Dairy and weight control
what's the evidence?

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The Beginning

Calcium Intake and Body Weight

K. MICHAEL DAVIES, ROBERT P. HEANEY, ROBERT R. RECKER,JOAN M. LAPPE, M. JANET BARGER-LUX, KAREN RAFFERTY, AND SHARILYN HINDERS

J Clin Endocrinol Metab **85:** 4635–4638, 2000

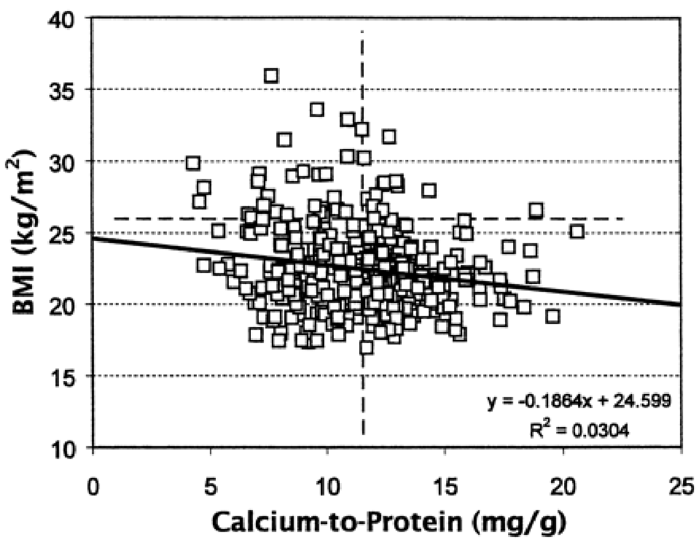


Figure 1. Plot of baseline BMI values (kg/m2) against entry calcium to protein ratio (mg/g) in 348 3rd decade women. The *horizontal dashed line* represents the boundary between normal and overweight, and the *vertical line* represents the median intake ratio for these young women. (Copyright 2000, Robert P. Heaney; used with permission.)

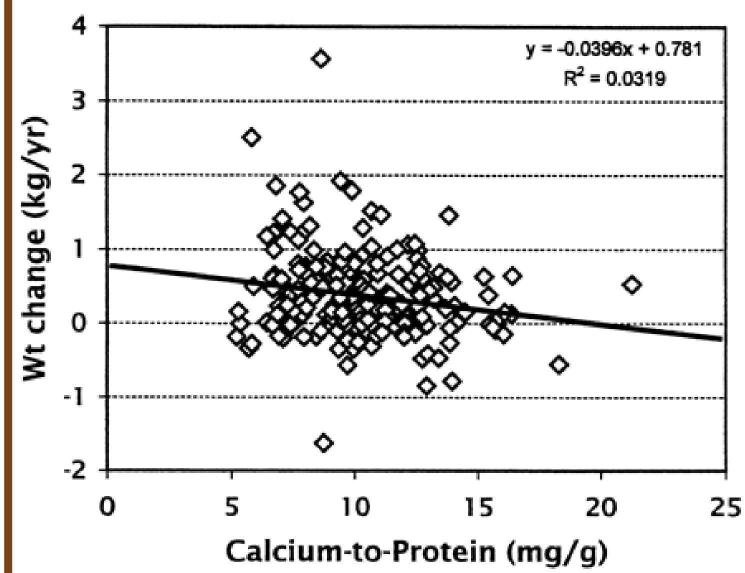


Figure 2. Plot of weight change (kg/yr) against average calcium to protein ratio (mg/g) in 216 middle-aged women. (Copyright 2000, Robert P. Heaney; used with permission.)

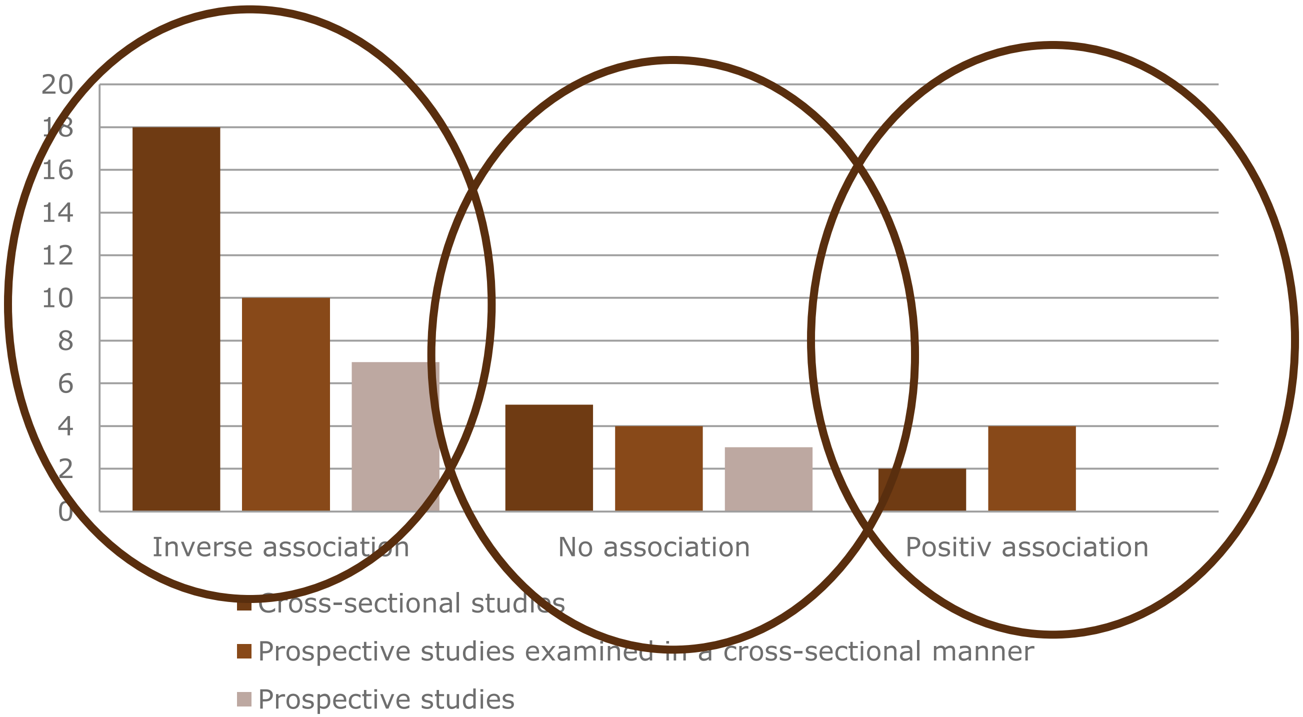
Calcium intake explains ~3% of the variance in body weight.

Nutrition Research Reviews (2011), **24**, 72–95 doi:10.1017/S095442241000034X

Associations between dairy consumption and body weight: a review of the evidence and underlying mechanisms

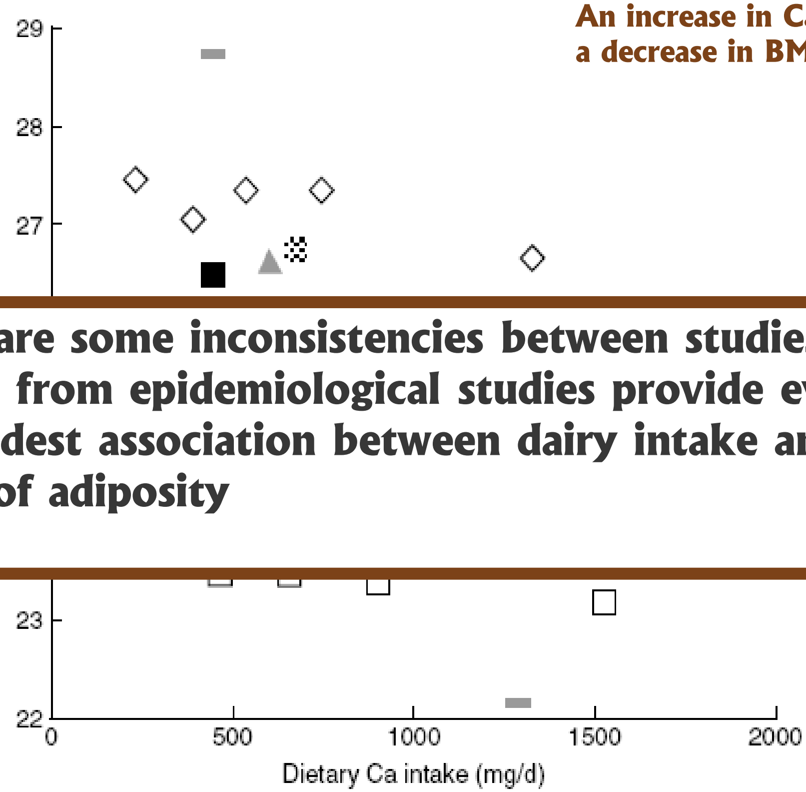
Anestis Dougkas[1], Christopher K. Reynolds[2], Ian D. Givens[1], Peter C. Elwood[3] and Anne M. Minihane[4]*

Epidemiological studies examining the association between consumption of dairy products and measures of body composition



400mg Ca/d : BMI of 25·6 kg/m2
VS.
1200 mg/d a BMI of 24·7 kg/m2

An increase in Ca intake of 800 mg/d is associated with a decrease in BMI of 1.1 kg/m2



Although there are some inconsistencies between studies, the majority of data available from epidemiological studies provide evidence of a negative but modest association between dairy intake and BMI and other measures of adiposity

International Journal of Obesity (2012) 1–9

www.nature.com/ijo

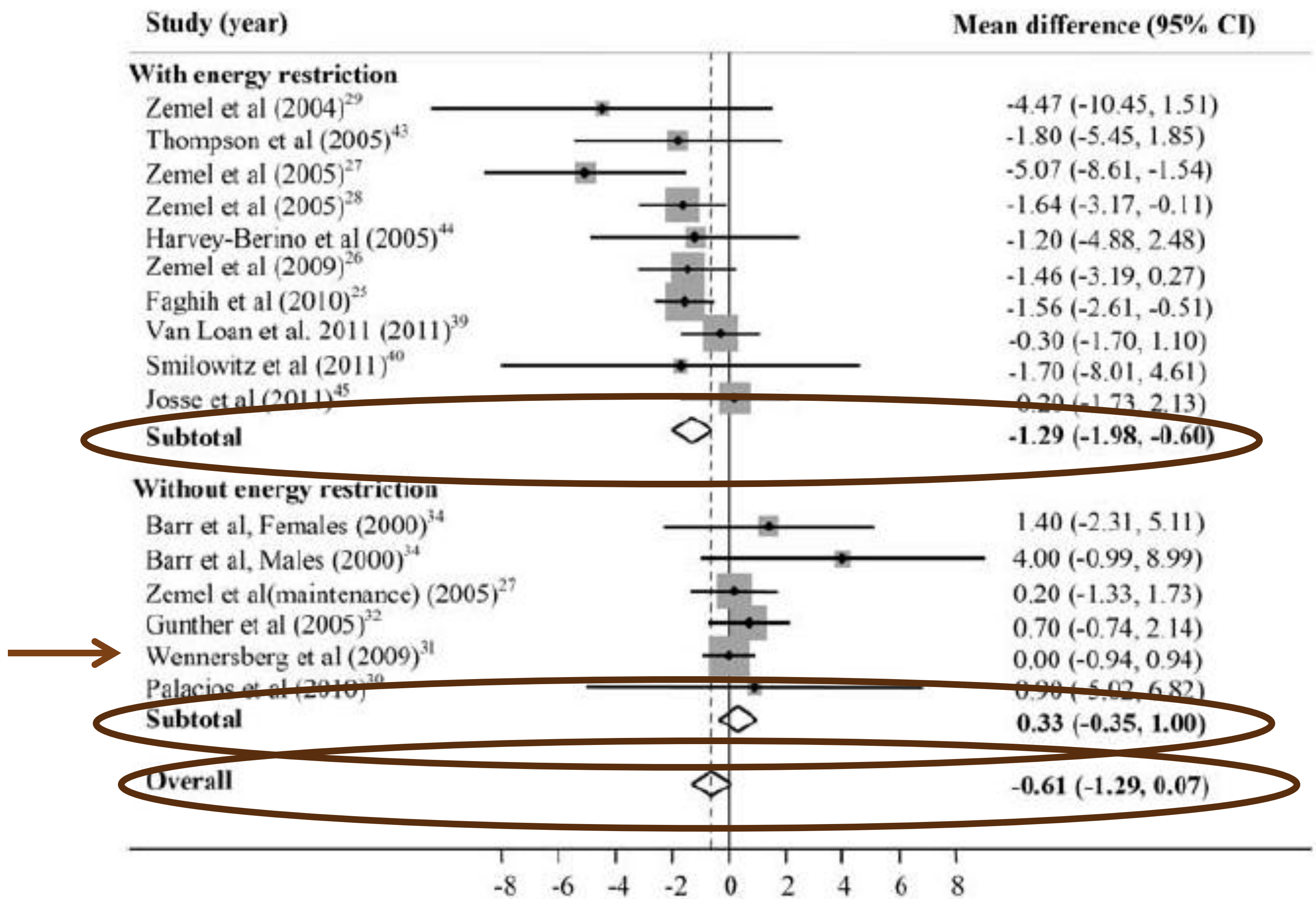
ORIGINAL ARTICLE

Effect of dairy consumption on weight and body composition in adults: a systematic review and meta-analysis of randomized controlled clinical trials

AS Abargouei[1,2], M Janghorbani[3], M Salehi-Marzijarani[3] and A Esmaillzadeh[1,2]

OBJECTIVE: *This systematic review and meta-analysis was conducted to summarize the published evidence from randomized controlled clinical trials (RCTs) regarding the effect of dairy consumption on weight, body fat mass, lean mass and waist circumference (WC) in adults*.

