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Nutrition Discussion Forum

The energy cost of protein turnover is arbitrarily distributed between maintenance requirements and protein retention efficiency – Comments by Hall

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A recent paper published in the *British Journal of Nutrition* by Roux[1] describes the use of theoretical efficiencies of protein and fat synthesis to calculate the energy requirements for growth in pigs. Not only is this an important topic for animal science, but the issues highlighted by Roux have significant implications for mathematical modelling of human weight gain – a fact that becomes especially clear when considering the consequences of a small mathematical error in the paper.

Roux erroneously asserts that the energy intake devoted to maintenance, IM, must either equal the intercept of the Kielanowski regression equation[2], INT, or the intercept plus the full cost of protein resynthesis: INT + PB/6, where PB is the protein breakdown rate in MJ/d. However, this is a false choice since there are actually an infinite number of alternatives for IM given by: IM = INT + xPB, where x is an arbitrary fraction. This implies that the energy intake devoted to protein retention (IPR) is given by:

$$\mathrm{IPR} = (1/6 - x)\mathrm{PB} + (7/6)\mathrm{PR},$$

where PR is the protein retention rate in MJ/d.

The two choices proposed by Roux are equivalent to $x = 0$ or 1/6. The infinity of possible choices for x demonstrates that the energy cost for protein turnover can be distributed arbitrarily between the maintenance energy requirement and the efficiency of protein deposition which is often represented by the dimensionless parameter k_P. Thus, it is not surprising that the value of k_P calculated via linear regression depends sensitively on the functional form of the maintenance energy expenditure since different expressions for IM will account for different proportions of the protein turnover cost[3,4]. Furthermore, a particular value for k_P can therefore only be applied in conjunction with the particular expression for IM determined in the same linear regression procedure. Otherwise, the energy cost of protein turnover will be inappropriately partitioned and incorrectly accounted. Nevertheless, several mathematical models of human weight gain have used regression values for k_P derived from rats[5], pigs[6] and infants[7] and have erroneously combined these values with equations for IM modelled for human adults[8,9] and adolescents[10].

How can this problem be avoided for modelling human energy expenditure? I have previously proposed modelling tissue deposition costs using the theoretical biochemical efficiencies for protein and fat synthesis in combination with an explicit model of protein and fat breakdown rates and their dependence on diet and body composition[11]. This approach avoids the arbitrary partitioning problem and Roux also follows this path by advocating the choice $x = 1/6$ with the corresponding theoretical value of $k_P = 6/7$, thereby allocating all of the protein turnover cost to the maintenance energy requirement. Thus, the main conclusions of Roux's paper are unaffected by his small mathematical error and he correctly points out that the theoretical biochemical efficiency of protein synthesis is a constant and can be applied across different genetic backgrounds and probably also across species.

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I declare no conflict of interest.

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