

Lack of meal intake compensation following nutritional supplements in hospitalised elderly women

Amanda Boudville¹ and David G. Bruce^{2*}

¹Department of Community and Geriatric Medicine, Fremantle Hospital, Fremantle, Western Australia

²School of Medicine & Pharmacology, University of Western Australia, Western Australia

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Undernutrition contributes to poor clinical outcomes in hospitalised elderly patients but the potential impact of oral nutritional supplements may be reduced by suppressing subsequent food intake. We investigated this possibility in elderly female patients recovering mainly from hip fracture by studying the effect of oral supplements on subsequent food intake during an *ad libitum* buffet luncheon meal. We tested the effect in seven women by giving the supplement 90 min before the meal and compared energy and macronutrient intake with a control water pre-load condition. A similar study was carried out in another seven women with the supplement or water drink given 30 min beforehand. Both self-rated appetite and energy intake were low in these women. The nutritional supplement did not alter ratings of hunger, fullness or prospective consumption or subsequent energy and macronutrient consumption whether given 90 or 30 min before the meal. There were significant independent correlations between the lack of adequate compensation of energy intake at meals and chronic undernutrition (as assessed by skinfold thickness) and energy intake during the control meal. We conclude that elderly women during the recovery phase after major fractures have low appetites and energy intakes and markedly impaired adjustment of energy intake following liquid oral nutritional supplements. The reasons for this are unknown but are related to anorexia and undernutrition. The consumption of liquid oral supplements given up to 30 min before a meal does not suppress subsequent energy intake from meals.

Older women: Inpatient care: Oral supplements: Meal intake compensation

Nutritional surveys have shown that undernutrition is common in hospitalised elderly patients (Sullivan *et al.* 1995). This occurs on a background of decreased energy intake seen in older people probably due to a combination of physiological, patho-physiological and psycho-social changes that cause a reduced appetite (Morley, 1997). Elderly patients hospitalised with hip fractures are often malnourished at the time of the fracture (Bastow *et al.* 1983) and many have suboptimal intakes during the recovery phase (Stableforth, 1986; Jallut *et al.* 1990) that lead to further weight loss (Bruce *et al.* 2003) and adverse clinical outcomes (Bastow *et al.* 1983; Sullivan *et al.* 1995). Recent reviews of the use of oral nutritional supplements to combat low energy intakes during hospital stays have concluded that their use may be beneficial on mortality rates and rehabilitation outcomes, but that available evidence is weak (Potter *et al.* 1998; Avenell & Handoll, 2001). Nevertheless, the use of liquid oral supplements has been widely adopted, in part stimulated by possible cost savings for hospitals (Tucker & Miguél, 1996).

Not all trials have demonstrated benefit from oral supplements (Potter *et al.* 1998; Avenell & Handoll, 2001), possibly because poor compliance with oral supplements occurs due to anorexia (Avenell & Handoll, 2001; Bruce *et al.* 2003). Anorexia in older hospitalised patients may be multifactorial in origin, related

to medications, the inflammatory response, inactivity, sarcopaenia and a number of peripheral or central regulatory systems (Morley, 1997). One potential problem that has been little studied in these patients is the impact of oral nutritional supplements on subsequent food intake. When healthy young adults are given 'pre-meals', subsequent food intake is reduced and total energy intake is balanced. This energy compensation is remarkably precise in young men and in older people has been reported to be normal (Zandstra *et al.* 2000) or mildly impaired (Rolls *et al.* 1995). A recent study found a severe lack of compensation of energy intake after pre-meals in profoundly malnourished elderly women (Sturm *et al.* 2003). In contrast to this latter study, there is anecdotal and research evidence that suggests that prescribing oral supplements to undernourished elderly subjects may not always be beneficial because they may suppress subsequent food intake (Banerjee *et al.* 1978; Fiatarone *et al.* 1994; Kayser-Jones *et al.* 1998). In two controlled studies, no net increase in total energy intake was seen in nursing home residents given oral supplements because they reduced the amount of food eaten during meals (Banerjee *et al.* 1978; Fiatarone *et al.* 1994). We have utilised a pre-meal study design to examine the impact of a standard oral nutritional supplement on subsequent food intake in a group of elderly hospitalised patients.