DESIGN: *PubMed, ISI Web of Science, SCOPUS, Science Direct and EMBASE were searched from January 1960 to October 2011 for relevant English and non-English publications. Sixteen studies were selected for the systematic review and fourteen studies were included in meta-analysis.*


Study (year)
Mean difference (95% CI)
With energy restriction
Zemel et al (2004)29 -4.47 (-10.45, 1.51)
Thompson et al (2005)43 -1.80 (-5.45, 1.85)
Zemel et al (2005)27 -5.07 (-8.61, -1.54)
Zemel et al (2005)28 -1.64 (-3.17, -0.11)
Harvey-Berino et al (2005)44 -1.20 (-4.88, 2.48)
Zemel et al (2009)26 -1.46 (-3.19, 0.27)
Faghih et al (2010)25 -1.56 (-2.61, -0.51)
Van Loan et al. 2011 (2011)39 -0.30 (-1.70, 1.10)
Smilowitz et al (2011)40 -1.70 (-8.01, 4.61)
Subtotal -1.29 (-1.98, -0.60)
Without energy restriction
Barr et al, Females (2000)34 1.40 (-2.31, 5.11)
Barr et al, Males (2000)34 4.00 (-0.99, 8.99)
Zemel et al(maintenance) (2005)27 0.20 (-1.33, 1.73)
Gunther et al (2005)32 0.70 (-0.74, 2.14)
Wennersberg et al (2009)31 0.00 (-0.94, 0.94)
Subtotal 0.33 (-0.35, 1.00)
Overall -0.61 (-1.29, 0.07)
-8 -6 -4 -2 0 2 4 6 8

Dairy products and metabolic effects in overweight men and women: results from a 6-mo intervention study[1–4]

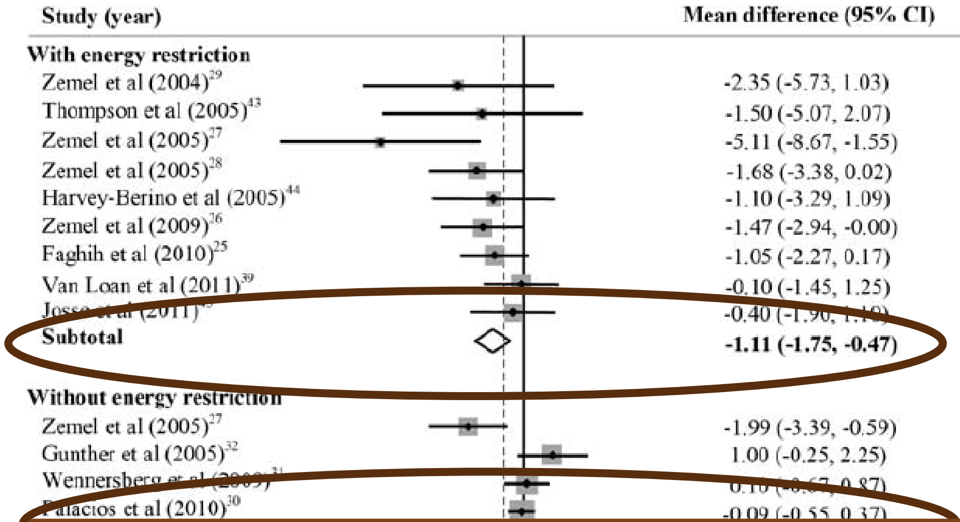
Marianne Hauge Wennersberg, Annika Smedman, Anu M Turpeinen, Kjetil Retterstøl, Siv Tengblad, Endla Lipre, Antti Aro, Pertti Mutanen, Ingebjørg Seljeflot, Samar Basu, Jan I Pedersen, Marja Mutanen, and Bengt Vessby

Intake of energy and nutrients at baseline and after 6 mo in the control and milk groups, calculated from 3-d food records[1]

	Control (*n* = 52–53)			Milk (*n* = 53)			*P* for difference between change in control vs change in milk[2]
	0 mo	6 mo	6 mo – 0 mo	0 mo	6 mo	6 mo – 0 mo	
Energy (kJ)	7987 ± 2381	7849 ± 2169	−150 ± 2200	8309 ± 2219	8940 ± 2705	684 ± 2487	0.07
Protein (g)	79 ± 28.9	78 ± 29.1	−2.7 ± 24.8	81 ± 24.0	94 ± 26.8	12.9 ± 23.3	0.002

Anthropometric variables, body composition, and blood pressure at baseline and after 6 mo in the control and milk groups[1]

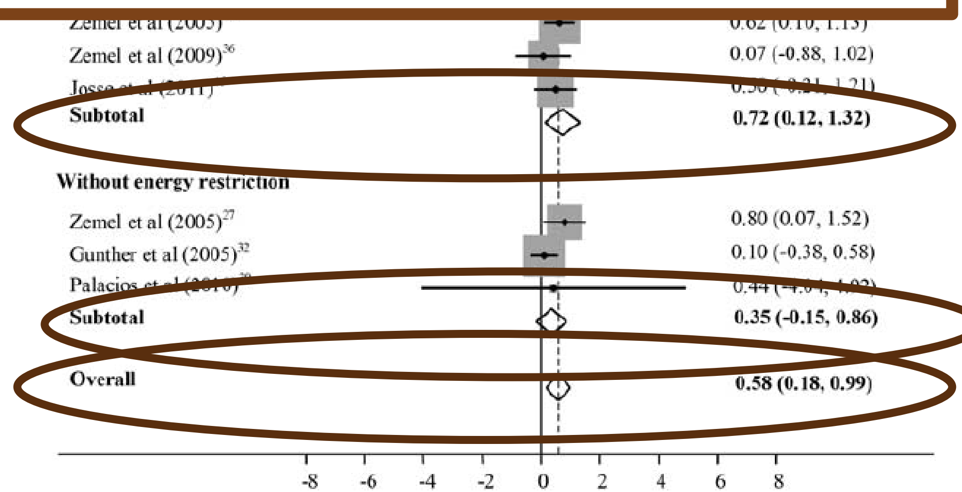
	Control (*n* = 55–56)			Milk (*n* = 56–57)			*P* for difference between change in control vs change in milk[2]
Variable	0 mo	6 mo	6 mo – 0 mo	0 mo	6 mo	6 mo – 0 mo	
Body weight (kg)	87.5 ± 12.2	87.4 ± 12.6	−0.1 ± 2.6	86.0 ± 12.5	85.8 ± 12.5	−0.1 ± 2.5	0.678
BMI (kg/m^2)	30.0 ± 3.3	30.0 ± 3.4	0.0 ± 0.9	30.1 ± 3.6	30.0 ± 3.5	−0.1 ± 1.7	0.673



← **Fat mass (n=638)**

Increased dairy consumption without energy restriction might not lead to a significant change in weight or body composition; whereas inclusion of dairy products in energy-restricted weight loss diets significantly affects weight, body fat mass, lean mass and WC compared with that in the usual weight loss diets

Lean body mass →



AS Abargouei et al. 2012

How may dairy products affect energy balance?

What do we get from dairy?

Contribution of energy and macronutrients (% of total intake)

	Energy	fat	SFA	MUFA	PUFA	trans	CHO	suger	fibre	protein
Milk	10	10	16	7	2	26	8	5	1	17
Cheese	5	9	14	7	2	24	-	0	0	10

Contribution of vitamins (% of total intake)

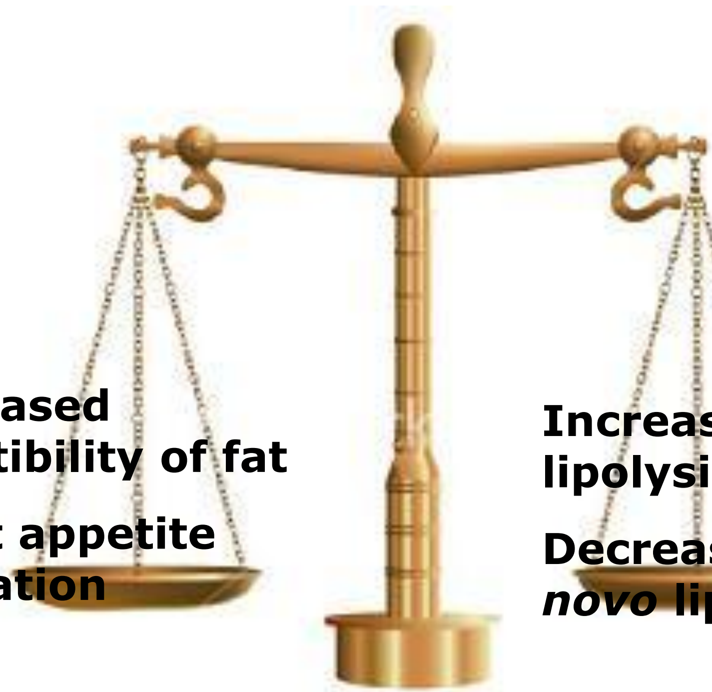
	vit. A	retinol	ß-caroten	vit. D	vit. E	thiamin	riboflavin	niacin	vit. B_6	folat	vit. B_{12}	vit. C
Milk	7	9	1	10	3	12	38	12	12	11	29	3
Cheese	6	8	1	2	3	1	7	7	2	5	8	-

Contribution of minerals (% of total intake)

	Mineraler							
	calcium	fosfor	magnesium	jern	zink	Jod	selen	kalium
Milk	41	25	13	2	15	35	13	17
Cheese	19	12	3	1	10	2	6	1

Danskernes kostvaner 2003-2008 (n=4431)

How may calcium affect energy balance?



Decreased digestibility of fat

Affect appetite regulation

Increased lipolysis

Decreased *de novo* lipogenesis

Energy intake

Energy utilization

High Dietary Calcium Reduces Body Fat Content, Digestibility of Fat, and Serum Vitamin D in Rats

Emilia Papakonstantinou, William P. Flatt,* Peter J. Huth,† and Ruth B.S. Harris**

Obes Res. 2003;11:387–394.

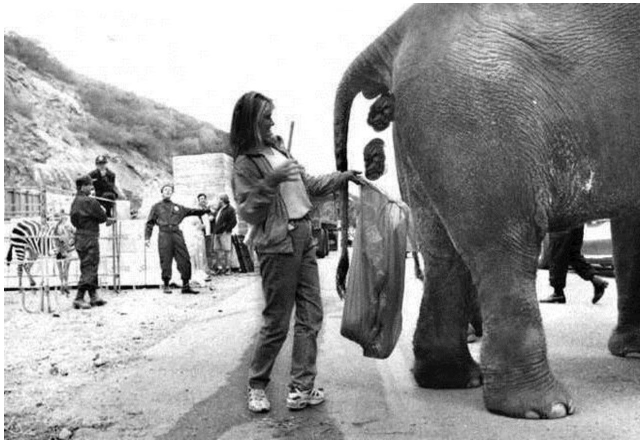
Design

- 24 male Wistar rats
- high or low dairy calcium diet (25E% fat, 14E% protein)
- 85 days

Table 3. Fecal analysis

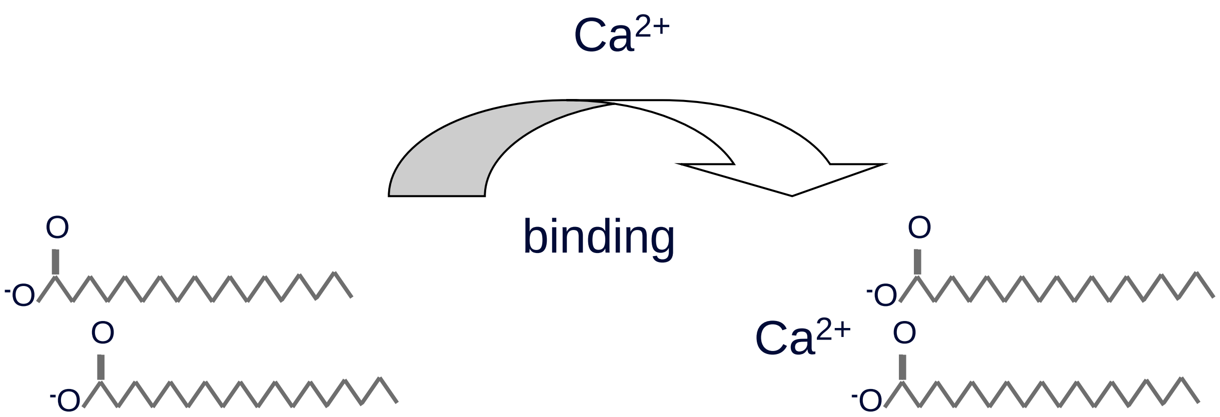
	Control	High-calcium	Statistical significance
Fecal weight (g/5 days)	8.9 ± 0.6	15.9 ± 0.6	$p < 0.01$
Fecal fat (%)	0.11 ± 0.01	0.13 ± 0.02	
Fecal fat (g/5 days)	0.95 ± 0.11	2.04 ± 0.25	$p < 0.001$
Fecal ash (%)	0.12 ± 0.001	0.37 ± 0.005	$p < 0.001$
Fecal ash (g/5 days)	1.1 ± 0.1	5.8 ± 0.2	$p < 0.001$

The feces from each rat were pooled from Days 48 to 52 of the experiment. Values are means ± SEM for groups of 12 rats. Statistically significant differences were determined by unpaired Student's *t* test, assuming equal variance.



