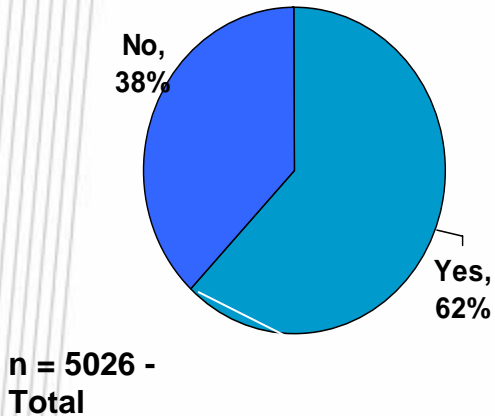




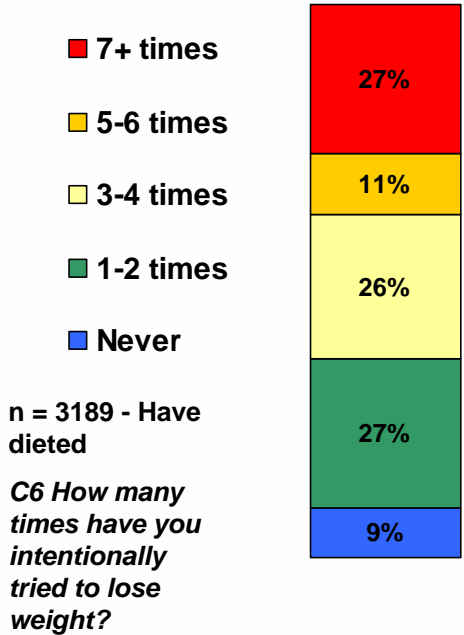
The Science Behind Weight Management

A/Professor Manny Noakes
CSIRO Human Nutrition

Australians, Weight Control and Diet



Q5. Have you ever gone on a diet or special eating plan either for health reasons or to try to lose or gain weight?



91% were looking to lose weight

Likely to be female and currently trying to lose weight

Two thirds of Australians have at some stage gone on a special eating plan or diet. For most of these, the aim was to lose weight.

Metabolic Benefits of Weight Loss

- Improves insulin sensitivity
- Improves lipid profile
- Lowers BP
- Lowers fasting and post prandial glucose/insulin response
- Reduces inflammation
- Prevents development of type 2 diabetes
- Improves reproductive function



Diet & Lifestyle Project

Goals:

- To improve the health and wellbeing of the community as well as reducing the burden of health costs to *Australia related to obesity*.

Objectives:

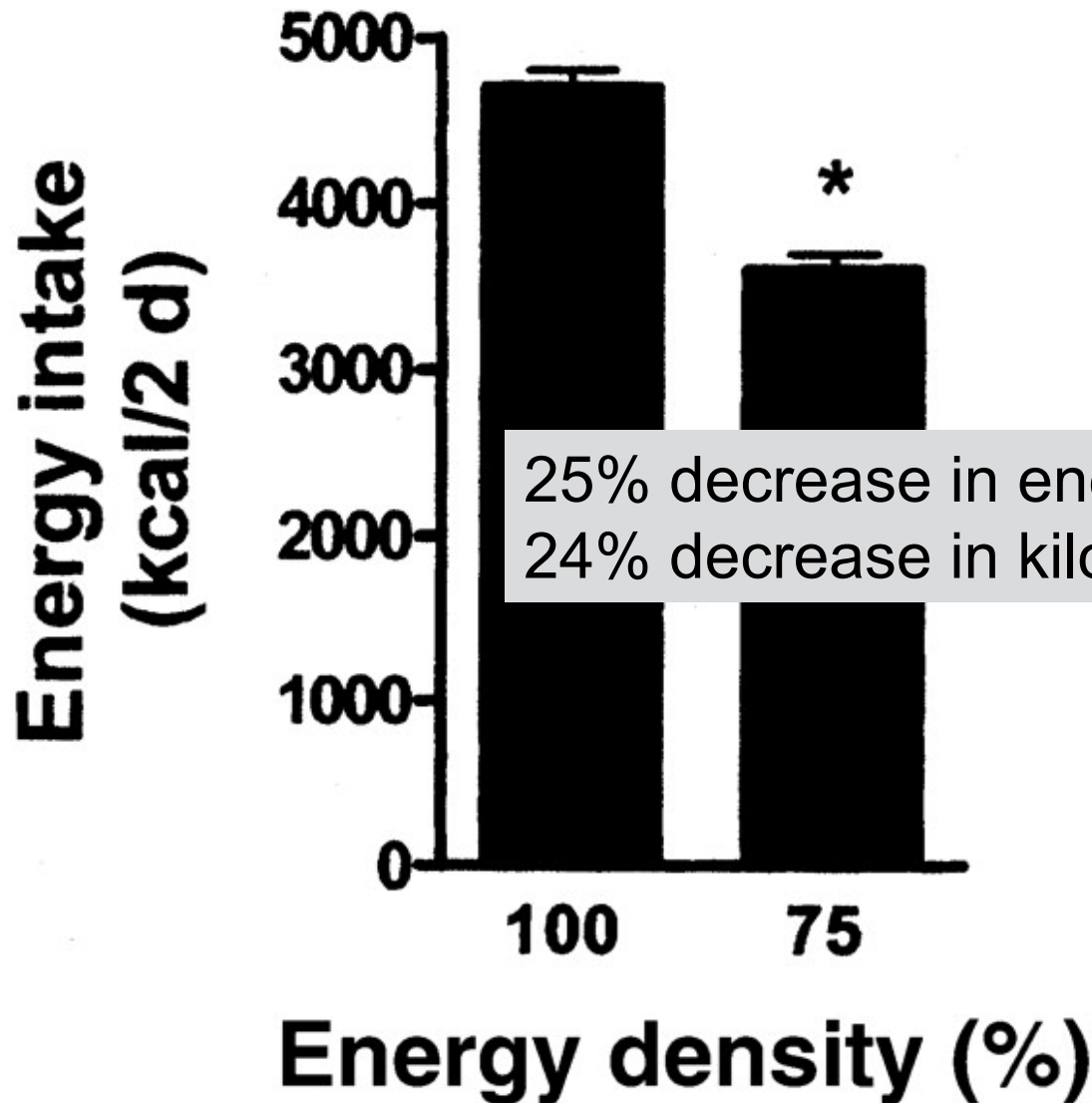
- To develop evidence based diet and lifestyle strategies
- To facilitate their *delivery* and adoption
 - by working with food industry
 - influencing government policy either directly or indirectly through key stakeholders

