Adjustment of fat oxidation for metabolic body size

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CORRESPONDENCE

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In the paper on 'Relation between calcium intake and fat oxidation in adult humans', Melanson, Sharp, Schneider, Donahoo, Grunwald and Hill conclude that higher acute Ca intake is associated with higher rates of whole-body fat oxidation.[1] The conclusion was based on a positive association between 24-h fat oxidation and Ca intake, as measured in a respiration chamber. To minimize the effects of body weight, calcium intake was expressed relative to total calories consumed (mg $kcal^{-1}$) and fat oxidation relative to fat-free mass (FFM) (g kg FFM^{-1} min^{-1}). Additionally, the association between Ca intake and 24-h fat oxidation was shown by plotting the respiratory quotient (RQ) as a function of Ca intake in mg $kcal^{-1}$. The question is whether adjustment of fat oxidation for metabolic body size is correct by dividing by FFM or by adoption of RQ as a reflection of fat oxidation.

Indeed, fat-free body mass is the best predictor of energy expenditure and fuel utilization.[2] However, as stated by the same authors, energy expenditure and fuel utilization should not be divided by the absolute FFM value, as the relation with FFM has a y and x intercept significantly different from zero. When energy expenditure and fuel utilization is divided by the fat-free body mass, larger subjects tend to have lower values because of a relative overestimate of their metabolically active mass when compared with smaller subjects. Comparing sleeping metabolic rate per kg FFM between women and men, resulted in a significant difference: 143 ± 12 and 128 ± 80 kJ kg^{-1} ($P < 0.0001$) for women and men, respectively.[3] The accepted method of comparing energy expenditure and fuel utilization is by regression analysis with FFM as a covariate. In the paper by Melanson *et al*, 24-h fat oxidation (g) could be related to FFM (kg) and Ca intake (mg) in a multiple regression analysis with absolute values. Alternatively, relative values of fat oxidation (g kJ^{-1}) could be related to Ca intake (mg kJ^{-1}) in a simple regression analysis. Of course, the results can only be speculated. The subject group consisted of women ($n = 14$) and men ($n = 21$) and, as explained above, fat oxidation in gm kg FFM^{-1} min^{-1} is expected to be on average higher in women than in men. One reason to expect a higher Ca intake in mg $kcal^{-1}$ in women is due to the fact that women have a lower energy intake, but might consume a similar amount of dairy products as men. One glass of milk per day results in a higher Ca intake per kJ consumed for women compared to men. For a more realistic comparison, one could do a covariance analysis, comparing relative values of fat intake (g kJ^{-1}) as a function of Ca intake (mg kJ^{-1}) with relative values of fat oxidation (g kJ^{-1}) as a function of Ca intake (mg kJ^{-1}), assuming subjects were fed in energy balance in the respiration chamber.

The adoption of RQ as a reflection of fat oxidation is unusual, as the RQ value is a function of the oxidation of fat, carbohydrate and protein. The standard procedure is the correction of oxygen consumption and carbon dioxide production for protein oxidation as calculated from urine nitrogen output.[4] Thus, the nonprotein respiratory quotient can be calculated (NPRQ). Similarly, a nonprotein food quotient (NPFQ) can be calculated. The results should confirm the covariance analysis, comparing relative values of fat intake (g kJ^{-1}) as a function of Ca intake (mg kJ^{-1}) with relative values of fat oxidation (g kJ^{-1}) as a function of Ca intake (mg kJ^{-1}), also assuming subjects were fed in energy balance in the respiration chamber. The adoption of NPRQ instead of RQ is especially important for the presented relation with Ca intake. As mentioned, $59.5 \pm 1.7\%$ of Ca intake was from dairy products and thus, there possibly was a relation between protein intake and Ca intake reflected in the RQ relation with Ca intake. Additionally, when fat oxidation is related to Ca intake, one has to realize that apparent calcium absorption, the difference between Ca intake and Ca excretion in faeces are highly variable and at the most about 30% of intake.[5] It would be interesting to include in future studies on the effect of Ca on substrate utilization, a measurement of apparent Ca absorption in relation to variation in Ca intake, as well to get further insight into a possible relation of calcium with fat utilization.

Finally, when calcium has an effect on energy balance through an effect on fat oxidation, it has to have an effect on energy intake or total energy expenditure. The data in the study of Melanson *et al*[1] could give an answer on the latter option. Kahler *et al*[6] observed an effect of fat oxidation on energy intake. Inhibition of hepatic fat oxidation stimulated eating when baseline fat oxidation was sufficiently high.

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