Abbreviations: AMA, arm muscle area; CAMA, corrected arm muscle area; SGA, Subjective Global Assessment.

*Corresponding author: Associate Professor David G. Bruce, School of Medicine & Pharmacology, Fremantle Hospital, P.O. Box 480, Fremantle, Western Australia 6959, Australia, fax +61 618 9431 3229, email dbruce@cyllene.uwa.edu.au

Subjects and methods

Subjects

A convenience sample of fourteen consecutive women with recent osteoporotic fracture were recruited from the geriatric rehabilitation ward at Fremantle Hospital. All were in the rehabilitation phase of recovery after having been admitted to hospital with an osteoporotic fracture (i.e. following a simple fall) then transferred to the rehabilitation ward for further management. Of the fourteen, thirteen had a hip fracture and had undergone surgical repair and one had sustained a pelvic fracture. All had been in hospital for at least 14 d and none had dysphagia or feeding problems related to dentition or other conditions or a history of recent pre-fracture weight loss. None was suffering from post-operative complications or acute illness at the time of study and other exclusion criteria were alcohol abuse, significant gastrointestinal symptoms, previous gastrointestinal surgery, active malignancy, diabetes mellitus, depression (score >7 on the BASDEC depression screen; McCrea *et al.* 1994), severe cognitive impairment (score <20 on Mini-mental State Examination), or the use of drugs known to affect appetite (e.g. antidepressants, opiates). Most had other conditions such as hypertension, coronary artery disease or arthritis and most were regularly taking other medications for them. None of the subjects had evidence of high dietary restraint or eating abnormalities (Garner & Garfinkel, 1979; Stunkard & Messick, 1985). All subjects gave informed consent and the study was approved by the Fremantle Hospital Research and Ethics Committee.

Procedure

The study had a within-subject design with each subject acting as her own control. Each subject was studied on two occasions within 2–3 d in random order. The meal procedure and nutrient calculations were carried out by a trained research dietitian. All study sessions were conducted in a social room adjoining the rehabilitation ward. All subjects were allowed a standardised light breakfast meal before 08.00 hours (tea, one or two slices of toasted bread, butter), then they were required to fast until the study procedure. They were taken to the study room and allowed to settle themselves before the procedure commenced at 11.30 hours. They were required to drink either a nutritional supplement drink or an equal volume of water (250 ml) within 10 min and all succeeded in this requirement. They then waited before being offered a standard, buffet-style meal. This was prepared in excess of what would normally be eaten by an adult and they were invited to eat as they wished. In study A, seven subjects were given the buffet meal 90 min after the pre-meal drink. A delay of 90 min was used as this corresponds to other pre-meal studies (Zandstra *et al.* 2000; Sturm *et al.* 2003) and has been recommended for clinical use in nursing homes (Wilson *et al.* 2002). A subsequent seven subjects underwent the identical procedure except that the meals were provided 30 min after the pre-meal drink (study B). A 30 min time delay is recommended as the most effective time to demonstrate energy compensation (Rolls *et al.* 1995).

Foods and supplemental nutrition

The nutritional supplement was a commercially available product in regular use in our hospital (Resource, Novartis Nutrition) that

contained 1046 kJ (250 kcal) energy, 13 g protein, 11 g fat, 52 g carbohydrate in 250 ml by volume. The test meals were standardised in all studies. Identical quantities of foods were prepared by one of the investigators (A. B.) and the research dietitian. Subjects had unrestricted access to a variety of foods including tomato, ham, cheese, chicken, crackers, bread, butter, fruits, biscuits that were offered in separate portions and quantities were weighed before and after the meals to determine how much was consumed.

Measurements

Nutritional status. Each subject was assessed by the dietitian in the morning before the meal for nutritional status using the Subjective Global Assessment method (SGA; Detsky *et al.* 1987) and anthropometry (height, weight, triceps skinfold, mean arm circumference) to allow calculation of BMI, arm muscle area (AMA) and corrected arm muscle area (CAMA) using standard equations (Gurney & Jelliffe, 1973; Friedman *et al.* 1985). Serum albumin levels were obtained from hospital records that were obtained within 4 d of the meal studies but not on the study day to avoid possible effects from venepuncture.

