546–2548.

Objective: To assess the impact of differences in basal energy expenditure on adiposity.

Research Methods and Procedures: Statistical analysis was performed on a published database giving anthropometric and energy expenditure measurements for 433 women and 335 men. Published equations derived by multiple regression analysis were used to predict basal metabolic rates in women and in men as a function of age, weight, and height. The differences between the observed and predicted rates (i.e., the residuals) were computed and expressed in terms of percentage deviation from the predicted rates of basal energy expenditure (BEE). In addition, individual body fat contents were computed using equations based on National Health and Nutrition Examination Study 3 data relating to body fat content determined by bioimpedance to BMI.

Results: There is no correlation between percentage body fat content and deviations from predicted (which one would refer to as normal) BEE.

Discussion: It can be concluded that relatively high or relatively low rates of BEE do not influence body weights and adiposity in a statistically identifiable manner. This contradicts and challenges the widely held view that low resting metabolic rates promote the development of obesity.

Key words: basal metabolic rate, energy expenditure, body weight, adiposity

Introduction

In dealing with the obesity issue, one generally invokes the energy balance equation, i.e., energy balance = energy intake − energy expenditure to point out that excessive accumulation of body fat is obviously the result of a sustained positive energy balance. This can be attributed to excessive energy intakes and/or to abnormally low rates of energy expenditure. Changes in resting energy expenditure (REE)[1] and in adaptive thermogenesis (1) can only modestly attenuate the impact of excessive or inadequate energy intake on the energy balance (2). It has long been evident that REE increases with body size and that it is most accurately predictable when expressed in relation to the fat-free mass (3). Because the latter expands as the adipose tissue mass becomes enlarged, increased adiposity and REE are positively correlated (as illustrated in Figure 1). Nevertheless, interest in the possible role of differences in metabolic rates adjusted for body size and in possible adaptive changes in resting metabolic rates on body weight regulation has remained high (1). However, despite massive research efforts, there is still much controversy about the possible influence, or lack thereof, of relatively high or relatively low rates of REE on the development of obesity (1,2).

Research Methods and Procedures

In the preparation of the recently released Dietary Reference Intakes (DRI) report (4), all accessible published studies reporting measurements of total energy expenditure by the doubly labeled water method were evaluated. Careful attention to experimental technique is needed to obtain valid data by this method. The results considered to be sound were included in a database used to define total daily energy expenditure and energy requirements. The database, published in the DRI report, also contains information on basal energy expenditure (BEE) measurements in 433 women and 335 men. Multiple regression analysis of the latter yielded the following two equations (4):

Received for review November 16, 2006.
Accepted in final form April 6, 2007.
The costs of publication of this article were defrayed, in part, by the payment of page charges. This article must, therefore, be hereby marked "advertisement" in accordance with 18 U.S.C. Section 1734 solely to indicate this fact.
Department of Biochemistry and Molecular Biology, University of Massachusetts Medical School, Worcester, Massachusetts.
Address correspondence to Jean-Pierre Flatt, Department of Biochemistry and Molecular Biology, 364 Plantation Street, Room 813, Worcester, MA 01605.
E-mail: j.p.flatt@umassmed.edu

[1] Nonstandard abbreviations: REE, resting energy expenditure; DRI, Dietary Reference Intakes; BEE, basal energy expenditure.

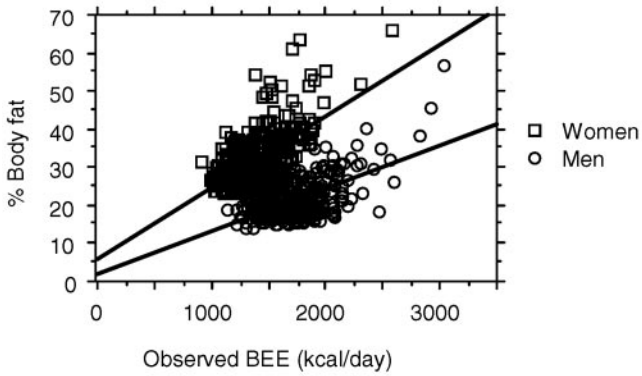

Figure 1: Percent body fat contents of 433 women and 335 men whose ages, anthropometric data, and BEE are listed in the DRI database (4), plotted against their observed daily BEEs.

$$\text{fBEE} = 247 - 2.67 \times \text{age (years)} + 8.60 \times \text{weight (kilograms)} + 401.5 \times \text{height (meters)};\ R^2 = 0.62 \quad (1)$$

$$\text{mBEE} = 293 - 3.8 \times \text{age (years)} + 10.12 \times \text{weight (kilograms)} + 456.4 \times \text{height (meters)};\ R^2 = 0.63 \quad (2)$$

where fBEE and mBEE stand for BEEs in terms of kilocalories per day in women and men, respectively. These two equations yield slightly better predictions than those proposed by Harris and Benedict (5), Schofield (6), and Henry (7), particularly because predictions made with the DRI equations show no bias relative to age, weight or height (8). The differences between the observed BEEs and the fBEE and mBEE calculated by these equations (i.e., the residuals) were calculated and expressed in terms of percentage deviation from the predicted values.

In addition to being parameters in the prediction of basal metabolic rates, weight and height data also provide information about body composition. The data collected for the National Health and Nutrition Examination Study 3 survey contain anthropometric and bioimpedance measurements from which body fat contents were calculated (9), allowing the establishment of the correlation between percentage body fat content and the BMI [i.e., the ratio of body weight (kilograms) divided by height (meters) squared]. The equations relating body fat content to BMI published in the DRI report (3), i.e.:

Percentage body fat in women

$$= 1.4303 + 1.1735 \times \text{BMI},\ R^2 = 0.77 \quad (3)$$

Percentage body fat in men

$$= -4.3422 + 0.9921 \times \text{BMI},\ R^2 = 0.55 \quad (4)$$

were used to compute the body fat contents (percentage) of the subjects in the DRI database.