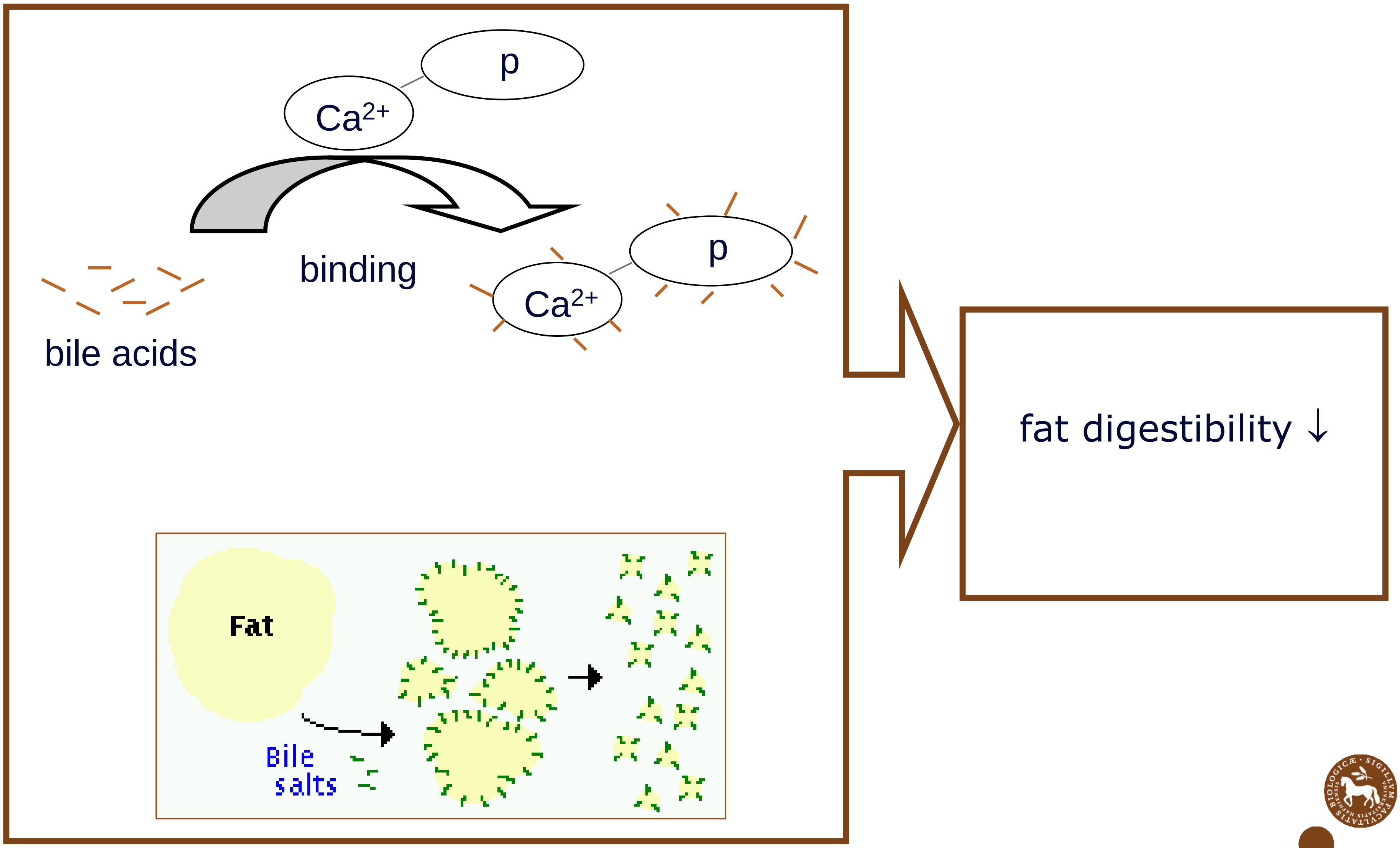
BBC

Formation of insoluble calcium fatty acid soaps



fat digestibility ↓

Binding of bile acids



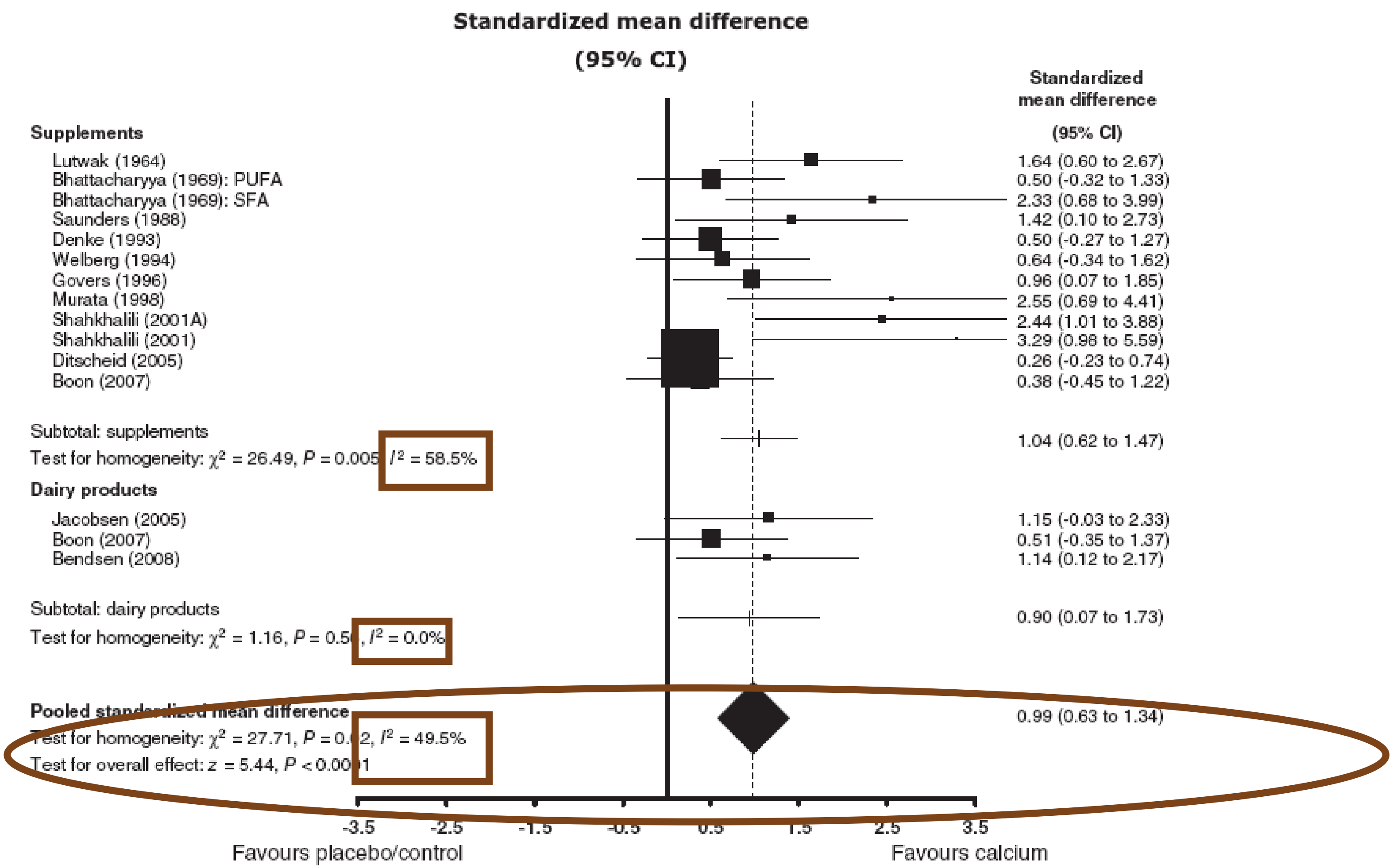
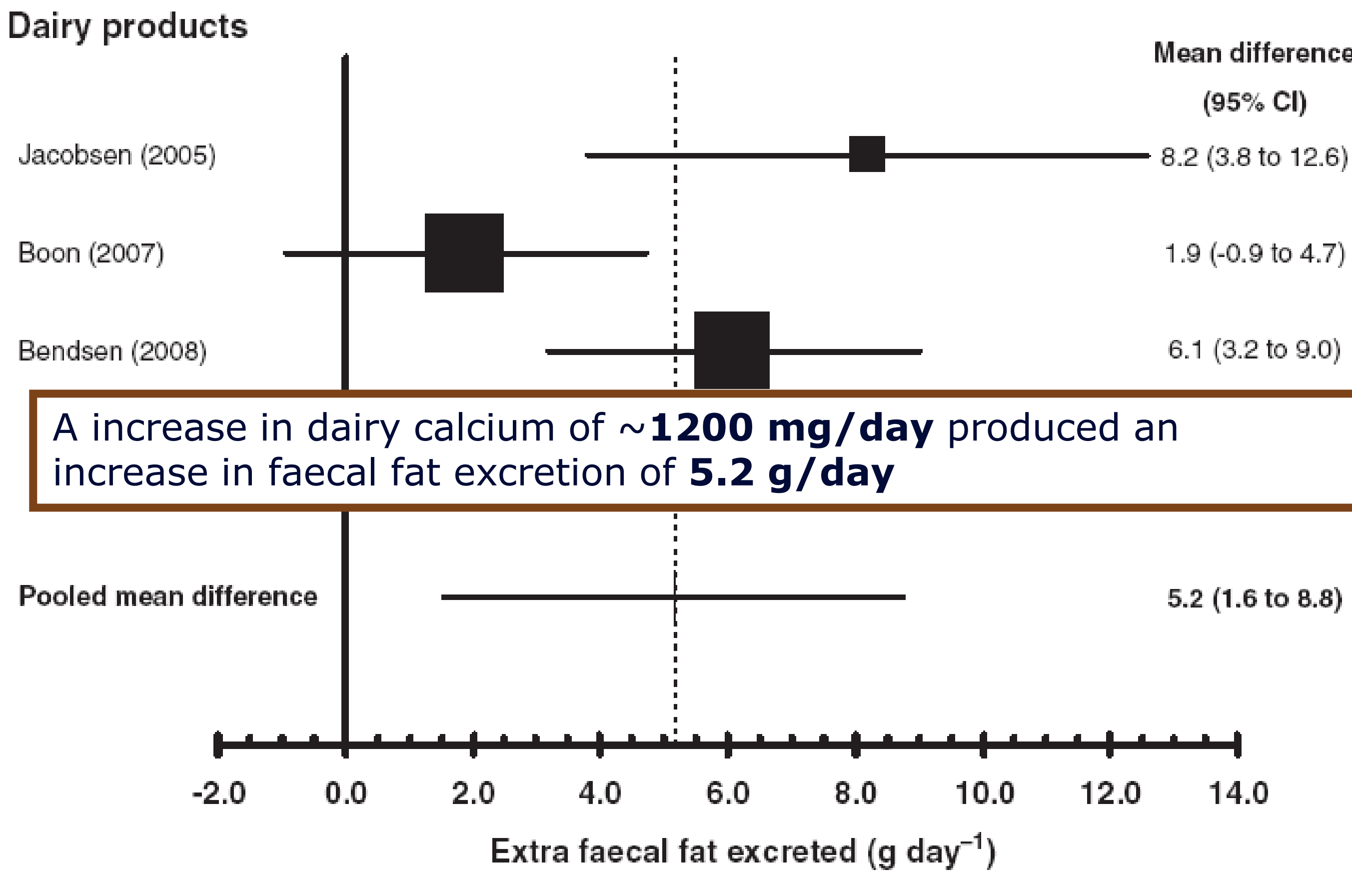


Figure 2 Effects of calcium supplementation on faecal fat excretion; presented as supplements or dairy products. Every square represents the individual study's SMD with 95% CI indicated by horizontal lines; square sizes are directly proportional to the precision of the estimate.



A increase in dairy calcium of ~**1200 mg/day** produced an increase in faecal fat excretion of **5.2 g/day**

Does it matter?

An increase in fat excretion of 5.2 g/day corresponds to increased excretion of 198 kJ/d or 72 MJ/y

Assuming that an increased excretion of 14.64 MJ/year (3500 kcal) will result in a weight loss of about 0.45 kg/year (1 pound)

The increased fat excretion corresponds to a weight change of -2.2 kg/year

In the young Ameraican population the average weight gain is 0.8-0.9 kg/year

Hill JO Science 2003 2003; 299:853-5

Affecting energy balance by just 100 kcal/day, or perhaps less, would be sufficient to prevent the gradual weight gain in most of the American population

How may calcium affect energy balance?

Decreased digestibility of fat

Affect appetite regulation

Energy intake

Original Research Communications

Effect of dairy calcium or supplementary calcium intake on postprandial fat metabolism, appetite, and subsequent energy intake[1–3]

Janne Kunchel Lorenzen, Sanne Nielsen, Jens Juul Holst, Inge Tetens, Jens Frederik Rehfeld, and Arne Astrup

ABSTRACT

Background: High calcium intake has been shown to increase fecal fat excretion.

intake or intake of dairy products and body weight, composition, or both (1–6). On the basis of a reanalysis of data from 4 observational studies, Davies et al (1) concluded that differences in

Am J Clin Nutr 2007;85:678–87.

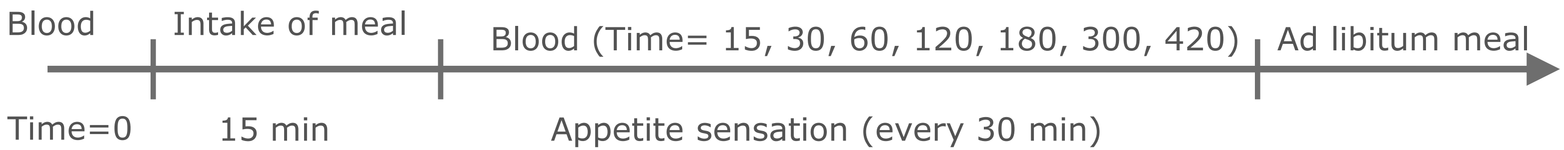
Design

Randomized cross-over study, 18 subjects

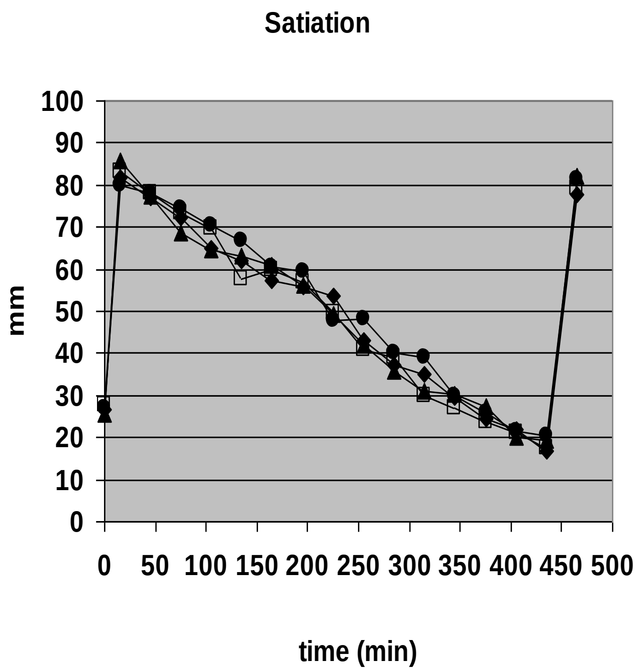
Four isocaloric meals with:

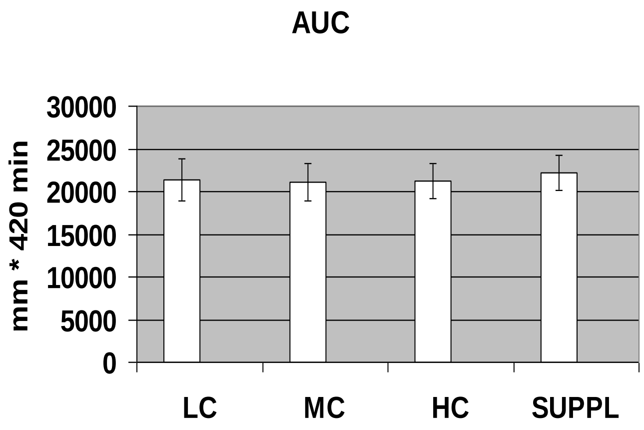
HC: high calcium (182mg/MJ) from dairy products
MC: medium calcium (82 mg/MJ) from dairy products
LC: low calcium (15mg/MJ) from dairy products
SUPP: high calcium (182mg/MJ) from calcium supplement (calcium carbonate)