Appetite. The subjects completed five-point Likert scales on four occasions immediately before and 10 min after the pre-meal drinks and immediately before and after the meals to assess hunger, thirst, fullness, prospective consumption ('how much they could eat') and nausea (Rolls *et al.* 1995). Each scale had 0 representing the lowest level, e.g. not hungry/thirsty/full/nauseated; 5 representing as hungry/thirsty/full/nauseated as possible; and scores 1–4 representing 'slightly', 'moderately', 'very', 'extremely' hungry/thirsty/full/nauseous. For prospective consumption, they were asked to rate 'how much could you eat?' and could respond nothing (0), slight amount (1), moderate amount (2), large amount (3), very large amount (4), extremely large amount (5) of food.

Food intake. The amount of foodstuffs consumed during each meal was determined and energy and macronutrient intakes were calculated using the Nuttab nutrient database (SERVE 3.95, SERVE Nutrition Management System, St Ives, New South Wales, Australia).

Statistics and calculations. Data were analysed using SPSS for Windows (version 10.0, SPSS Inc., Chicago). All subjects acted as their own control and Student's paired *t*-test was used to compare energy and macronutrient intakes. Energy regulatory responses were calculated in two ways as suggested by Rolls *et al.* (1995). The first method assessed the response to the energy content of the nutritional supplement. The percentage compensation at lunch for the supplement energy content was determined for each individual by subtracting lunch energy intake (kcal) after the supplement was consumed from the lunch intake in the control condition, dividing this difference by the supplement energy content 1046 kJ (250 kcal) and converting to a percentage. In this calculation, 100% (perfect) compensation would indicate that the subject consumed 1046 kJ less energy during the meal after the nutritional supplement. The second method calculated, as a percentage, the control meal energy relative to the total energy measured in the supplement condition (supplement plus meal intake) multiplied by 100. Again 100% indicates perfect compensation. For both calculations, values $<100\%$ indicate undercompensation or overeating following the supplement. Student's *t* tests were used to compare group means for unpaired normally distributed data. Likert scale

scores were analysed using non-parametric tests and relevant pairs of data points compared included baseline scores for each condition (control *v.* supplement condition) and responses, e.g. difference scores after drinks and meals using Wilcoxon signed rank tests. Pearson correlation coefficients were obtained where data were normally distributed. Multiple linear regression was used with the stepwise procedure to examine correlates of energy compensation where univariate correlations existed. Correlates of energy intake and percentage energy compensation used all subjects combined given the similarity of responses between studies A and B.

Results

Sample

Subject characteristics are provided in Table 1. Two subjects in each study group were rated as having suspected or mild-moderate malnutrition by SGA and the others were rated as well nourished. These four subjects plus another two in study B had AMA levels below the fifth percentile compared with normative data (Chumlea *et al.* 1988) and no subjects had severe wasting malnutrition as defined by CAMA.

Subjective sensations

There were no significant differences between the pre-meal scores on the Likert scales (hunger, prospective consumption, fullness, thirst) following the control or supplement drinks (Table 2). The subjects reported low levels of hunger, thirst and prospective consumption before the meals with all scores between 0 and 3. Nausea was rarely reported and only transient or slight. The hunger, fullness and prospective consumption scores changed significantly but modestly ($P < 0.05$) in the expected directions after the meals and there was no significant difference in post-meal or change scores between supplement and control conditions (Table 2).

Energy and macronutrient intake

The results of studies A and B were virtually identical and are presented in Table 3. There was no significant difference in mean total energy intakes during the buffet meals following the nutritional supplement drinks compared with non-caloric drinks,

whether the supplements were taken 90 or 30 min beforehand. As a result, in both studies A and B, a net gain in energy intake was seen when the energy content of the supplement drinks was added to the content of the meals. In both studies A and B, this resulted in a net significant increase in energy that was virtually identical to the energy content of the nutritional supplement.

The calculated intakes of protein, carbohydrate and fat from the buffet meals were not significantly different following the nutritional supplement drinks compared with the control drinks whether the supplements were taken 90 or 30 min beforehand. As with energy intake, the estimated net increased intake of the macronutrients was very similar to the content of the supplement.