Some Food Related Factors That Affect Kilojoule Intake

- **Satiation and Satiety**
 - Energy density
 - KJ per gram, or unit volume
 - Portion size
 - Macronutrient composition (protein, fat carbohydrate)
 - Physical properties, GI, food structure
 - Palatability
 - Variety
- **Environmental**
 - Availability/Convenience
 - Social Context
 - Cultural
 - Variety
 - Cost
 - Marketing



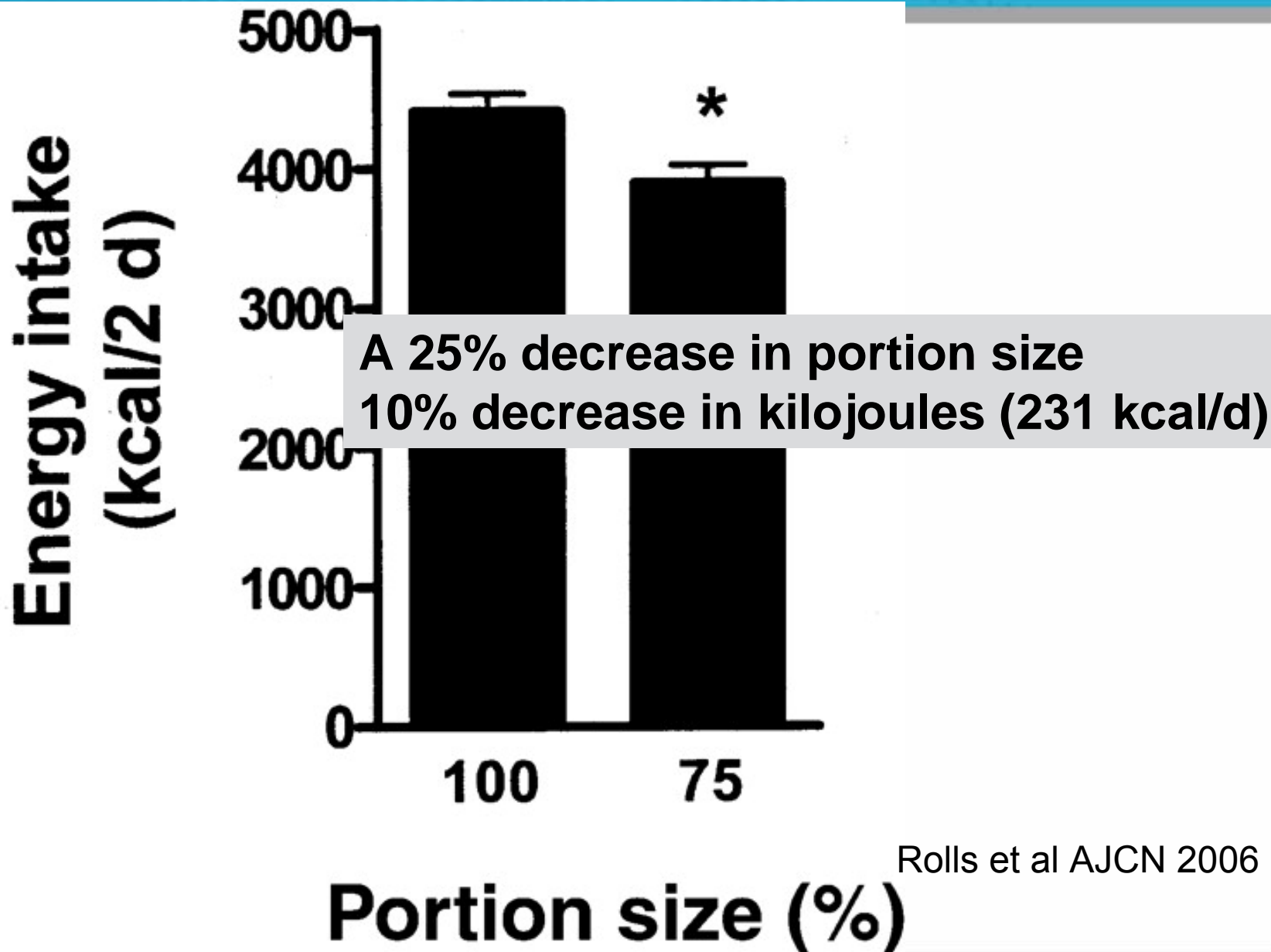
Energy density and *ad lib* kilojoule intake



