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Invited Commentary

How are normal, high- or low-protein diets defined?

In their very interesting article published in this issue of the *British Journal of Nutrition*, Keogh *et al.* (2006) observe that 'long term weight maintenance and cardiovascular risk factors are not different following weight loss on carbohydrate-restricted diets high in either monounsaturated fat or protein in obese hyperinsulinaemic men and women'.

During intensive dietary counselling for 36 weeks subjects received a 'high monounsaturated fat standard protein diet', with a macronutrient composition of 30 %, 20 % and 50 % energy from carbohydrate, protein and fat, respectively, implying an intake of 67 g/d protein, or a 'high-protein moderate fat diet', with a macronutrient composition of 30 %, 40 % and 30 % energy from carbohydrate, protein and fat respectively, implying an intake of 136 g/d protein. Although clinically significant weight losses and improvements in cardiovascular risk factors, with no adverse effects of the high-monounsaturated fat diet, were present after 1 year, no diet effects were observed.

Recently, the number of publications on 'high-protein diets' seems to increase and seemingly different results are presented. Discriminating between neutral or negative energy balance or an energy balance necessary for weight maintenance after weight loss (thus continuously preventing a challenging positive energy balance) with regard to 'high-protein diets' and 'normal protein diets' may shed some light on this issue. The interpretations of what is a low-, normal or high-protein diet are related to the energy balances that differ from neutral. It contributes to our understanding to give the protein intake in g as well as in % energy, as was done in the paper by Keogh *et al.* (2006) mentioned earlier.

In neutral energy balance, dietary protein should account for approximately 10–15 % energy when one is weight stable according to the World Health Organization (2000). Average daily protein intakes in various countries indicate that these recommendations are reflective of what is being consumed worldwide (McLennan & Podger, 1998; World Health Organization, 2000; Food and Agriculture Organization Statistics Division, 2004; Hulshof *et al.* 2004; Wright *et al.* 2004).

During weight loss the absolute intake of protein is of greater importance than the percentage energy as protein, in order to ensure that subjects are not in a negative N and protein balance, which will lead to loss of metabolically active fat free mass (FFM). Observations made in the 1980 s showed that varying the protein content of a formula diet, from 0 to 50 g/d, resulted in a body protein loss varying between 1202 to 91 g, respectively, measured over 28 d. This indicates that the absolute protein intake (expressed in g), which is normal in neutral energy balance, preserves FFM (Ditschuneit, 1984).

Although a protein intake of 90 g/d can be considered normal while ingesting 10 MJ/d (protein as 15 % energy), this protein intake becomes relatively high if energy intake is low, e.g. 5 MJ/d (i.e. protein as 30 % energy). In another study a relatively high-protein diet was compared with a control diet in order to evaluate weight loss over 6 months, when energy intake was *ad libitum*. The effect of 25 % *v.* 12 % energy intake from protein (45 % energy as carbohydrate and 30 % as fat *v.* 58 % energy as carbohydrate and 30 % as fat) on weight loss in obese subjects (BMI 30) was examined. It was found that weight loss (8.9 *v.* 5.1 kg) and fat loss (7.6 *v.* 4.3 kg) were higher in the high-protein group, partly due to a lower energy intake (5.0 MJ/d *v.* 6.2 MJ/d, $P<0.05$) (Skov *et al.* 1999). Here, 25 % energy from protein at an energy intake of 5 MJ/d implies 75 g/d protein; in absolute terms a normal protein intake with neutral energy balance as a reference (Westerterp-Plantenga *et al.* 2006). Therefore, in absolute terms, in fact, a normal protein intake was compared with a low-protein intake.

Similarly, during weight maintenance after weight loss, FFM should be preserved. Fat mass still reduced and FFM increased on a relatively high-protein diet, i.e. 18–25 % energy intake, which is in absolute terms 60–75 g/d protein intake. Since weight maintenance after weight loss usually implies a slight weight regain, Stock's model can be applied (Stock, 1999). Here, the greatest metabolic efficiency of weight gain is shown when protein intake is 10–15 % energy during overfeeding, and inefficiency is shown with <5 % and >20 % energy from protein. The latter metabolic inefficiency is related to body composition. To build 1 kg body weight with 60 % fat mass and 40 % FFM, 30 MJ needs to be additionally ingested, whereas to build only 1 kg consisting of FFM, 50–70 MJ needs to be additionally ingested (Pullar and Webster, 1977; Stock, 1999,). Therefore, a high-protein diet may promote weight maintenance by its metabolic inefficiency because of the cost involved in sparing FFM. An absolutely normal protein intake of 90 g/d while ingesting 10 MJ/d (protein as 15 % energy) also becomes a relatively high-protein diet at weight maintenance of 7.5 MJ/d (i.e. protein as 22.5 % energy). Similarly, recommendations of 'high-protein weight-maintenance diets' only suggest keeping protein intake as g/d at the same level, i.e. representing 10–15 % energy with neutral energy balance, as a reference

(Westerterp-Plantenga *et al.* 2006). For example, moderately obese men and women who consumed 18 % energy intake as protein regained less weight, i.e. 1 kg, during 3 months after 7.5 ± 2.0 % body weight loss over 4 weeks, compared with the 2 kg regained by their counterparts who consumed 15 % energy intake as protein (Westerterp-Plantenga *et al.* 2004). The composition of the body mass regained was more favourable in the additional protein group (i.e. no regain of fat mass, but only of FFM, resulting in a lower percentage body fat). Energy efficiency (kg body-mass regain/energy intake) was significantly lower in the additional protein group. With a similar design, after 6 months, a weight maintenance of 0.8 kg (high-protein group) *v.* 3.0 kg weight regain ($P < 0.05$) was shown (Lejeune *et al.* 2005); 6 months later, when the treatment had stopped and the follow-up took place, these figures were 1.0 kg *v.* 3.9 kg ($P < 0.05$) Lejeune *et al.* 2005). This suggests that, with an energy intake at weight-maintenance level, a relatively high-protein diet provides an absolutely normal protein intake, still with reference to the original, neutral energy balance. In addition, again, in fact, a normal protein intake is compared with a low-protein intake. In this way, a normal protein intake sustains FFM and is related to that energy expenditure, as well as satiety, even though total energy intake is lower compared with the original level.

With regard to the paper mentioned earlier (Keogh *et al.* 2006), it appears that the two different amounts of protein, i.e. 67 g/d or 136 g/d offered in negative energy balance, are sufficient and effects from the protein content of the diet may be small, as indicated by regression analysis in the study. The expectation of diet effects on weight loss partly due to the differences in amounts of protein offered was based upon earlier studies, where in fact a normal protein intake was compared with a lower protein intake. Therefore, it should be recommended that the relative changes in macronutrient compositions, when given in negative or positive energy balance, should also be expressed in absolute terms, so that a different understanding of what is low, normal or high may be avoided.

Dr Margriet S. Westerterp-Plantenga
Maastricht University
Maastricht
The Netherlands
M.Westerterp@HB.unimaas.nl

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