Does energy expenditure influence body fat accumulation in pregnancy?

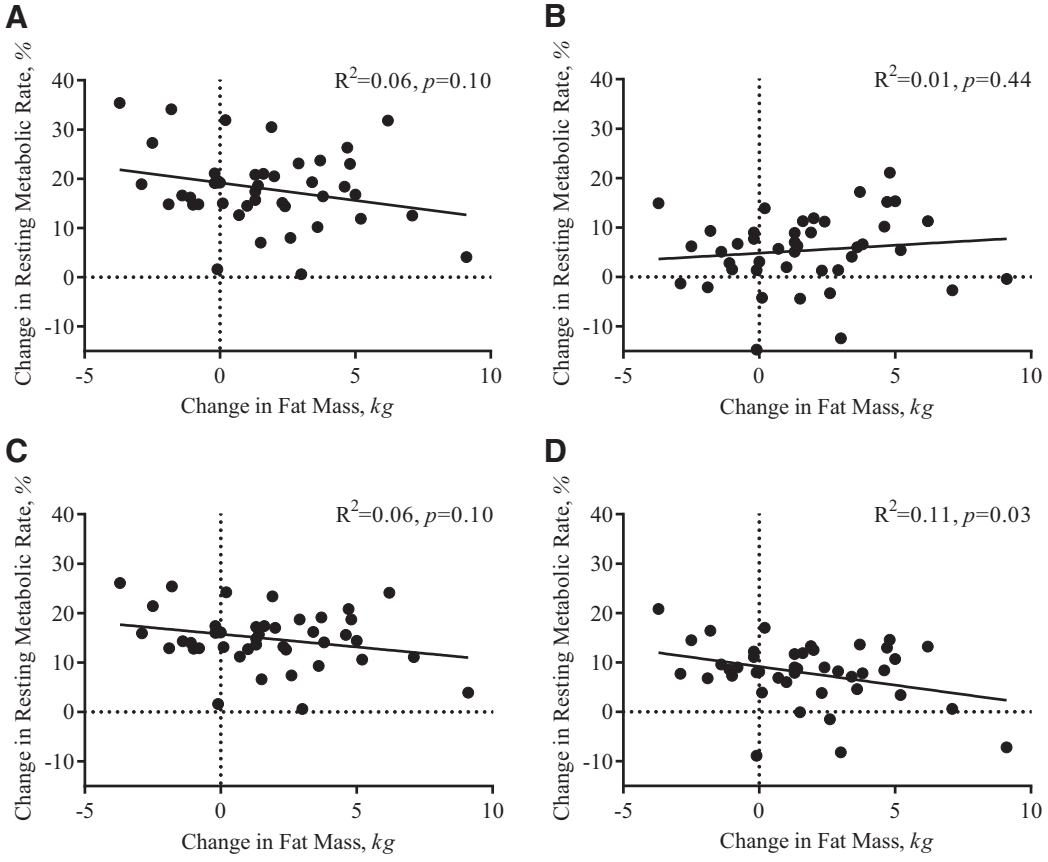
TO THE EDITORS: Berggren et al[1] provide valuable data that describe the increase in resting metabolic rate (RMR) during pregnancy and its relationship with changes in body composition. The authors showed RMR increased 19 ± 6% from early to late pregnancy.

Expressing RMR per kilogram of fat-free mass (FFM), the most important determinant of RMR, the authors account for pregnancy-related changes in FFM and showed that RMR was 7 ± 11% higher in late pregnancy and therefore concluded that there was an adaptive thermogenesis (wasting of energy). A negative correlation between the change in RMR/FFM and the change in maternal fat mass then led to the conclusion that low adaptive thermogenesis (or the inability to waste energy) may contribute to fat accumulation for some women.

The energy metabolism field has spent extensive time considering different approaches for estimating adaptive thermogenesis.[2] The field asserts that using a simple ratio (RMR/FFM) is insufficient because the y-intercept of this relation is not equal to zero.[2] Furthermore, only considering FFM when estimating adaptive thermogenesis is not sufficient because fat mass (FM) contributes 7−12 kcal/kg to RMR per day.[3,4] Age and race are also significant determinants of RMR in especially large heterogeneous cohorts.

The accepted practice is to use linear regression to model independent variables of interest on the initial measured energy expenditure (ie, early pregnancy). This approach provides an equation (ie, RMR = a*[fat-free mass] + b*[fat mass] + c*[age] + intercept) that, when individual data for

FIGURE
Effect of using different methodologies to adjust resting metabolic rate



Changes in fat mass and RMR are shown from mid- to late pregnancy (weeks 22−36). Changes in RMR from mid- to late pregnancy are expressed as percentage change absolute values **(A)**, as percentage change in the ratio, RMR/FFM **(B)**, as percentage adaptive thermogenesis, using FFM as the only independent determinant of RMR **(C)**, and as percentage adaptive thermogenesis, using FFM, FM, and age as independent determinants of RMR **(D)**.