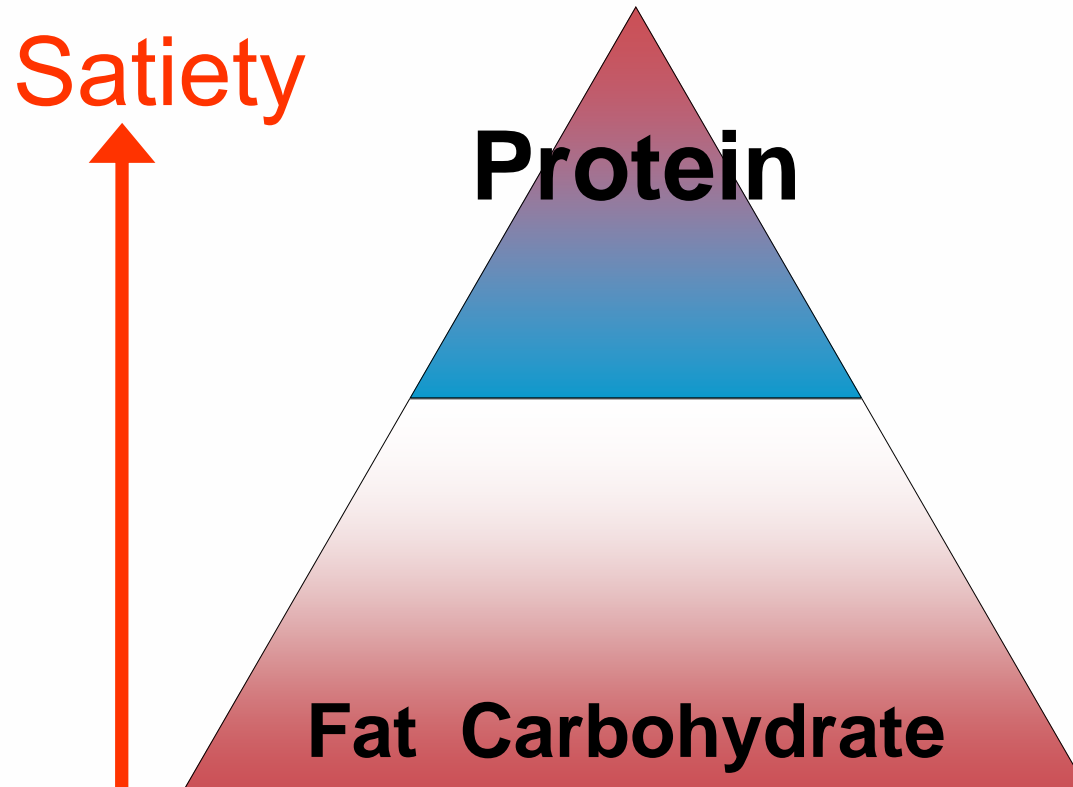
25% decrease in energy density -
24% decrease in kilojoules (575 kcal/d).

Rolls et al AJCN 2006

Portion size and *ad lib* kilojoule intake (2d)