Energy compensation

There were no significant differences seen between the compensatory responses comparing the 90 and 30 min studies (unpaired *t* tests; response to energy in supplement, *t* 0.46; based on control: total intake, *t* 0.88) (Table 4). The calculations for energy compensation indicated that on average, compensation for the pre-meal supplement was absent with the degree of overeating by the women close to the content of the supplement. When calculated in relation to the total energy intake after the supplement (meal plus supplement), this absence of energy compensation to the supplement meant that the elderly women increased their energy intake (overate) by about 40–50%.

Correlates of hunger, prospective consumption, energy intake and compensation

Possible causes of low energy intake and impaired energy compensation were explored in relation to the nutritional indices (SGA, BMI, AMA, triceps skinfolds), subjective sensations, age and cognitive and depression scores.

Hunger and prospective consumption. No associations with pre-lunch hunger scores were found. Pre-lunch prospective consumption was significantly associated with triceps skinfold thickness as the nine subjects who scored 2 had thicker skinfolds than the five subjects who scored 1 on the scale (16.2 (SD 2.6) *v.* 11.7 (SD 2.1) cm, *t* 3.011, $P = 0.012$).

Energy intake. There was a significant positive correlation between AMA and energy intakes during the control lunch (r 0.60, $P = 0.032$). In addition pre-lunch prospective consumption scores were significantly associated with energy intakes; those who scored 2 on the scale consumed 1690 (SD 536) kJ whilst those who scored 1 consumed 862 (SD 352) kJ (t 3.077, $P = 0.01$).

Energy compensation. Individual percentage compensatory energy responses in relation to the total energy intake (percentage control:total) were significantly associated with serum albumin levels (r 0.59, $P = 0.025$), triceps skinfolds (r 0.75, $P = 0.003$) and with energy intake during the control meal (r 0.73, $P = 0.003$). With stepwise linear multiple regression analysis examining these three variables, both triceps skinfold thickness and control energy intake remained significantly associated with percentage energy compensation (skinfold: β 0.52, *t* 2.63, $P = 0.025$; control energy intake: β 0.46, *t* 2.34, $P = 0.041$; see Fig. 1 for univariate correlations).

Table 1. Characteristics of elderly women who participated in the meal studies (Mean values and standard deviations)

	Study A (n 7)		Study B (n 7)	
	Mean	SD	Mean	SD
Age (years)	77.0	6.3	81.9	7.4
Weight (kg)	58.6	11.9	55.4	12.5
SGA status (A/B)	5/2		5/2	
BMI (kg/m ²)	22.7	2.5	22.5	3.7
Triceps skinfold (cm)	15.9	2.7	13.8	3.5
Mid-arm circumference (cm)	27.7	4.1	25.3	3.8
Arm muscle area (cm ²)	41.7	12.5	36.0	14.4
MMSE	25.3	3.9	24.1	3.3
Albumin (g)	34.9	2.9	33.9	3.6

SGA, Subjective Global Assessment; MMSE, mini-mental State Examination.

Table 2. Immediate pre-meal and post-meal scores for subjective meal-related sensations, assessed using five-point Likert scales in studies A and B during the control and nutritional supplement conditions† (Median value and range)

	Study A (90 min condition)						Study B (30 min condition)					
	Control meal			Supplemented meal			Control meal			Supplemented meal		
	Pre-meal		Post-meal	Pre-meal		Post-meal	Pre-meal		Post-meal	Pre-meal		Post-meal
	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range
Hunger	1	0-2	0	0-1*	1	1-2	0	0-0*	1	0-2	0	0-0*
Prospective consumption	2	1-2	0	0-1*	2	1-2	0	0-0*	2	1-2	0	0-0*
Fullness	1	0-2	2	1-3*	1	0-3	2	2-4*	1	0-2	2	1-4*
Thirst	2	1-3	1	0-3*	2	0-3	1	0-3	0	0-1	0	0-1

* $P < 0.05$ comparing pre-meal and post-meal conditions by Wilcoxon signed ranks test.

† A score of 0 denotes absence or minimum sensation and a score of 5 the greatest or highest degree of that sensation.