Protein: 15E%, Fat: 39E%, CHO: 46E%

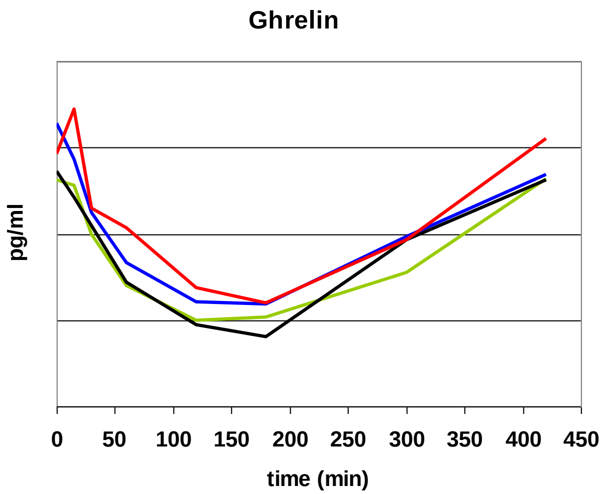


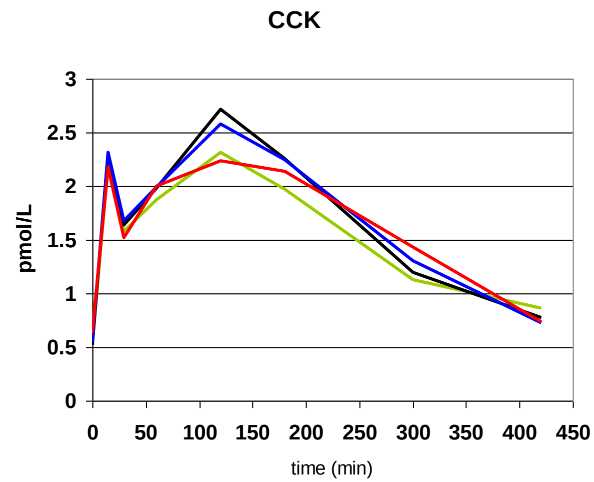
No effect on sateity

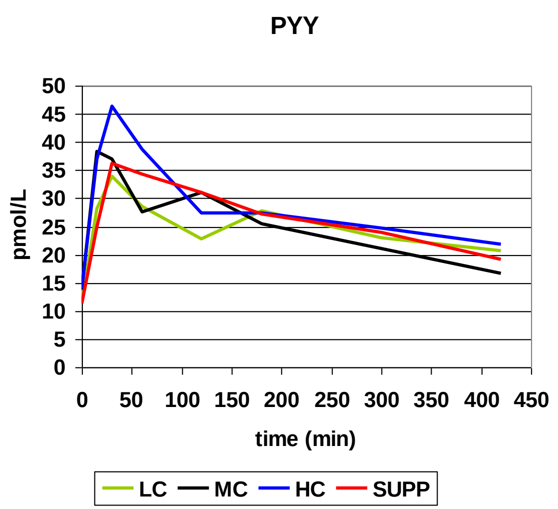


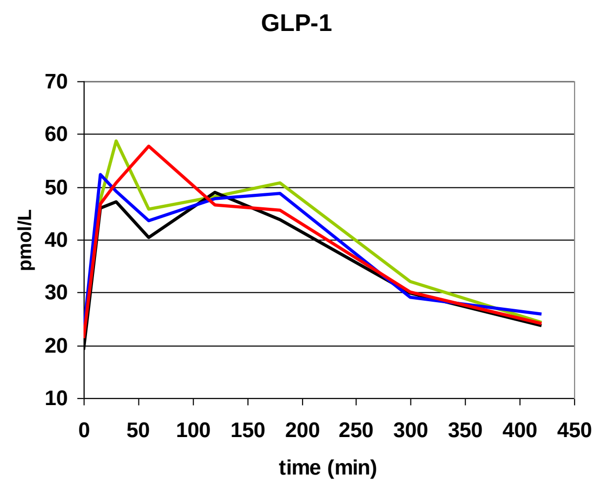


No effects on appetite hormones









Short Communication

Calcium plus vitamin D supplementation and fat mass loss in female very low-calcium consumers: potential link with a calcium-specific appetite control

Geneviève C. Major, Francine P. Alarie, Jean Doré and Angelo Tremblay*

Table 1. Characteristics of very low-calcium consumer (VL-CC; habitual calcium intake ≤600 mg/d) calcium plus vitamin D (calcium+D) and placebo groups in baseline and after the weight-loss programme‡

(Mean values and standard deviations)

	VL-CC calcium+D (*n* 7)						VL-CC placebo (*n* 6)									
	Week 0		Week 15		Change		Week 0		Week 15		Change		*P*<			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Time	Treat	Inter§	95 % CI
Body weight (kg)	78·0	6·0	72·2***	4·9	−5·8	2·6	83·0	12·3	81·6††	13·9	−1·4	−2·4	0·0003	0·01	0·009	−5·7, −1·7
BMI (kg/m²)	29·8	1·2	27·6***	1·3	−2·2	0·9	32·1†	3·8	31·6†††	4·5	−0·5	0·9	0·0002	0·12	0·008	−2·2, −0·7
Waist circumference (cm)	97·1	3·8	91·5	4·4	−5·6	3·3	104·7	9·3	101·2	11·1	−3·5	2·9	0·0002	0·03	0·25	−6·6, −2·8
Fat mass (kg)	29·0	4·1	24·3**	3·7	−4·7	2·3	31·8	7·4	30·6††	8·7	−1·2	2·4	0·36	0·0009	0·02	−4·8, −1·3
Fat-free mass (kg)	49·0	4·9	47·9	4·3	−1·1	1·5	51·2	5·8	51·0	5·7	−0·2	0·7	0·09	0·85	0·20	−1·4, 0·1
Percentage fat	37·2	4·2	33·7**	4·3	−3·5	2·2	38·0	4·3	36·9†	4·8	−1·0	2·0	0·003	0·70	0·06	−3·8, −0·9
Energy intake (kJ)‖	3655	1544	2893	758	−182	330	3994	1851	4245	2282	26	349	0·49	0·97	0·36	−320, 164
Lipid intake (g)‖	45	14	27*	7	−18·2	12·5	41	21	50	30	7·5	14	0·98	0·24	0·02	−19, 8
RMR																
kJ/24 h per kg fat-free mass	131·8	10·5	128·4	9·6	−0·8	5·4	133·9	7·1	131·0	8·8	−2·9	9·6	0·59	0·46	0·72	−7·1, 3·3
kcal/24 h per kg fat-free mass	31·5	2·5	30·7	2·3	−0·2	1·3	32·0	1·7	31·3	2·1	−0·7	2·3	0·59	0·46	0·72	−1·7, 0·8

European Journal of Clinical Nutrition (2013) **67**, 371–376

www.nature.com/ejcn

ORIGINAL ARTICLE

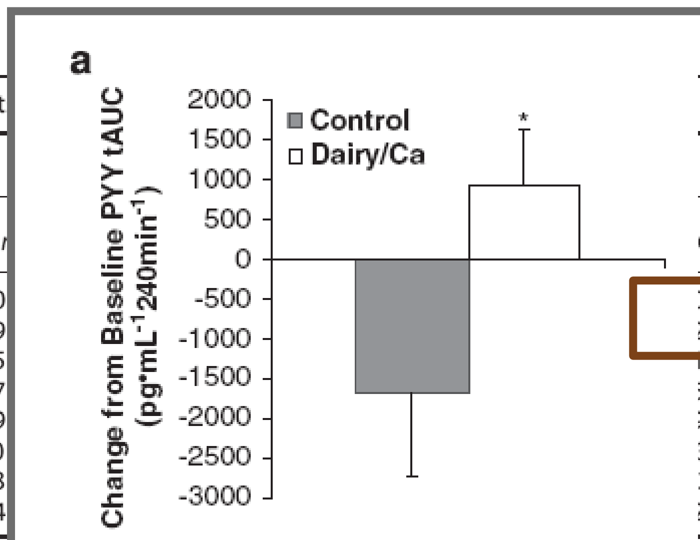
Effect of a dairy- and calcium-rich diet on weight loss and appetite during energy restriction in overweight and obese adults: a randomized trial

KW Jones[1], LK Eller[2], JA Parnell[3], PK Doyle-Baker[1], AL Edwards[4] and RA Reimer[1,2]

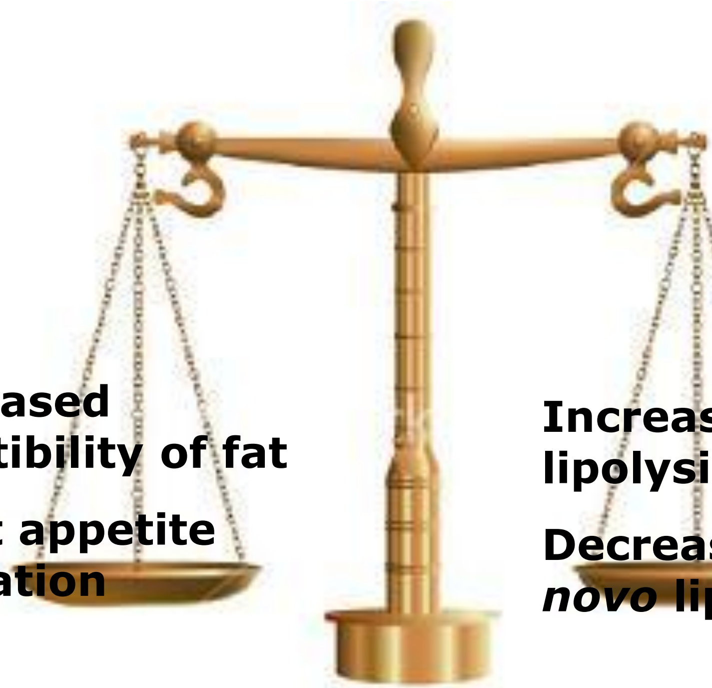
49 participants were randomized to one of two treatment groups for 12 weeks:
Control (low dairy, ~700mg/day Ca, -500 kcal/day)
Dairy/Ca (high dairy, ~1400 mg/day Ca, - 500 kcal/day)

Table 2. Daily dietary intake of participant… n the Control or Dairy/Ca groups[a]

		Study[a]	
	Co…	…ontrol	Dairy/Ca
Energy, kcal	2274.0	…5 ± 136.6[b]	1661.8 ± 83.8[b]
Fat, %	38.9	…2 ± 1.6	26.6 ± 1.5[c]
Protein, %	18.5	…5 ± 1.1	22.1 ± 0.7
Carbohydrate, %	45.7	…5 ± 2.9	50.9 ± 1.5
Low-fat milk[d], ml	129	…2 ± 20.8	463 ± 61.3[c]
Low-fat yogurt[d], g	20	…1 ± 8.2	126 ± 35.7[b,c]
Calcium, mg/day	943	…6 ± 37	1400 ± 79[c]
Vitamin D, μg/day	2.4	…7 ± 0.6	6.1 ± 0.6[c]



How may calcium affect energy balance?