Protein Enhances Satiety



Protein and appetite – substantiation

- 1000 kJ
- <1g fat
- 50g Protein

Liquid Preload Studies

OR

50g Carbohydrate



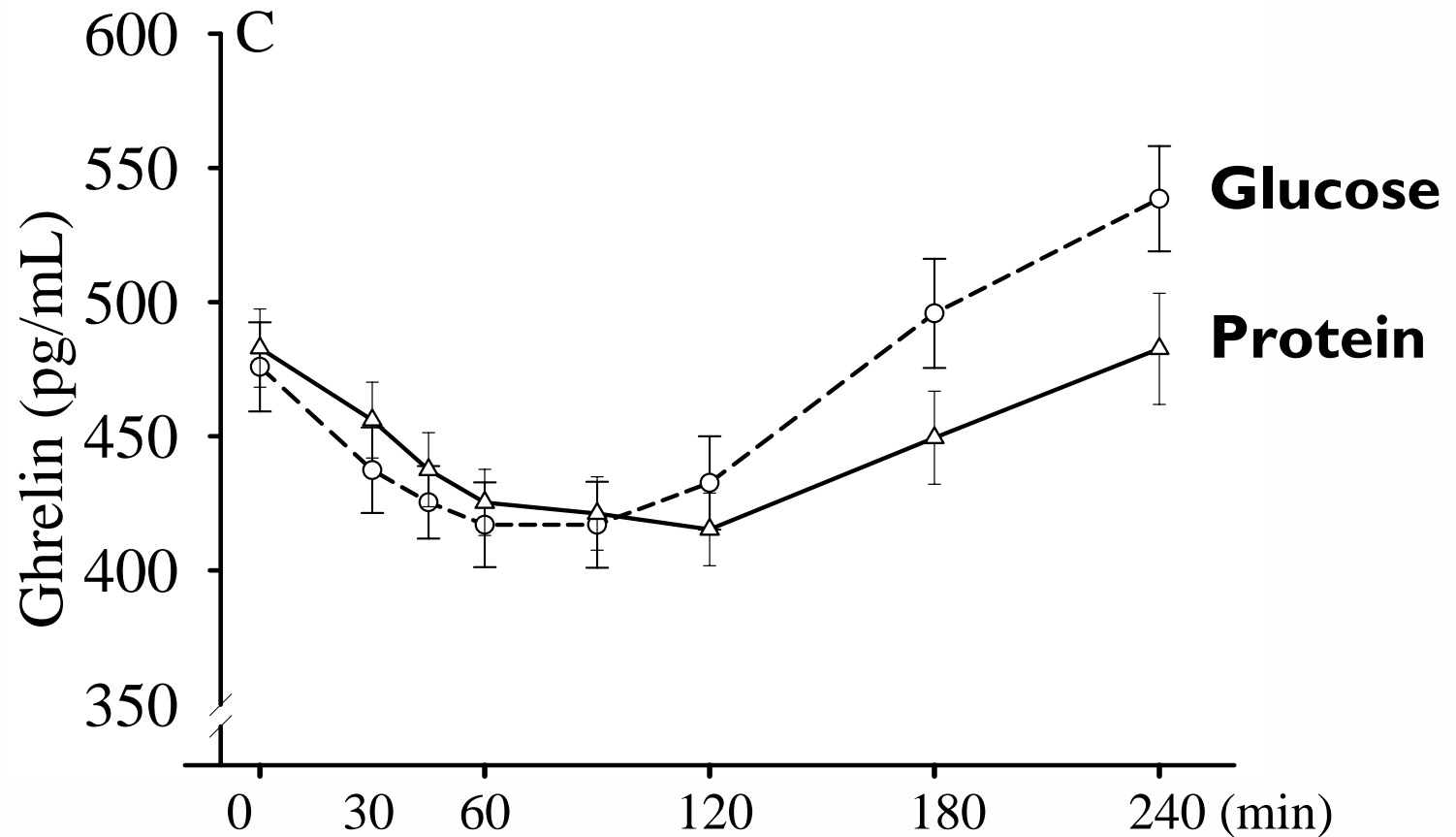
- Whey protein isolate
- OR
- Calcium caseinate
- OR
- Other protein sources



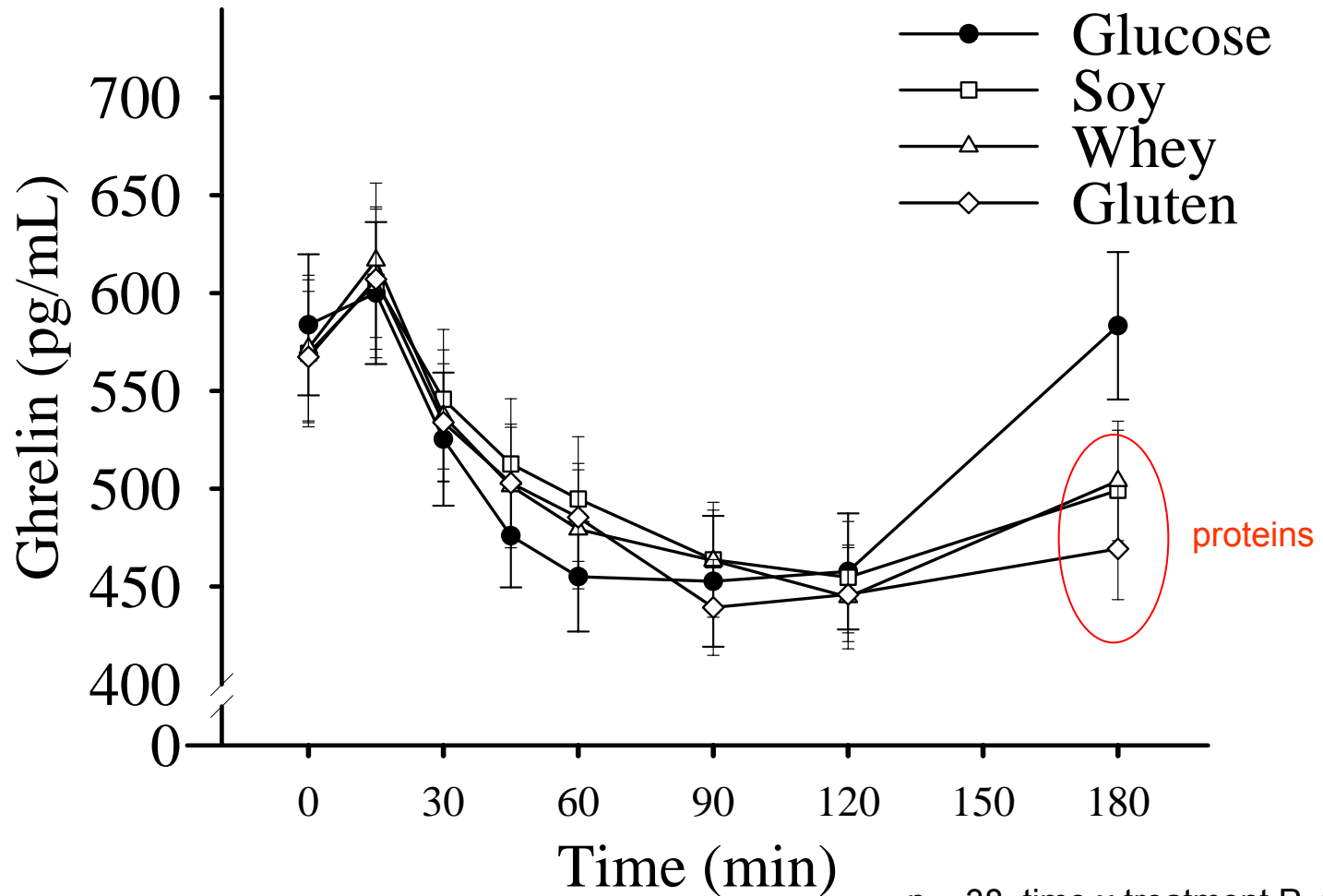
- Lactose
- OR
- Glucose
- OR
- Other carb sources