Discussion

Significant undernutrition is an important problem in elderly hospital patients that has grave implications for their survival and recovery (Bastow *et al.* 1983; Sullivan *et al.* 1995). Studies have examined the effect of pre-loads on meal regulation in healthy elderly subjects (Rolls *et al.* 1995; Zandstra *et al.* 2000) and in malnourished community-dwelling subjects (Sturm *et al.* 2003) but to our knowledge this is the first study examining this topic in hospitalised patients. The major findings of this study carried out in elderly hospitalised women recovering from major lower limb fractures were as follows. (1) The women demonstrated low ratings of hunger and readiness to eat and consumed fairly small quantities of energy (food) during an *ad libitum* luncheon meal. (2) There was a complete absence of suppression of food intake after a liquid oral nutritional supplement given as a pre-load whether given 30 or 90 min before the meal. (3) There were significant associations between assessments of nutritional status (skinfold thickness, AMA) and appetite ratings, energy intake and the deficit in energy compensation, suggesting that these abnormal compensatory responses are related to longer-term (under)nutrition.

The midday meal generally provides around 33% of the daily energy intake of older Britons (Schlettwein-Gsell *et al.* 1999). Extrapolating this estimate to our cases (predominantly of British origin) who consumed an average 1393 kJ (333 kcal) during the lunch (range 372–2494 kJ) indicates that these women probably had low daily energy intakes, that would be considered sub-optimal for rehabilitation and good health. This is consistent with previous surveys, which have shown that patients recovering from hip fracture often have inadequate energy intakes (Stableforth, 1986; Jallut *et al.* 1990) and continue to lose weight for many weeks (Bruce *et al.* 2003).

We found that energy intake correlated with triceps skinfold thicknesses and with AMA indicating that the subjects with evidence of loss of body fat stores and sarcopaenia had the lowest energy intakes during the meals. In addition, those with reduced appetite as measured by the readiness-to-eat scale had lower skinfold thicknesses and lower energy consumption. Thus those with poorer appetites were both thinner and consumed lower energy intakes consistent with the hypothesis that it was chronic anorexia that led to both pre-fracture undernutrition and poor energy intakes during the recovery phase.

Substantial abnormalities in the adjustment of energy intake were seen as the subjects failed to reduce their intake of food after drinking a pre-meal supplement even when given only 30 min before the meal, a rigorous test of energy compensation (Rolls *et al.* 1995). Other studies have reported that energy compensation after pre-meals in healthy older subjects is generally normal (Zandstra *et al.* 2000; Sturm *et al.* 2003) or slightly impaired (Rolls *et al.* 1995) compared to younger subjects. Sturm *et al.* (2003) recently reported a similar degree of failure of adjustment of food intake after a pre-meal in severely malnourished elderly women (BMI 16.9 kg/m²). The reasons for the lack of energy compensation cannot be deduced from this study. We have no control data from non-hospitalised subjects or hospitalised patients without fracture and so are unable to determine whether the nature or extent of illness response are important causative factors. However, energy compensation correlated independently with both triceps skinfold thicknesses and energy intake during the control meals, implicating chronic undernutrition (as assessed by low

Table 3. Calculated energy and macronutrient intakes in elderly women given a buffet meal after a non-caloric drink (control meal) or commercial nutritional supplement (supplemented meal) given either 90 min before (study A) or 30 min before (study B) the meal (Mean values with their standard deviations)

	Study A (n 7)						Study B (n 7)									
	Control meal		Supplemented meal		Supplemented meal plus supplement		Control		Supplemented meal		Supplemented meal plus supplement		Net change			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Energy (kJ)	1544	640	1422	741	2469	741**	921	540	1247	611	1239	749	2284	749**	1038	469
Protein (g)	20.1	8.8	19.7	7.2	32.7	7.2*	12.6	9.6	19.0	11.2	13.9	10.7	26.9	10.7*	8.0	7.7
Carbohydrate (g)	29.1	5.4	24.6	17.4	76.6	17.4**	47.5	13.7	17.4	14.7	17.8	13.8	69.8	13.8**	52.4	5.1
Fat (g)	19.7	8.2	17.8	10.8	28.8	10.5**	9.1	4.6	17.9	9.8	17.9	10.0	28.9	10.0**	11.0	7.7

*P<0.05, **P<0.01 significantly greater than control meal.