Decreased digestibility of fat

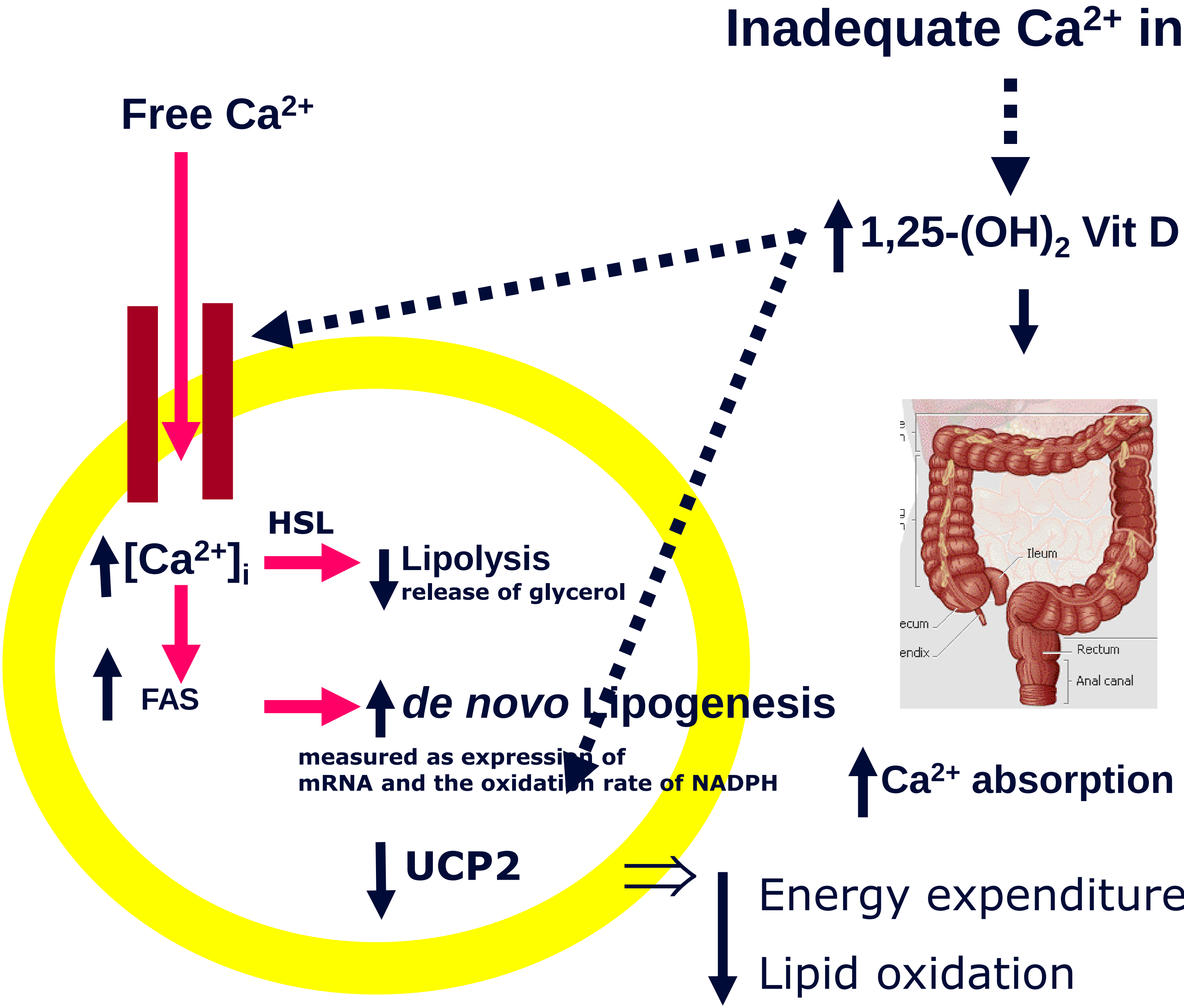
Affect appetite regulation

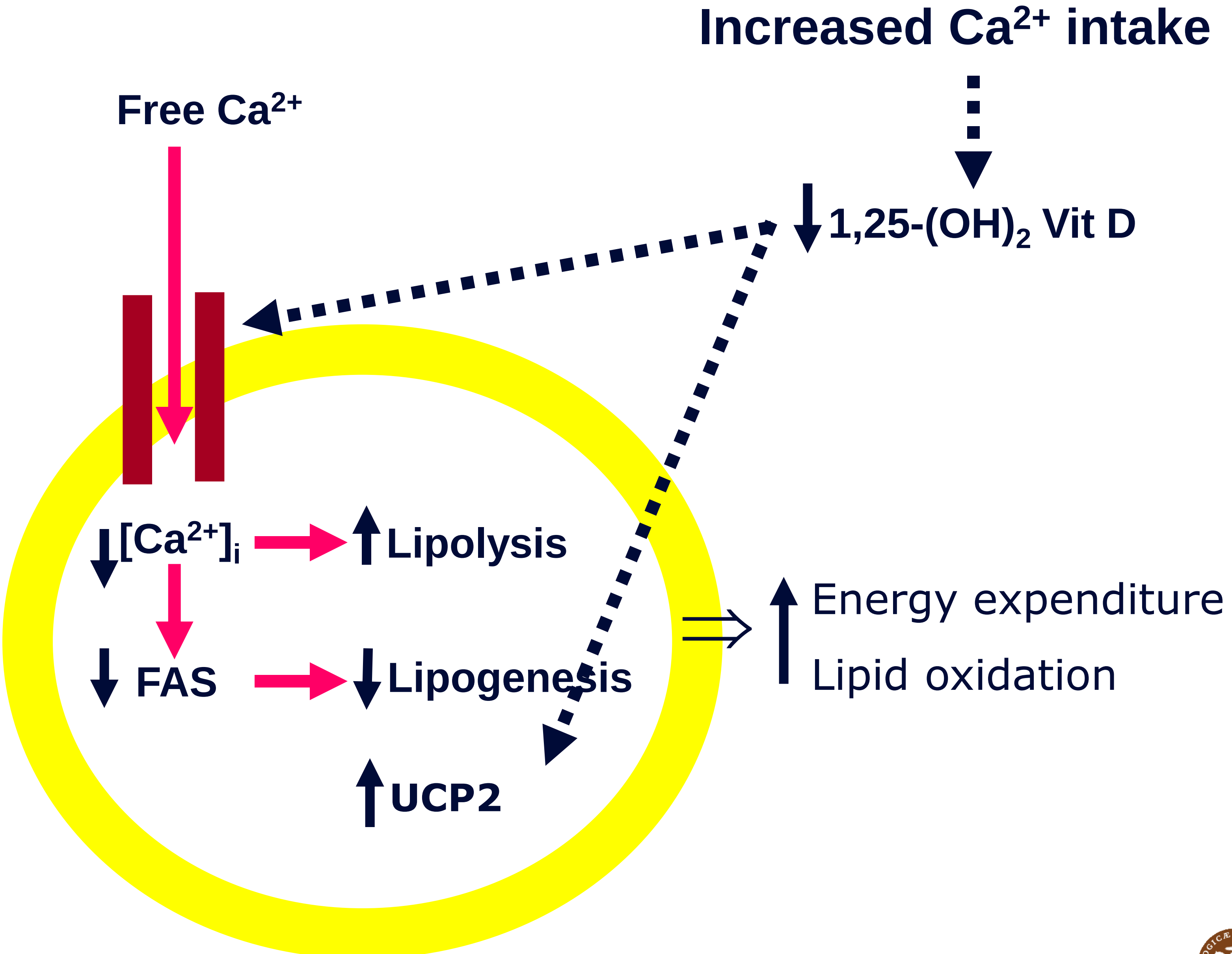
Energy intake

Increased lipolysis

Decreased *de novo* lipogenesis

Energy utilization


Inadequate Ca^{2+} intake
Free Ca^{2+}
↑ 1,25-$(OH)_2$ Vit D
Ileum
Rectum
Anal canal
HSL
↑ $[Ca^{2+}]_i$
↓ Lipolysis
release of glycerol
↑ FAS
↑ *de novo* Lipogenesis
measured as expression of
mRNA and the oxidation rate of NADPH
↑ Ca^{2+} absorption
↓ UCP2
⇒
↓ Energy expenditure
Lipid oxidation


Increased Ca2+ intake
Free Ca2+
1,25-(OH)2 Vit D
[Ca2+]i
Lipolysis
FAS
Lipogenesis
UCP2
Energy expenditure
Lipid oxidation

Regulation of adiposity by dietary calcium

MICHAEL B. ZEMEL,*[,1] HANG SHI,* BETTY GREER,* DOUGLAS DIRIENZO,† AND PAULA C. ZEMEL*

FASEB J 14, 1132-38 (2000)

Basal: 0.4% calcium

High calcium: 1,2% calcium

Medium dairy: 1,2% calcium

High dairy: 2,4% calcium

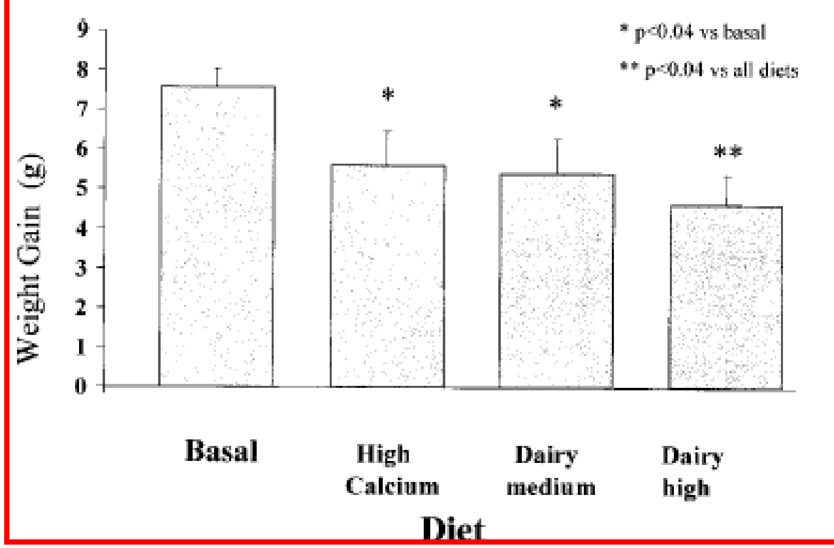
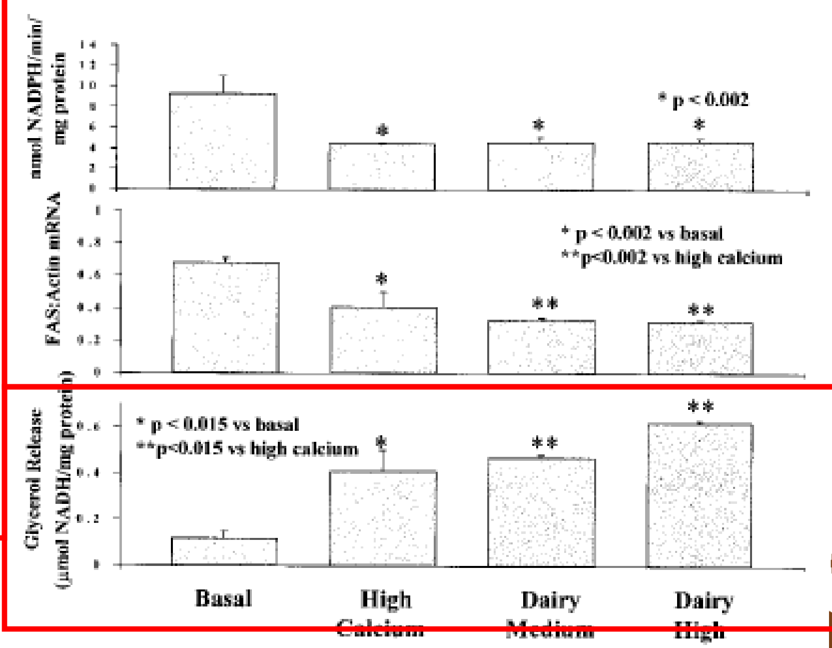


Figure 4. Effects of calcium and dairy products on 6 wk weight gain in transgenic mice expressing *agouti* in adipose tissue under the control of the aP2 promoter.



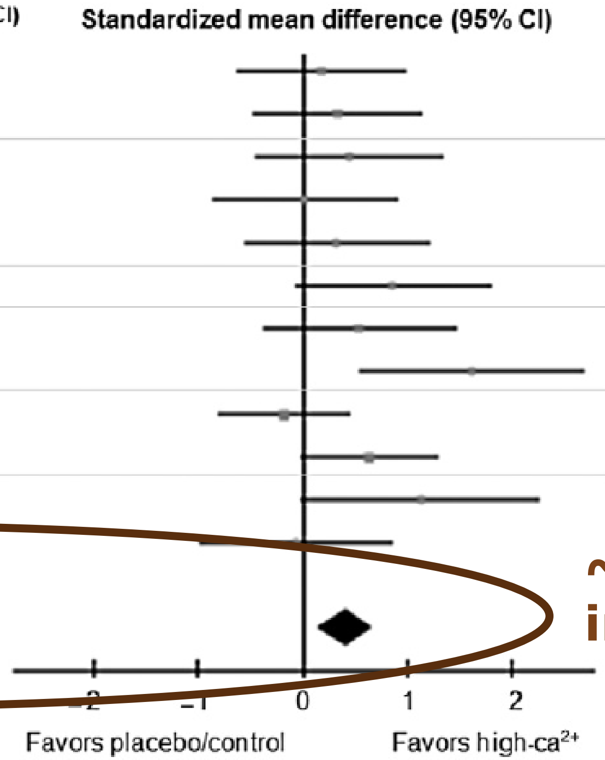
obesity reviews   doi: 10.1111/j.1467-789X.2012.01013.x

Etiology and Pathophysiology

Effect of calcium intake on fat oxidation in adults: a meta-analysis of randomized, controlled trials

J. T. Gonzalez[1], P. L. S. Rumbold[2] and E. J. Stevenson[1]

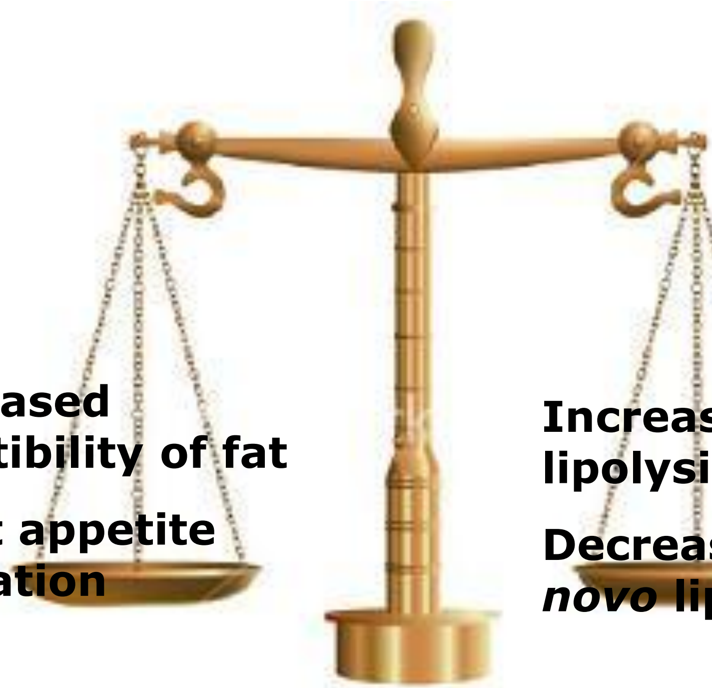
Study	Standardized mean difference (95% CI)
Boon *et al.* 2005 Ca^{2+}	0.18 (−0.62, 0.98)
Boon *et al.* 2005 DA	0.34 (−0.46, 1.15)
Boon *et al.* 2007 CA	0.45 (−0.44, 1.34)
Boon *et al.* 2007 DA2	0.03 (−0.85, 0.90)
Boon *et al.* 2007 DA1	0.33 (−0.56, 0.90)
Bortolotti *et al.* 2008 Ca^{2+}	0.87 (−0.06, 1.80)
Gunther *et al.* 2005 DA (High ca^{2+} meal)	0.54 (−0.38, 1.47)
Gunther *et al.* 2005 DA (Low-ca^{2+} meal)	1.63 (0.56, 2.71)
Melanson *et al.* 2005 DA (Energy balance)	−0.18 (−0.82, 0.46)
Melanson *et al.* 2005 DA2 (Energy deficit)	0.64 (−0.01, 1.29)
Teegarden *et al.* 2008 Ca^{2+}	1.14 (−0.00, 2.27)
Teegarden *et al.* 2008 DA	−0.07 (−0.99, 0.86)
Pooled standardized mean difference	
Overall effect: $Z = 3.00$, $P = 0.003$ Homogeneity: $\tau^2 = 0.04$ $\chi^2 = 13.46$, $P = 0.26$, $I^2 = 18\%$	0.42 (0.14, 0.69)



~11% increase

Figure 2 Effects of chronic high calcium intake on fat oxidation; every square represents the subgroup's standardized mean difference (SMD) with 95% confidence intervals (CI) indicated by horizontal lines; square sizes are proportional to the weighting of the study. Ca^{2+}, calcium; DA, dairy.