Randomised Cross-over Studies In Lean And Overweight Subjects

Protein – duration of effect on appetite hormones 3-4 hours

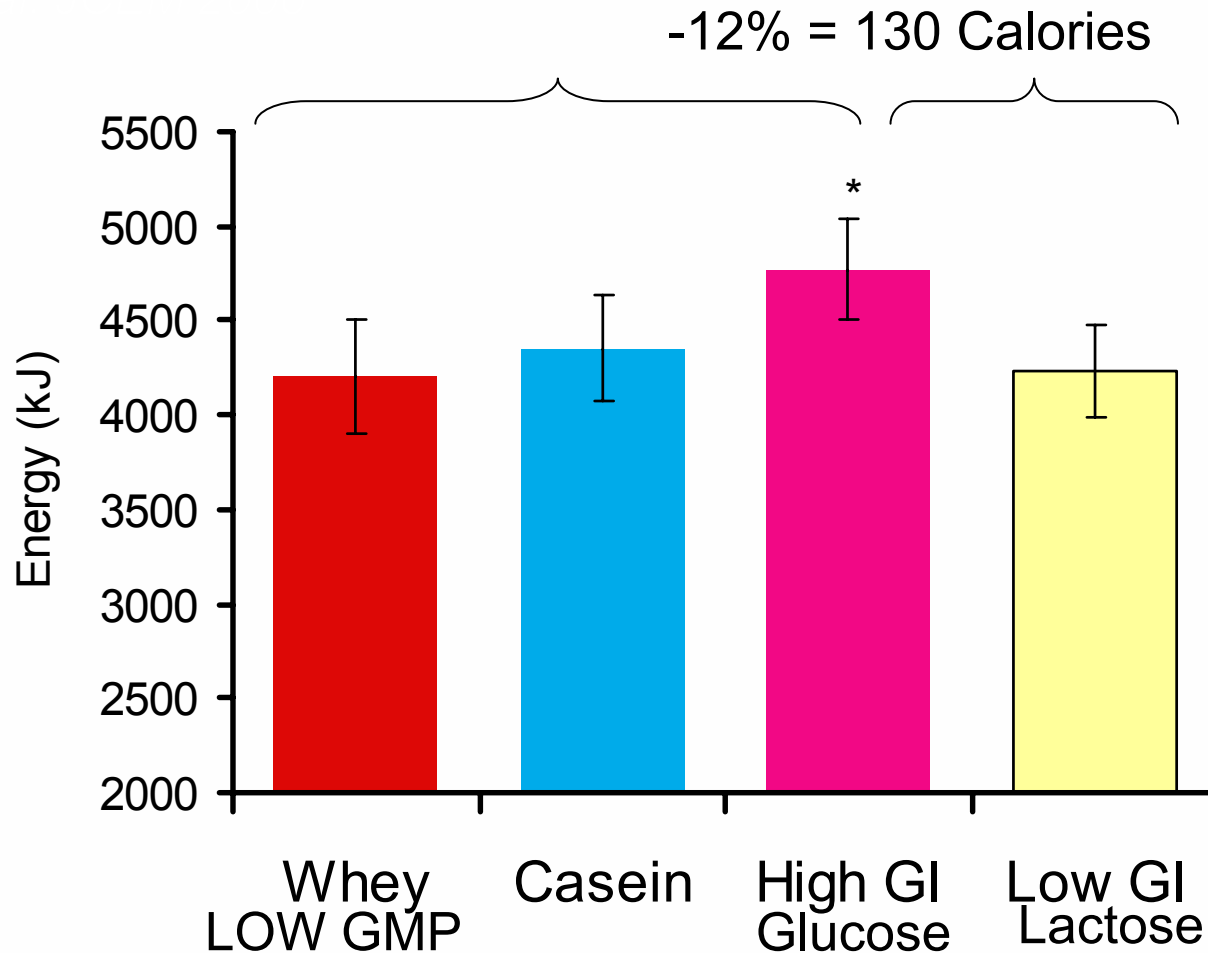


Protein sources – duration of effect on appetite hormones 3-4 hours



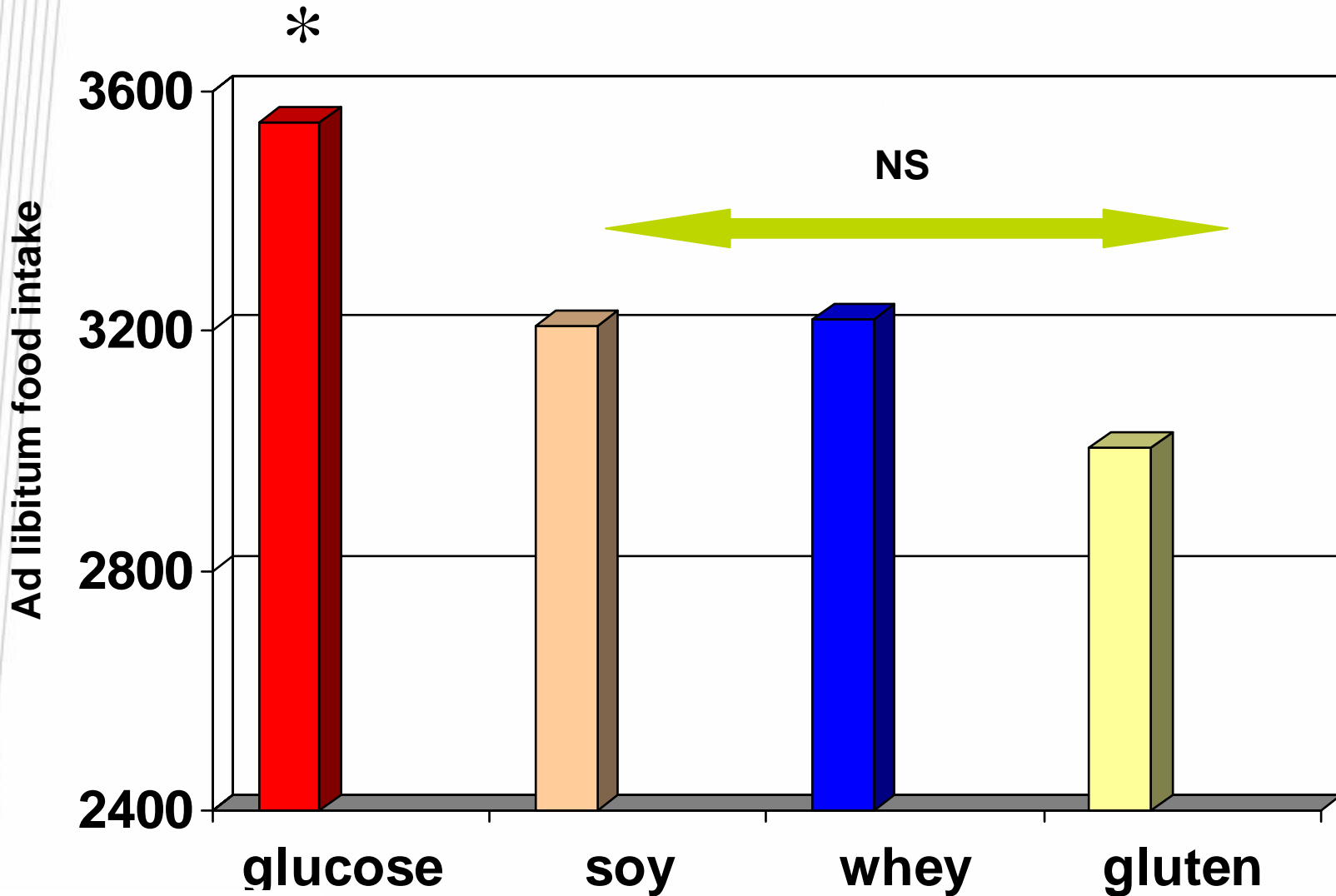
n = 38, time x treatment P < 0.001

Energy Intake 3 hours After Protein or Glucose Load



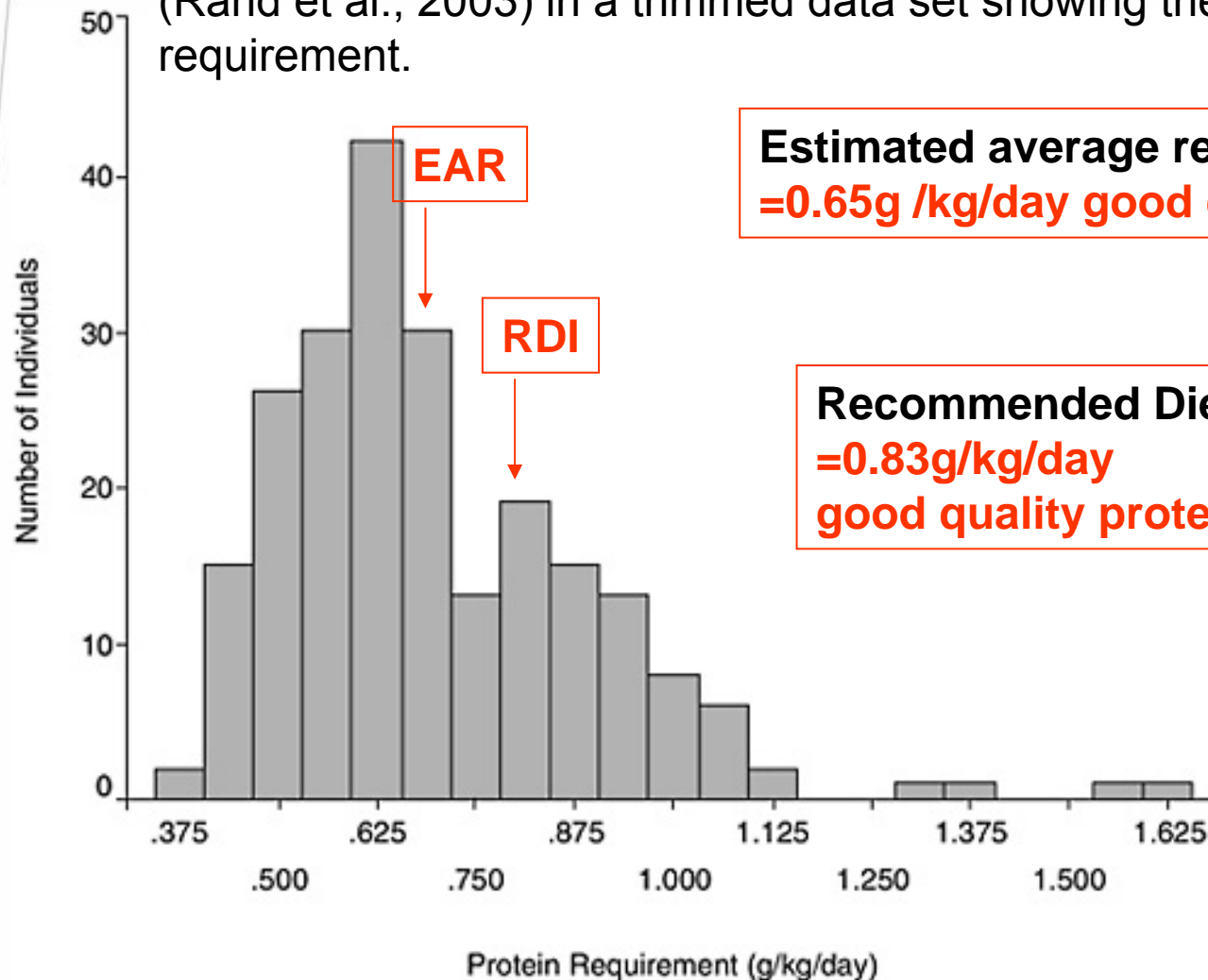
Bowen et al 2006

Energy Intake 3 hours After Protein or Glucose Load



Estimates of Protein Requirements

Distribution of the estimated protein requirements for 225 individuals (Rand et al., 2003) in a trimmed data set showing the skewness of protein requirement.



Estimated average requirement (EAR)
=0.65g /kg/day good quality protein

Recommended Dietary Intake (RDI)
=0.83g/kg/day
good quality protein

High-protein lower carb diets and body composition – meta regression

Lower carbohydrate higher protein diets*

□ a 2.05 kg greater loss of fat mass

□ 0.60 -1.21kg additional muscle mass spared

over a 12 week period

Higher protein intakes of >1.05 g/kg

Lower carb intake of < 42%

Kreiger AJCN 2006

Protein Intakes in Australia