Table 4. Percentage energy compensation due to nutritional supplements in elderly hospitalised women (Mean values with their standard deviations)

	% Energy compensation			
	Response to energy content of nutritional supplement*		Based on control: total intake**	
	Mean	SD	Mean	SD
Study A	11.8	51.7	62.8	19.4
Study B	0.8	45.0	53.6	19.7

* Calculation: (baseline – condition intake)/energy in supplement; 100% indicates perfect compensation.
 ** Calculation: (baseline/total (meal + supplement) intake).

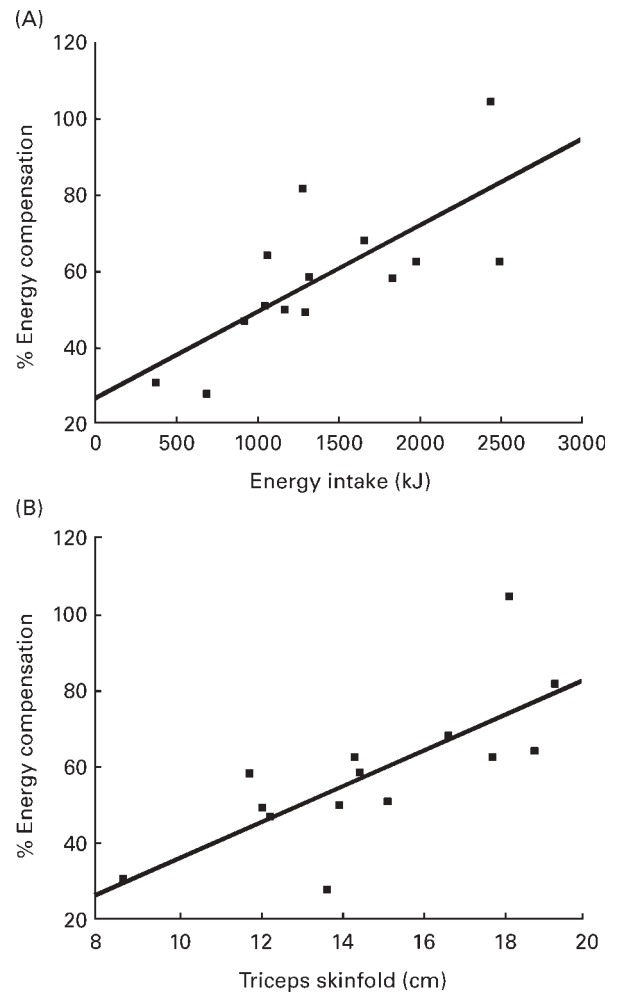


Fig. 1. Univariate correlations between percentage energy compensation in relation to total energy intake (see text for calculation) and energy intake during control meals (A) and triceps skinfold thickness (B) in fourteen elderly hospitalised women.

skinfold) and anorexia (as assessed by low food intake) as important determinants of this phenomenon. This conclusion is similar to that of Sturm *et al.* (2003) although the average BMI of our hospitalised women (22.5 kg/m²) who failed to compensate was close to their well-nourished women (BMI 23.7 kg/m²) who compensated normally (Sturm *et al.* 2003). These differences may suggest that other factors contribute to the lack of energy compensation in

hospitalised patients, possibly related to the metabolic response to injury (Paillaud *et al.* 2000) and appetite-suppressing cytokines (Morley, 2001).

In the present study, because of absence of energy compensation and low baseline energy and macronutrient intakes, the standard nutritional supplement we used increased lunch-time energy intake 60–80% and protein intake 60% over baseline levels. Our findings appear to show that the time period when liquid dietary supplements can be given without compromising meal intakes is closer to meal times than previously recommended (Wilson *et al.* 2002), at least in the hospital setting.

The study has several additional important limitations. The responses on the Likert scales were generally low in these subjects with the tests having limited discriminatory power. In general, these subjects appeared to have low motivation to eat during the experiments and we need to urge caution about conclusions based on associations with these variables. Other limitations are related to the small sample size, lack of blinding of study arms and heterogeneity of nutritional status of the subjects. Another important limitation of the present study is that we have studied patients at a single time point and it is not known whether our findings represent a temporary or prolonged phenomenon. It would be important to determine whether the apparently positive impact on energy intakes provided by nutritional supplements close to regular mealtimes in hospitalised patients is maintained in longer-term studies.

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