How may calcium affect energy balance?



☺

?

Decreased digestibility of fat

Affect appetite regulation

Energy intake

Increased lipolysis

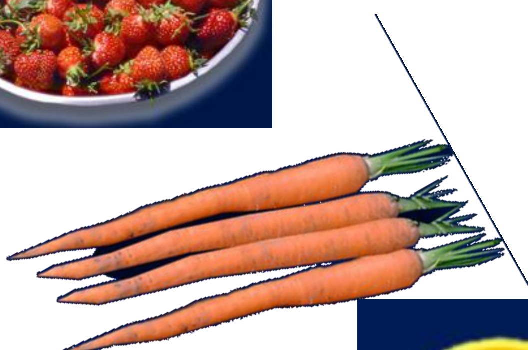
Decreased *de novo* lipogenesis

Energy utilization

😐

Can more (dairy) protein improve weight loss ?





or



Am J Clin Nutr doi: 10.3945/ajcn.112.044321. Printed in USA. © 2012 American Society for Nutrition

Effects of energy-restricted high-protein, low-fat compared with standard-protein, low-fat diets: a meta-analysis of randomized controlled trials[1–3]

Thomas P Wycherley, Lisa J Moran, Peter M Clifton, Manny Noakes, and Grant D Brinkworth

Study or Subgroup	High Protein Mean	SD	Total	Standard Protein Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
≥12 Weeks								
Belobrajdic 2010 (27)	-8.8	5	34	-8.5	4	42	4.3%	-0.30 [-2.37, 1.77]
Campbell 2010 (28)	-8.2	1.8	13	-9.1	3.1	15	4.6%	0.90 [-0.95, 2.75]
Evangelista 2009 (30)	-9.9	2	5	-5.6	0.8	5	4.6%	-4.30 [-6.19, -2.41]
Farnsworth 2003 - F (11)	-6.6	2.3	21	-7.4	2.3	22	5.4%	0.80 [-0.58, 2.18]
Farnsworth 2003 - M (11)	-11.4	5.6	7	-9.6	4.5	7	1.4%	-1.80 [-7.12, 3.52]
Flechtner-Mors 2010 (31)	-8.82	4.52	49	-4.24	3.91	53	5.0%	-4.58 [-6.23, -2.93]
Lasker 2008 (37)	-9.1	4.5	25	-6.9	4	25	3.9%	-2.20 [-4.56, 0.16]
Layman 2009 (39)	-8.2	3.6	52	-7	3.6	51	5.4%	-1.20 [-2.59, 0.19]
Kasim-Karakas 2009 (33)	-3.4	2.7	11	-1.1	2.2	13	4.4%	-2.30 [-4.29, -0.31]
Kleiner 2006 (34)	-4.1	1.8	9	-4.9	1.9	7	4.7%	0.80 [-1.03, 2.63]
Krauss 2006 (35)	-5	2.6	42	-5.3	2.1	49	6.0%	0.30 [-0.68, 1.28]
Labayen 2003 (36)	-9.2	3.7	6	-4.8	2.5	5	2.4%	-4.40 [-8.08, -0.72]
Layman 2003 (9)	-7.53	4.99	12	-6.96	4.71	12	2.2%	-0.57 [-4.45, 3.31]
Parker 2002 (24)	-6.07	2.64	26	-4.62	3.43	28	5.0%	-1.45 [-3.08, 0.18]
Stamets 2004 (40)	-3.7	1.9	13	-4.4	1.5	13	5.5%	0.70 [-0.62, 2.02]
Torbay 2002 (41)	-6.6	0.8	7	-7.2	1.3	7	5.8%	0.60 [-0.53, 1.73]
Subtotal (95% CI)			**142**			**147**	**45.2%**	**-0.49 [-1.34, 0.37]**
Heterogeneity: Tau² = 1.03; Chi² = 22.54, df = 9 (P = 0.007); I² = 60%								
Test for overall effect: Z = 1.12 (P = 0.26)								
Total (95% CI)			**494**			**516**	**100.0%**	**-0.79 [-1.50, -0.08]**
Heterogeneity: Tau² = 1.94; Chi² = 75.64, df = 22 (P < 0.00001); I² = 71%								
Test for overall effect: Z = 2.19 (P = 0.03)								
Test for subgroup differences: Chi² = 0.45, df = 1 (P = 0.50), I² = 0%								

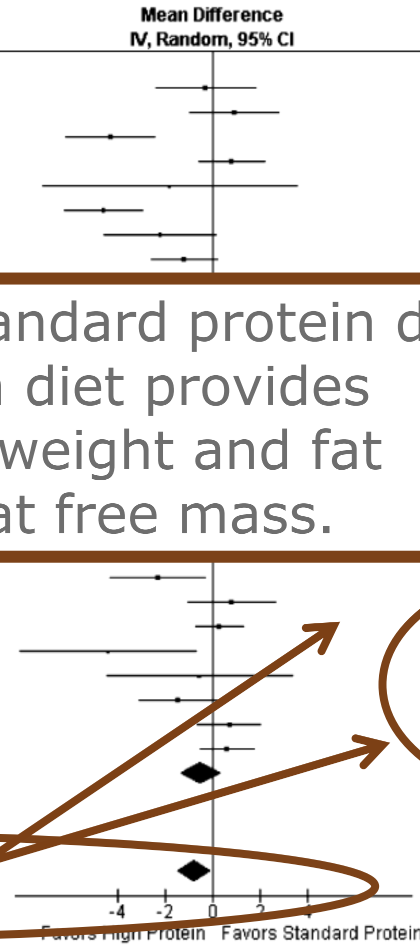


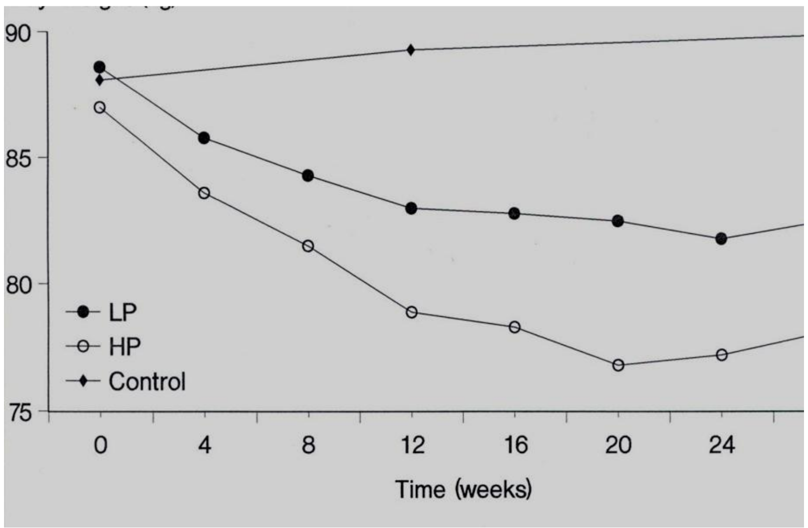
FIGURE 2. Meta-analysis for changes in body weight (kg) in randomized controlled trials that compared high-protein, low-fat diets with isocalorically prescribed standard-protein, low-fat, energy-restricted diets. IV, inverse variance.

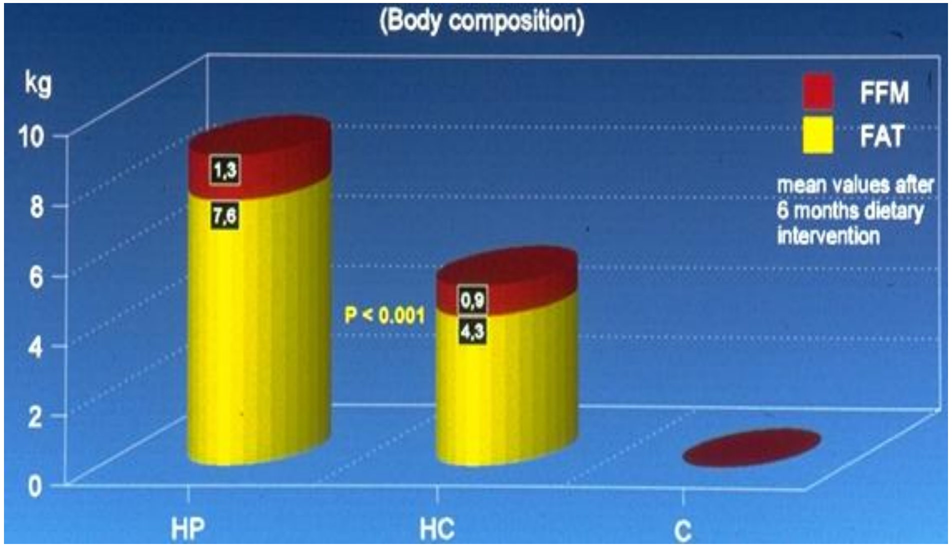
Compared with an energy-restricted standard protein diet, an isocalorically prescribed high protein diet provides modest benefits for reductions in body weight and fat mass and for mitigating reductions in fat free mass.

e mass
09, 0.78]

Fat mass
-0.87 [-1.26, -0.48]

A randomized 6 month trial on two fat-reduced *ad libitum* diets: High CHO *versus* high protein





Skov et al. Int. J. Obes 1999;23:528-536

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Diets with High or Low Protein Content and Glycemic Index for Weight-Loss Maintenance

Thomas Meinert Larsen, Ph.D., Stine-Mathilde Dalskov, M.Sc., Marleen van Baak, Ph.D., Susan A. Jebb, Ph.D., Angeliki Papadaki, Ph.D., Andreas F.H. Pfeiffer, M.D., J. Alfredo Martinez, Ph.D., Teodora Handjieva-Darlenska, M.D., Ph.D., Marie Kunešová, M.D., Ph.D., Mats Pihlsgård, Ph.D., Steen Stender, M.D., Ph.D., Claus Holst, Ph.D., Wim H.M. Saris, M.D., Ph.D., and **Arne Astrup, M.D., Dr.Med.Sc. for the Diet, Obesity, and Genes (Diogenes) Project**

The Diet, Obesity, and Genes (Diogenes) study is a pan-European, multicenter, randomized, dietary-intervention study designed to assess the efficacy of moderate-fat diets that vary in protein content and glycemic index for preventing weight regain and obesity-related risk factors after weight loss.

Diogenes diet intervention

2 SHOP model centres
aastricht & Copenhagen)

Low Calorie Diet (8 weeks)

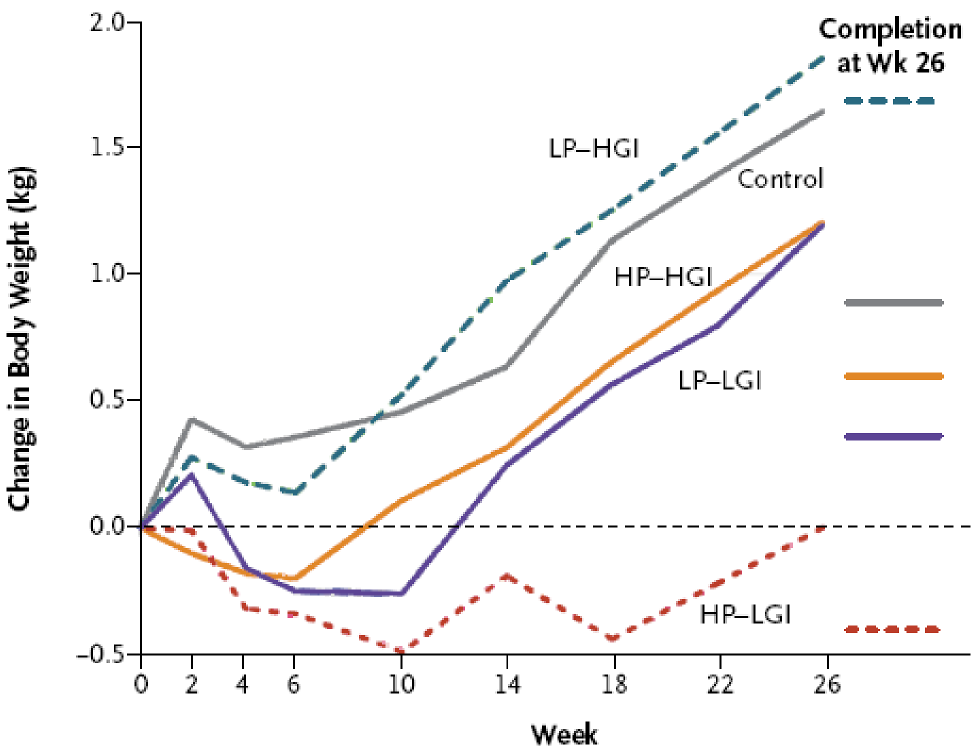
SHOP Intervention plus diet instruction (6 months)

- LP-LGI: 13 E% protein
- LP-HGI: 13 E% protein
- HP-LGI: 25 E% protein
- HP-HGI: 25 E% protein
- Control: ~15 E% protein

randomisation

www.diogenes-eu.org

- DIOGENES


Completion at Wk 26
LP–HGI
Control
HP–HGI
LP–LGI
HP–LGI
Change in Body Weight (kg)
2.0
1.5
1.0
0.5
0.0
−0.5
0
2
4
6
10
14
18
22
26
Week

Comparison of the effects of cows' milk, fortified soy milk, and calcium supplement on weight and fat loss in premenopausal overweight and obese women

Nutrition, Metabolism & Cardiovascular Diseases (2009) xx, 1–5

Sh Faghih [a], A.R. Abadi [b], M. Hedayati [c], S.M. Kimiagar [a,*]

Overweight – obese subjects

8 weeks energy restricted diet (-500 kcal pr day)

Table 2 - Estimates of the daily intake of energy, macronutrients, calcium and fiber of subjects during the study period.