Protein consumed in Australia (grams per day)

Males	5 th %	50 th %	95 th %
19-30y	77	115	186
31-49y	79	107	155
50-69y	63	96	144
70+y			
Females			
19-30y	47	74	120
31-49y	50	73	107
50-69y	47	70	101
70+y	38	61	95

Source : NNS 95

Some limitations of nitrogen balance studies to estimate protein needs for weight loss

- ❑ Duration of balance studies is short
- ❑ Makes assumption that zero balance is the goal
- ❑ Zero balance does not imply that protein and amino acid function in all organs and tissues is optimal
- ❑ Protein requirements not applicable to energy restricted states

Metabolic Effects Of Higher Protein Diet for Weight Loss

🍷 Greater weight and fat loss (Skov et al,1999)

- Obese subjects

🍷 Increased satiety (Latner & Schwartz, 1999)

- Glucose tolerant women

🍷 Thermic effects (Hwalla Baba et al,1999)

- Obese, hyperinsulinaemic men

🍷 Lean body mass spared (Piatti et al,1994)

- Glucose tolerant women

🍷 High protein/Low GI (Dumesnil et al)

- 25% decrease in ad libitum intake
- Obese men

Metabolic Effects Of Higher Protein Diet for Weight Loss - CSIRO Studies

- **Insulin sensitivity (Clifton et al,1998)**
 - Subjects with IGT