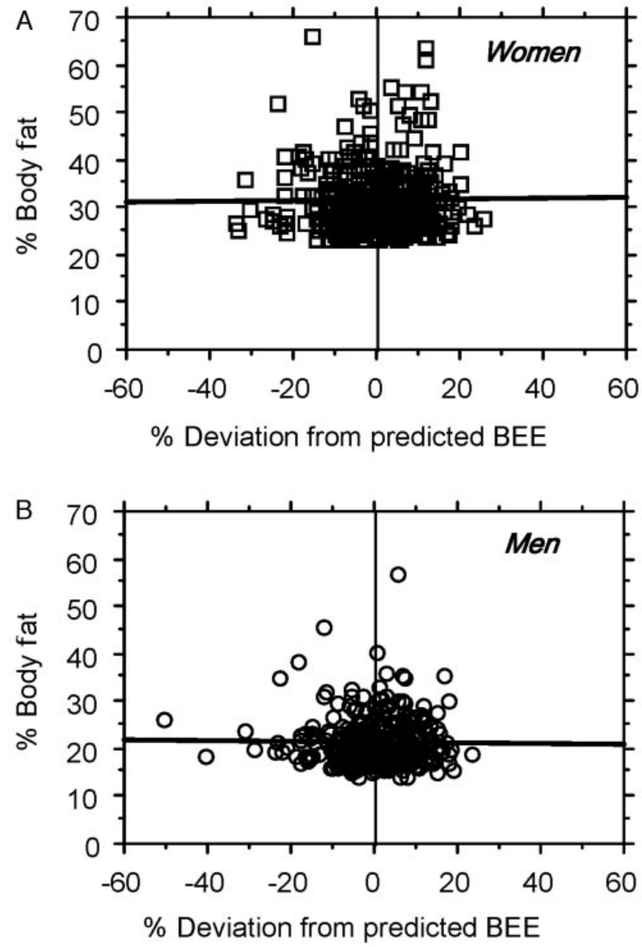

Figure 2: (Upper panel) Percent body fat contents of 433 women whose ages, anthropometric data, and BEE are listed in the DRI database (4), plotted against the deviation (percent) of their observed from their predicted (i.e., normal) daily BEE. (Lower panel) Percent body fat contents of 335 men whose ages, anthropometric data, and BEE are listed in the DRI database (4), plotted against the deviation (percent) of their observed from their predicted (i.e., normal) daily BEE.

Results

To assess the possible long-term impact of differences in basal metabolic rates on adiposity, one can first consider the relationship between body fat contents and BEE. Expansion of the adipose tissue mass brings about increases in lean body mass and in overall body size and, hence, in overall metabolic expenditure. This is reflected by the positive correlation between these two parameters described in Figure 1. It is of greater interest, however, to examine whether adiposity may be influenced by individual deviations from the average rates of BEEs predicted for their age, weight, and height. As shown in Figure 2, there is no correlation ($R^2 < 0.0002$) between men's and women's percentage body fat contents and the deviations of their basal rates of energy expenditure from the BEE predicted for their age, weight, and height. This evidence is consistent with a previous report that showed that no negative correlation can be detected between adiposity and height (2), even though height has a readily recognizable impact in raising basal and total energy expenditure (4).

Discussion

It can, therefore, be concluded that rates of BEE that are higher or lower than those predicted for a given sex, age, weight, and height do not influence adiposity in a statistically identifiable manner. This contradicts and challenges the widely held view that a low resting metabolic rate is a factor likely to contribute to the development of obesity. The lack of impact of differences in BEE on adiposity reinforces the importance of striving for a better understanding of the factors involved in the adjustment of food intake to energy expenditure (10).

Acknowledgments

There was no funding/outside support for this study.

References

1. **Dulloo AG, Jacquet J.** Adaptive thermogenesis is important in the aetiology of human obesity: the case for. *Progr Obes Res*. 2003;9:708–12.
2. **Flatt JP.** Adaptive changes in thermogenesis are NOT important in the aetiology of obesity. *Progr Obes Res*. 2003;9:713–7.
3. **Ravussin E, Lillioja S, Anderson TE, Christin L, Bogardus C.** Determinants of 24-h energy expenditure in man. *J Clin Invest*. 1986;78:1568–78.
4. **No authors listed.** *Dietary Reference Intakes.* Washington, DC: National Academy of Sciences; 2002.
5. **Harris J, Benedict F.** A biometric study of basal metabolism in man. *Carnegie Institute*. 1919;279:40–4.
6. **Schofield WN.** Predicting basal metabolic rate, new standards and review of previous work. *Hum Nutr: Clin Nutr*. 1985;39C:5–41.
7. **Henry CJK.** Mechanisms of changes in basal metabolism during ageing. *Eur J Clin Nutr*. 2000;54(Suppl 3):S77–91.
8. **Flatt JP.** A better equation for predicting basal metabolic rates (BMR) in adults. *Obesity*. 2006;14:A65.
9. **Kuczmarski RJ.** Bioelectrical impedance analysis measurements as part of a National Nutrition Survey. *Am J Clin Nutr*. 1996;64:453–8.
10. **Flatt JP.** What do we most need to learn about food intake regulation? *Obes Res*. 1998;6:307–10.