Variables	Control ($n = 20$)	Ca group ($n = 22$)	High milk ($n = 22$)	Soy milk ($n = 21$)	P-value[b]
Energy (kcal/day)	1221.21 ± 153.73[a]	1239.60 ± 180.09	1297.89 ± 137.83	1280.18 ± 140.09	0.36
Carbohydrates (%)	54.78 ± 3.58	56.04 ± 2.78	55.04 ± 4.12	55.04 ± 2.23	0.62
Protein (%)	17.63 ± 1.34	17.40 ± 2.78	17.59 ± 2.21	17.75 ± 1.06	0.92
Fat (%)	27.21 ± 3.77	26.45 ± 2.80	27.36 ± 3.25	26.70 ± 2.22	0.74
Fiber (g/day)	14.34 ± 3.76	14.37 ± 4.11	13.77 ± 2.35	14.70 ± 2.22	0.82
Calcium (mg/day)	495.46 ± 163.87	1320.53 ± 219.36	1302.00 ± 107.56	1327.60 ± 96.07	<0.001

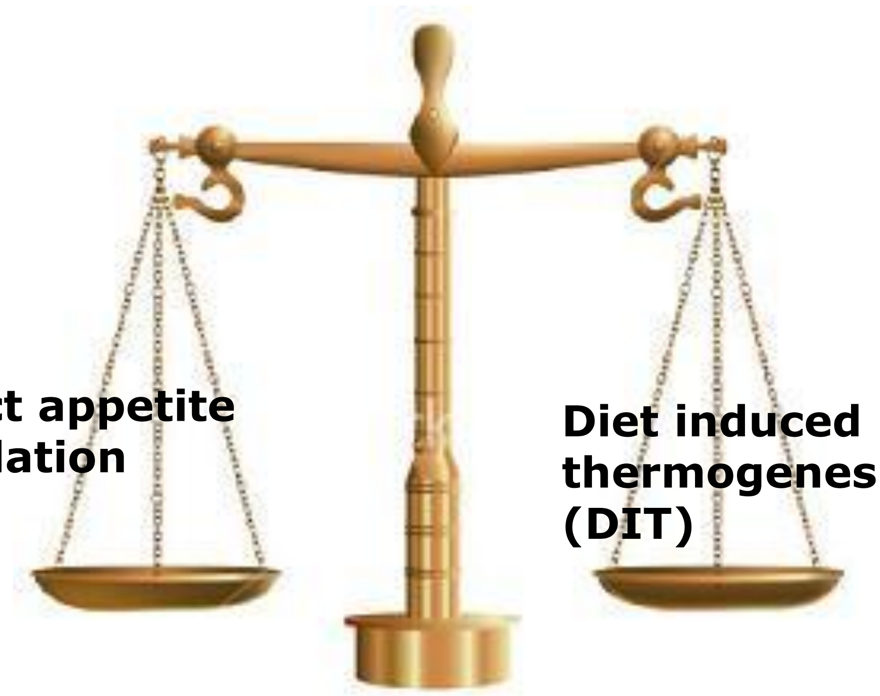
[a] Mean ± standard deviation (all such values).
[b] One-way ANOVA.

Table 3 - Means and standard deviations of changes of variables under study after the energy-restricted weight loss intervention.

Variables	Control ($n = 20$)		High calcium ($n = 22$)		High milk ($n = 22$)		Soy milk ($n = 21$)		P-value[b]
	Week 0–Week 8	P-value	Week 0–Week 8	P-value	Week 0–Week 8	P-value	Week 0–Week 8	P-value	
Body weight (kg)	2.87 ± 1.55[a],*	<0.001	3.89 ± 2.40	<0.001	4.43 ± 1.93*	<0.001	3.69 ± 1.91	<0.001	0.053ýý[c]
BMI (kg/m^2)	1.15 ± 0.62*	<0.001	1.55 ± 0.98	<0.001	1.74 ± 0.73*	<0.001	1.35 ± 0.49	<0.001	0.063[c]
Waist circumference (cm)	3.98 ± 2.77*, **	<0.001	5.13 ± 3.21	<0.001	6.32 ± 2.57*	<0.001	5.84 ± 1.47**	<0.001	0.028
WHR	0.021 ± 0.01*, **	<0.001	0.029 ± 0.01	<0.001	0.038 ± 0.01*	<0.001	0.034 ± 0.01**	<0.001	0.015
Fat mass (kg)	2.77 ± 1.29	<0.001	2.98 ± 1.96	<0.001	3.82 ± 2.46	<0.001	2.80 ± 1.69	<0.001	0.24
Body fat (%)	2.32 ± 1.41	<0.001	1.96 ± 1.25	<0.001	2.92 ± 2.23	<0.001	2.01 ± 2.25	<0.001	0.29
Weight change (% of initial)	3.80 ± 2.13*	–	4.80 ± 2.52	–	5.80 ± 2.1*, **	–	4.31 ± 1.42**	–	0.026

Matching letter superscripts in each column denote significant differences (*$p < 0.01$, **$p < 0.05$).
[a] mean ± standard deviation (all such values).
[b] One-way ANOVA.
[c] significant after adjustment for baseline values ($p < 0.05$).

How may proteins affect energy balance?



Affect appetite regulation

Diet induced thermogenesis (DIT)

Energy intake

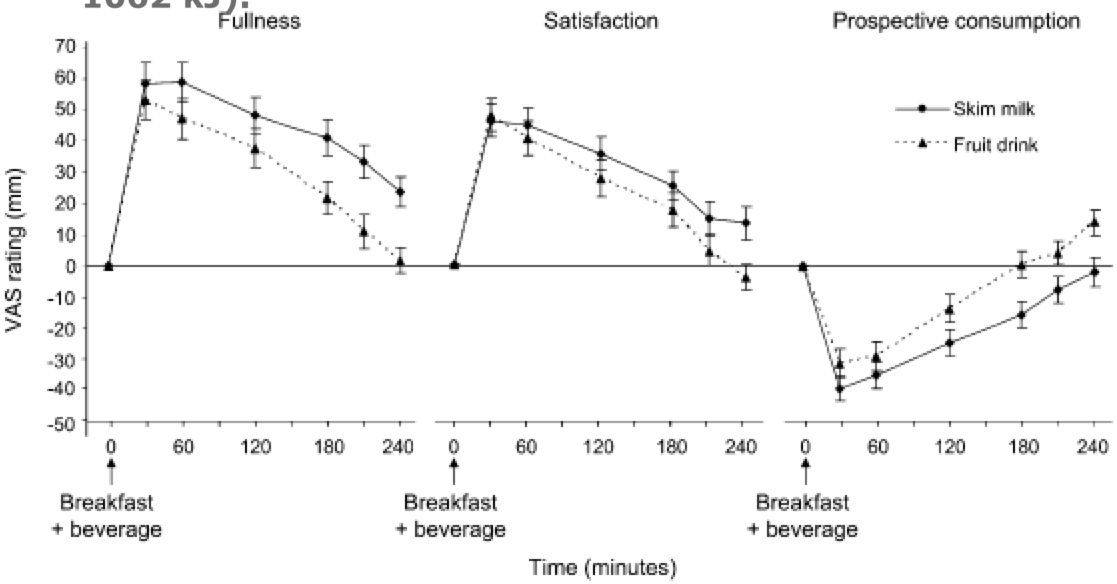
Energy utilization

Skim milk compared with a fruit drink acutely reduces appetite and energy intake in overweight men and women[1–3]

Emma R Dove, Jonathan M Hodgson, Ian B Puddey, Lawrence J Beilin, Ya P Lee, and Trevor A Mori

Randomized crossover trial, 34 overweight women and men

Participants consumed a fixed-energy breakfast together with either 600 mL skim milk (25 g protein, 36 g lactose, ,1 g fat; 1062 kJ) or 600 mL fruit drink (,1 g protein, 63 g sugar, 1 g fat; ’1062 kJ).



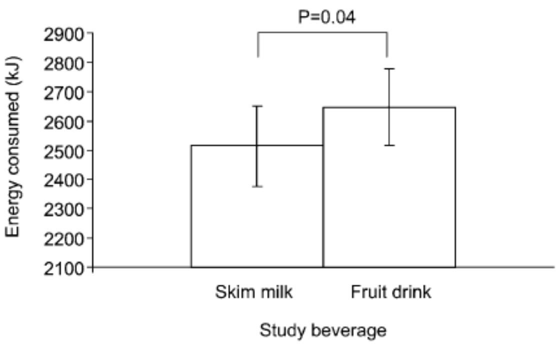


FIGURE 2. Mean (±SEM) energy intake at the lunch test meal for each study treatment.

Consumption of skim milk, in comparison with a fruit drink, leads to increased perceptions of satiety and to decreased energy intake at a subsequent meal.

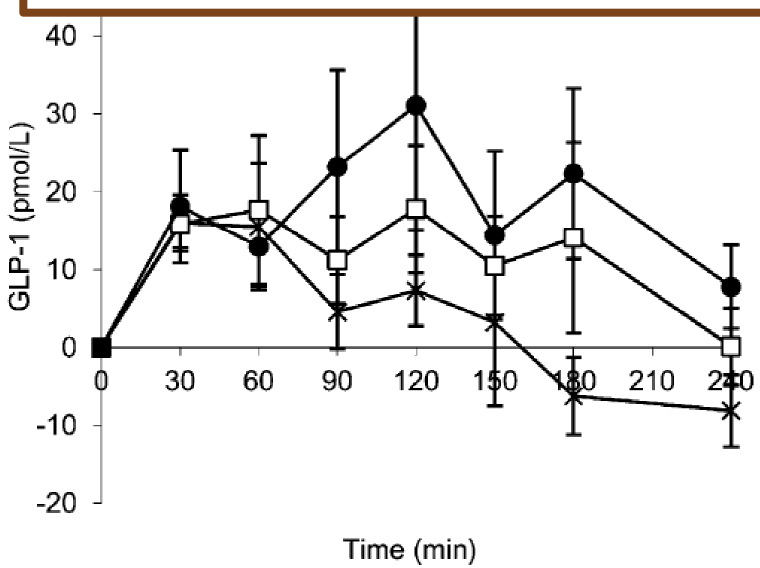
Contribution of gastroenteropancreatic appetite hormones to protein-induced satiety[1–3]

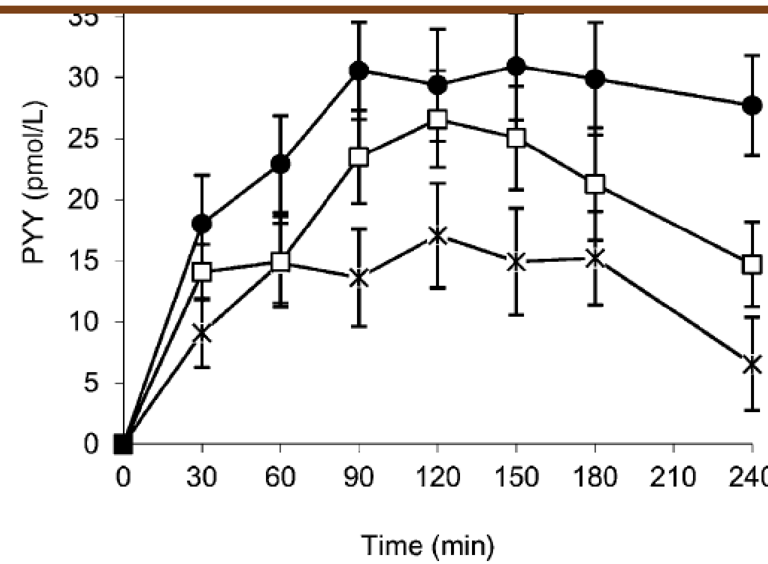
Anita Belza, Christian Ritz, Mejse Q Sørensen, Jens J Holst, Jens F Rehfeld, and Arne Astrup

25 men participated in the 3-way, randomized, double-blind crossover study.

Test meals were isocaloric with 30% of energy from fat and protein content adjusted at the expense of carbohydrate. Test meals were:
-normal protein (NP: 14% of energy from protein)

Protein dose-dependently increased satiety and GLP-1, PYY 3–36, and glucagon, which may, at least in part, be responsible for the satiety-stimulating effect of protein.





The acute effects of four protein meals on insulin, glucose, appetite and energy intake in lean men

Sebely Pal and Vanessa Ellis

British Journal of Nutrition / Volume 104 / Issue 08 / October 2010, pp 1241 - 1248
DOI: 10.1017/S0007114510001911, Published online: 11 May 2010

22 lean, healthy men
Randomized cross-over design study where participants consumed four liquid test meals on separate occasions
They were then offered a buffet meal 4 h later.

Table 4. *Ad libitum* food intake at a buffet lunch and postprandial total area under the curve (AUC) of visual analogue scale rating of hunger, fullness and prospective food consumption after the ingestion of equienergetic preloads containing egg, turkey, tuna and whey

(Mean values with their standard errors)

	Egg		Turkey		Tuna		Whey	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Ad libitum energy intake (kJ)	3534·8[a]	113·6	3513·7[a]	110·7	3275·2[b]	104·4	2950·1[c]	98·1
Hunger AUC (mm per 240 min)	253·6[a]	18·0	237·0[a]	18·0	201·6[b]	17·0	174·6[c]	16·0
Fullness AUC (mm per 240 min)	198·1[a]	13·0	205·4[a]	13·0	234·3[b]	15·0	238·7[b]	15·0
Prospective food consumption AUC (mm per 240 min)	244·9[a]	15·0	225·7[a]	15·0	192·5[b]	14·0	162·1[c]	13·0

[a,b,c] Mean values with unlike superscript letters were significantly different between the groups ($P < 0·05$).

Dairy protein

Casein and **whey** make up 80% and 20% of protein in cow's milk, respectively.

Whey consist of :
~50% β-lactoglobulin,
~20% α-lactalbumin,
~10% albumin and lactoferin
~20% lactoperoxidase

Whey induces a fast, high and transient rise in plasma amino acids.

Casein consists of:
α_{s1}- (~37%), α_{s2}- (~10%), β- (~35%) and κ-caseins (~12%)

Casein, unlike whey, coagulates in the acidic environment in the stomach, which delays its gastric emptying and induces a slow postprandial rise in amino acids.