- **Greater abdominal fat mass loss (Parker et al 2002)**
 - Type 2 diabetes
- **Greater lowering of LDL-C (Parker et al 2002)**
 - Type 2 diabetes
- **Thermic effect of HP meal 28% greater (Luscombe et al 2002)**
 - No change in REE
 - Type 2 diabetes
- **Greater lowering of Triglycerides (Farnsworth et al)**
 - Subjects with elevated insulin
- **Lean body mass spared (Farnsworth et al)**
 - Subjects with elevated insulin
- **Post prandial glucose response lower (Moran et al)**
 - **Women with PCOS**

Metabolic Effects Of Higher Protein Diet for Weight Loss

Study Design

12 weeks

5.6 MJ Higher Protein Diet (HP)

weight loss

5.6 MJ High Carbohydrate Diet (HC)

weight loss

	HP	HC
<i>n</i> (women)	52	48
Weight (kg)	87 ± 12	86 ± 12
Age (y)	50 ± 10	49 ± 9
BMI (kg/m ²)	32 ± 6	33 ± 4

Aim

- **To compare a high protein weight loss diet with a high carbohydrate diet in women participating in a 12 week intervention (and subsequent follow up) on the following outcomes:**
 - Weight loss and body composition
 - Nutrient status
 - Bone turnover markers
 - Measures of heart disease risk
- .
- **Diets:**
 - High carbohydrate
 - High protein

High Protein (5600 KJ)