FFM, fat-free mass; *FM*, fat mass; *RMR*, resting metabolic rate.

Most. Maternal energy expenditure and fat accumulation. Am J Obstet Gynecol 2019.

each independent variable is imputed, yields an RMR for each person that is now proportional to these variables ($RMR_{adjusted}$). $RMR_{adjusted}$ can then be used in statistical analyses to understand differences between individuals or changes throughout pregnancy that are dependent on body composition and to quantify adaptive thermogenesis that is independent of body composition (ie, RMR minus $RMR_{adjusted}$).

Using our published data (Figure),[3] we also observe increases in RMR from early to late pregnancy that are similar to data from Berggren et al[1] (A, 18 ± 8% as absolute values, and B, 5 ± 7% as RMR/FFM). When using linear regression considering FFM only, the adaptive thermogenesis in RMR is 15 ± 6% (C). Yet when FM and age are also included, the adaptive thermogenesis is 8 ± 6% (D).

Hence, there are important methodological considerations needed for appropriate analysis and interpretation of RMR data (Figure). Importantly, the accepted analytical approach supports the conclusion of Berggren et al.[1] We encourage the authors to use these more rigorous statistical approaches to test the robustness of their findings, which will allow for comparison with other published studies. ■

Jasper Most, PhD
Leanne M. Redman, PhD
Department of Reproductive Endocrinology and Women's Health
Clinical Division
Pennington Biomedical Research Center
Louisiana State University
6400 Perkins Road
Baton Rouge, LA 70808
leanne.redman@pbrc.edu

This work was supported by funds from the National Institutes of Health (grant R01DK099175; to Dr Redman).

The authors have no conflict of interest to disclose.

Jasper Most and Leanne M. Redman wrote the letter, both authors have read and approved the final version of this letter, and Leanne M. Redman takes full responsibility for the content of this letter.

REFERENCES

1. Berggren EK, O'Tierney-Ginn P, Lewis S, Presley L, De-Mouzon SH, Catalano PM. Variations in resting energy expenditure: impact on gestational weight gain. Am J Obstet Gynecol 2017;217:445.e1–6.
2. Muller MJ, Geisler C, Hubers M, Pourhassan M, Braun W, Bosy-Westphal A. Normalizing resting energy expenditure across the life course in humans: challenges and hopes. Eur J Clin Nutr 2018;72:628–37.
3. Gilmore LA, Butte NF, Ravussin E, Han H, Burton JH, Redman LM. Energy intake and energy expenditure for determining excess weight gain in pregnant women. Obstet Gynecol 2016;127:884–92.
4. Most J, Vallo PM, Gilmore LA, et al. Energy expenditure in pregnant women with obesity does not support energy intake recommendations. Obesity (Silver Spring) 2018;26:992–9.

 https://doi.org/10.1016/j.ajog.2018.08.037

REPLY

We thank Drs Most and Redman for their interest and comments on our publication evaluating the relationship between changes in resting metabolic rate (RMR) and fat accretion during pregnancy. As noted in the original manuscript, our primary objective was to quantify the changes in resting energy expenditure during pregnancy and their relationship with gestational weight gain and fat accretion among healthy women.

Based on our observations over a number of years, we hypothesized that gestational weight gain and fat mass in particular are inversely related to variations in RMR. In contrast to Most and Redman, we did not assume that the increase in RMR in late gestation was an "adaptive thermogenesis (wasting of energy)" but rather represented the increased physiological work of pregnancy, such as the increase in cardiac output with advancing gestation.

However, we elected to further test our hypothesis by evaluating the adjusted RMR and RMR residuals predicted from a regression equation including fat-free mass, fat mass, and maternal age as noted by Most and Redman. We did not adjust for ethnicity/race because 96% of the subjects were white. Both the adjusted RMR ($P < .0001$) and RMR residuals ($P = .0002$) were positively and significantly associated with changes in RMR from baseline. The change in RMR residuals from before pregnancy to late pregnancy was inversely associated with changes in fat mass ($P = .02$) and weight ($P = .03$). Therefore, as noted, and consistent with the findings in our original manuscript, we conclude that changes in fat mass and weight during pregnancy are inversely related to changes in RMR, whether adjusted for fat-free mass alone or with additional adjustment for fat mass and age. ■

Patrick M. Catalano, MD
Center for Reproductive Health
Department of Obstetrics and Gynecology
MetroHealth Medical Center
Case Western Reserve University School of Medicine
Cleveland, OH 44109
pcatalano@tuftsmedicalcenter.org

Rachel E. Silver, MPH
Friedman School of Nutrition Science and Policy
Maternal Infant Research Institute
Tufts University
800 Washington Street, Box 394
Boston, MA 02111

Dr Catalano received *Eunice Kennedy Shriver* National Institute of Child Health and Human Development support from grants HD 22965-19 and CTSC UL1TR000439 to conduct this research.

The authors report no conflict of interest.

 https://doi.org/10.1016/j.ajog.2018.08.038