Casein and whey exert different effects on plasma amino acid profiles, gastrointestinal hormone secretion and appetite

W. L. Hall*, D. J. Millward, S. J. Long and L. M. Morgan

Centre for Nutrition and Food Safety, School of Biomedical and Life Sciences, University of Surrey, Guildford, Surrey GU2 7XH, UK

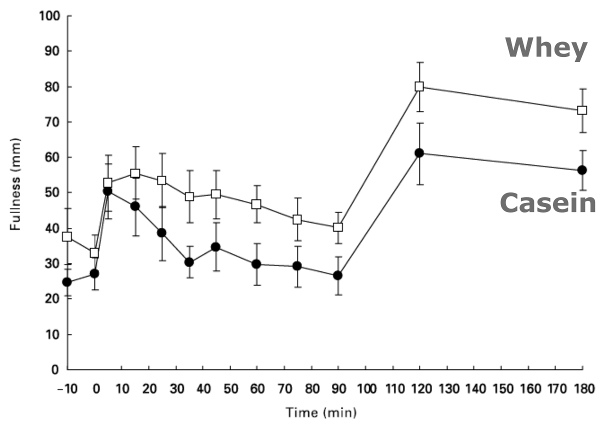


Fig. 3. Study 2: effects of 1700 kJ preloads (48 g casein or whey) on fullness ratings (visual analogue scale). ●, Casein; □, whey. The liquid test meal was given at 0 min and the standard lunch at 90 min. For details of liquid test meals, subjects and procedures, see Tables 1 and 2 and p. 240. Values are means for nine subjects with their standard errors shown by vertical bars. There was a

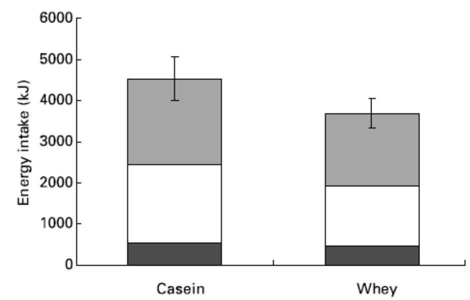
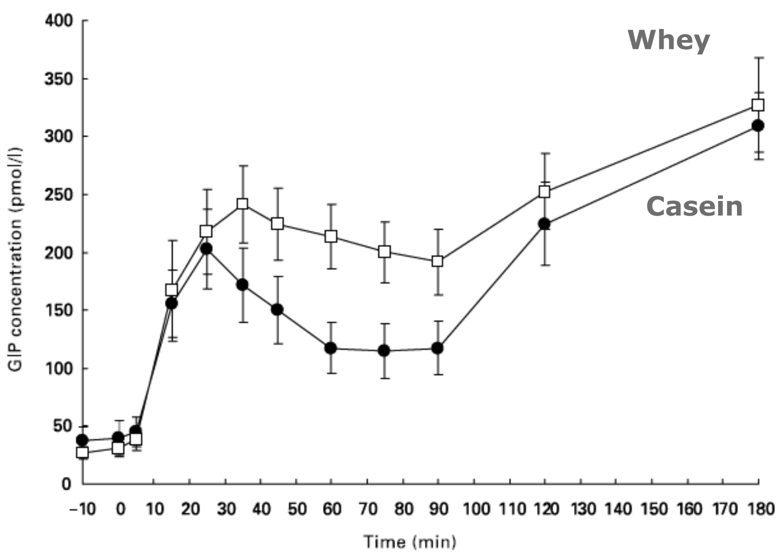
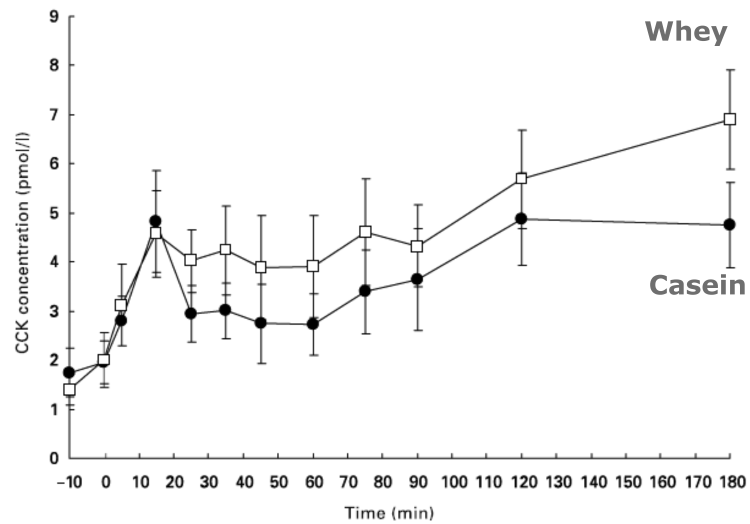
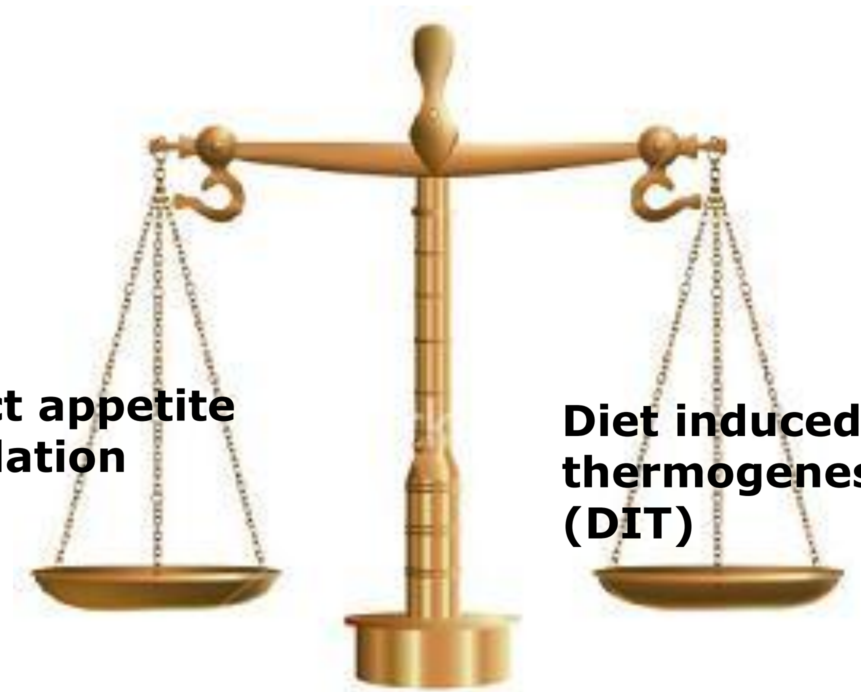


Fig. 1. Study 1: effects of 1700 kJ preloads (48 g casein or whey) on energy intake (including the proportions of total energy intake from protein, fat and carbohydrate) from a buffet lunch *ad libitum* 90 min later. ▒, Carbohydrate; □, fat; ■, protein. For details of liquid test meals, subjects and procedures, see Tables 1 and 2 and p. 240. Values are means for sixteen subjects with their standard errors shown by vertical bars. There was a significant reduction in energy intake following the whey compared with the casein preload ($P<0.05$).





How may proteins affect energy balance?



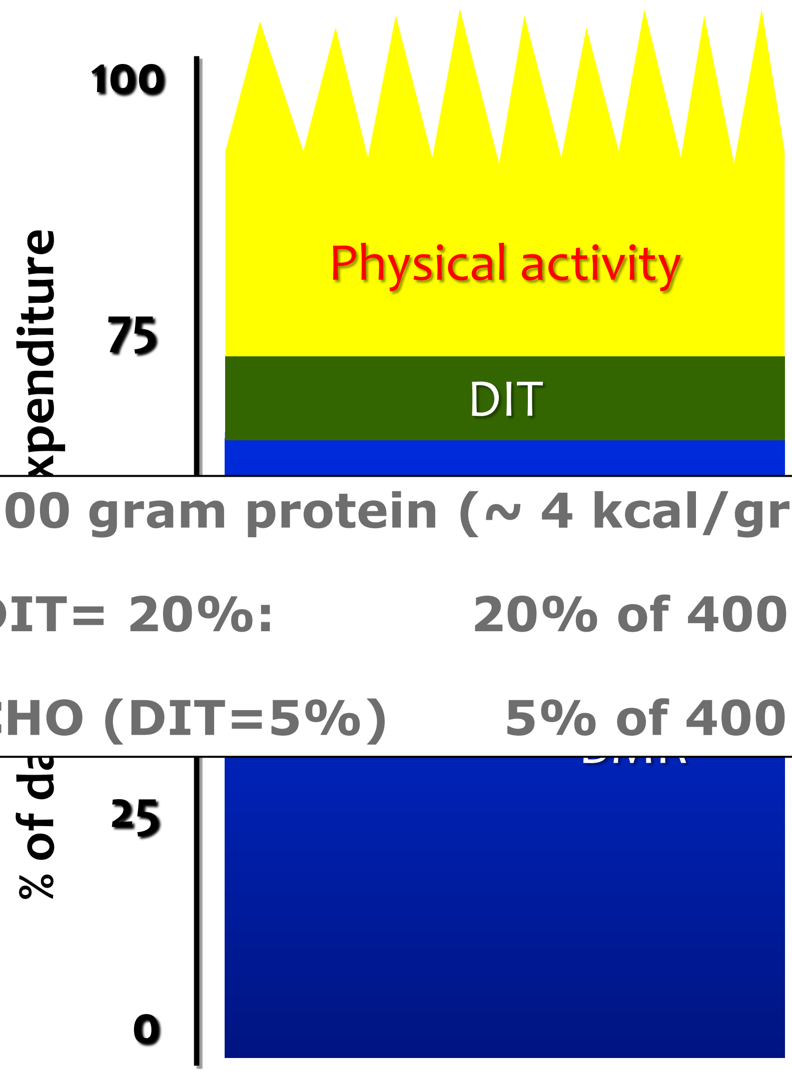
Affect appetite regulation

Diet induced thermogenesis (DIT)

Energy intake

Energy utilization

Diet induced thermogenesis



Protein: 20-30%

Fat: 0 to 3%

CHO: 5 to 10%

100 gram protein (~ 4 kcal/gram) = 400 kcal

DIT= 20%: 20% of 400 kcal = 80 kcal

CHO (DIT=5%) 5% of 400 kcal = 20 kcal

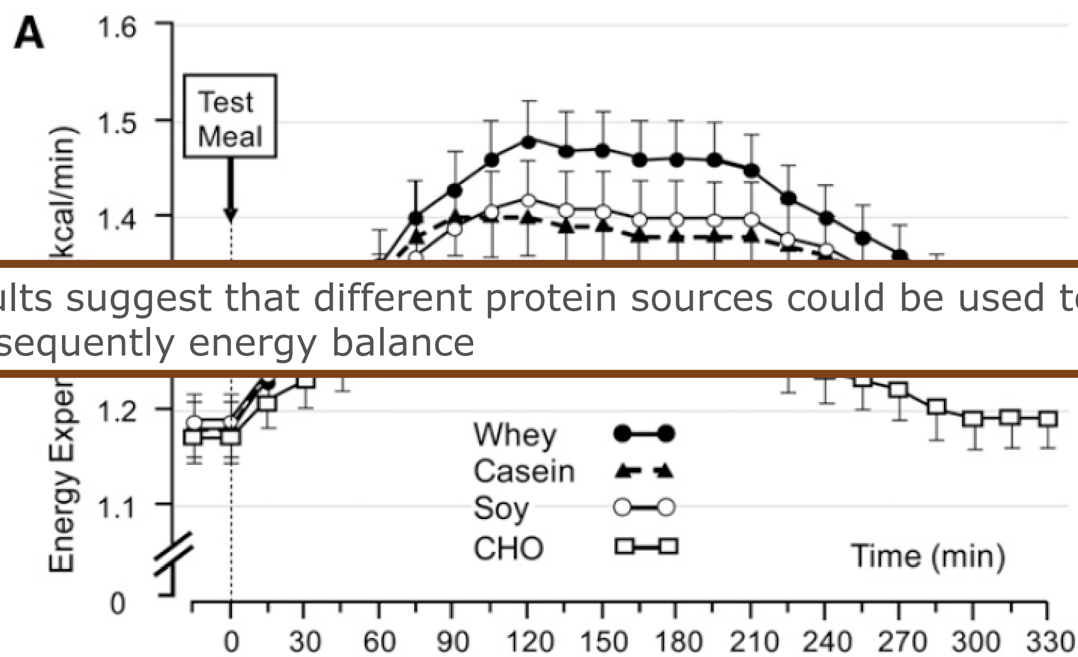
Protein choices targeting thermogenesis and metabolism[1–3]

Kevin J Acheson, Anny Blondel-Lubrano, Sylviane Oguey-Araymon, Maurice Beaumont, Shahram Emady-Azar, Corinne Ammon-Zufferey, Irina Monnard, Stéphane Pinaud, Corine Nielsen-Moennoz, and Lionel Bovetto

23 lean, healthy subjects

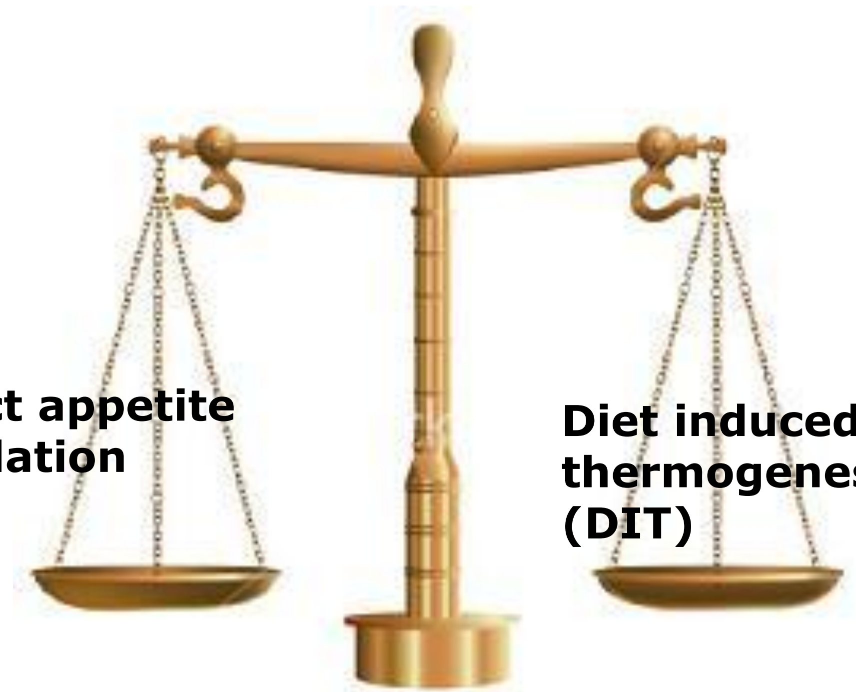
4 isocaloric test meals in a randomized, double-blind, crossover design.

Three meals consisting of 50% protein (whey, casein, or soy), 40% carbohydrate, and 10% fat and a fourth meal consisting of 95.5% carbohydrate



The results suggest that different protein sources could be used to modulate metabolism and subsequently energy balance

How may proteins affect energy balance?



Affect appetite regulation

Diet induced thermogenesis (DIT)

Energy intake

Energy utilization

Thank you for your attention