- Cereal
- Low fat milk (250ml)
- Wholemeal bread (2 slices)
- Fruit (2)
- Beef / lamb/fish/chicken 200g - dinner
- Chicken/fish/meat 100g - lunch
- Vegetables 2.5 cups
- Diet Yoghurt 200g
- Canola oil 3 tsp
- Wine 2 glasses/week (optional)

34% protein 20% fat 46% carbohydrate

109g protein 31g fat 161g carbohydrate



High Carbohydrate (5600 KJ)



- Cereal
- SKIM milk (250ml)
- Wholemeal bread (3 slices)
- Fruit (3)
- Chicken / pork / fish 80g
- Vegetables 2.5 cups
- Canola oil 3 tsp
- Pasta/rice 120g cooked
- Low fat biscuits 3
- Wine 2 glasses/week (optional)



17% protein 20% fat 64% carbohydrate

57g protein 31g fat 229g carbohydrate

Overall Results

Diet	Average Weight Loss	Min Weight Loss	Max Weight Loss	N	Dropouts
High Protein	7.6kg	0.55kg	18.2kg	51	5
High Carbohydrate	6.9kg	0.15kg	14.5kg	49	16

Weight Loss

Intention-to-treat analysis, baseline weight carried forward

- HP diet: 6.8 ± 3.9 kg;
- HC diet: 5.4 ± 4.3 kg; $P = 0.041$

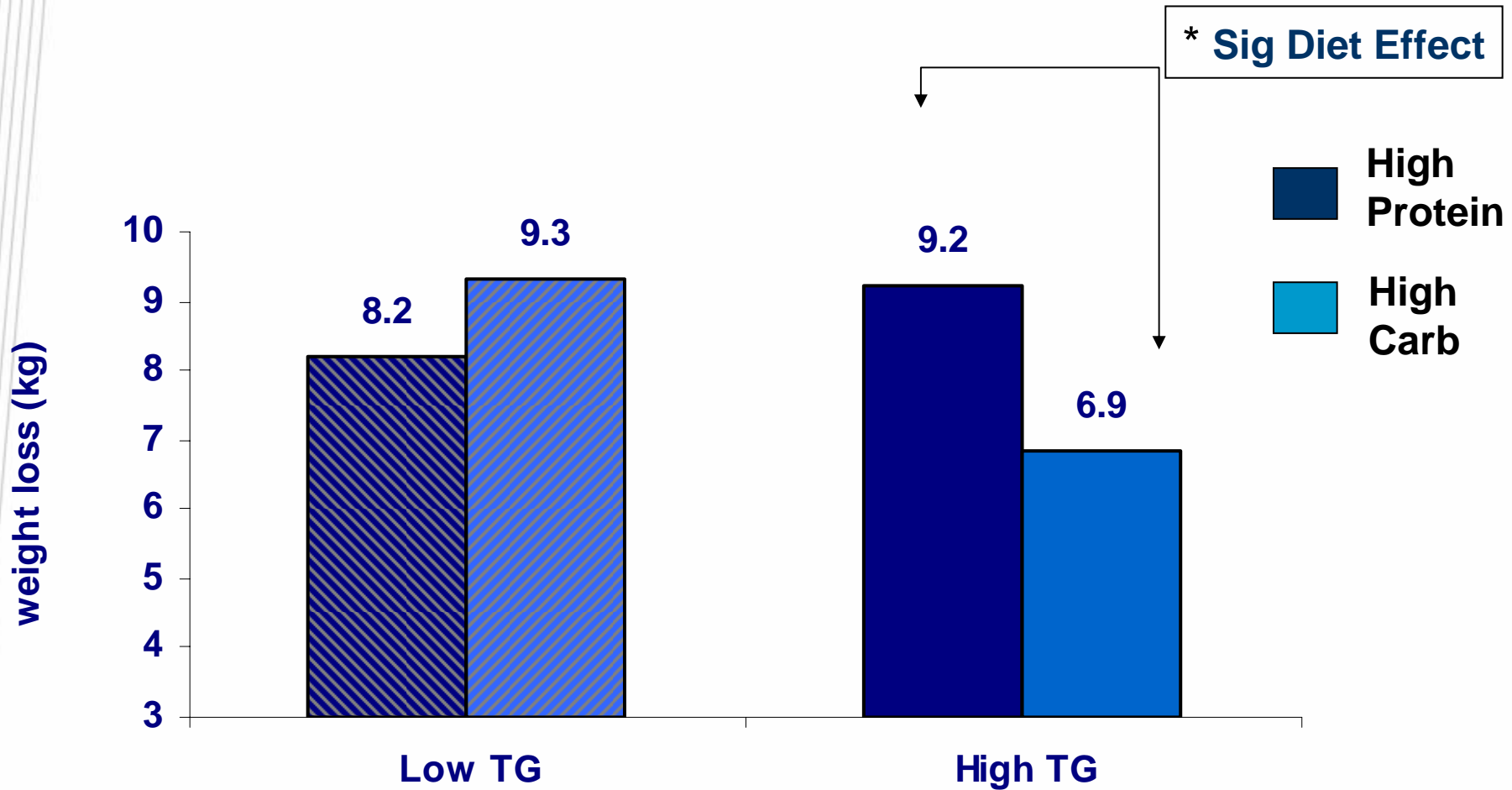
When the analysis was carried out by using the last weight carried forward for dropouts, the diet effect was weakened

- HP diet: 7.0 ± 3 kg;
- HC diet: 5.8 ± 4.0 kg; $P = 0.066$

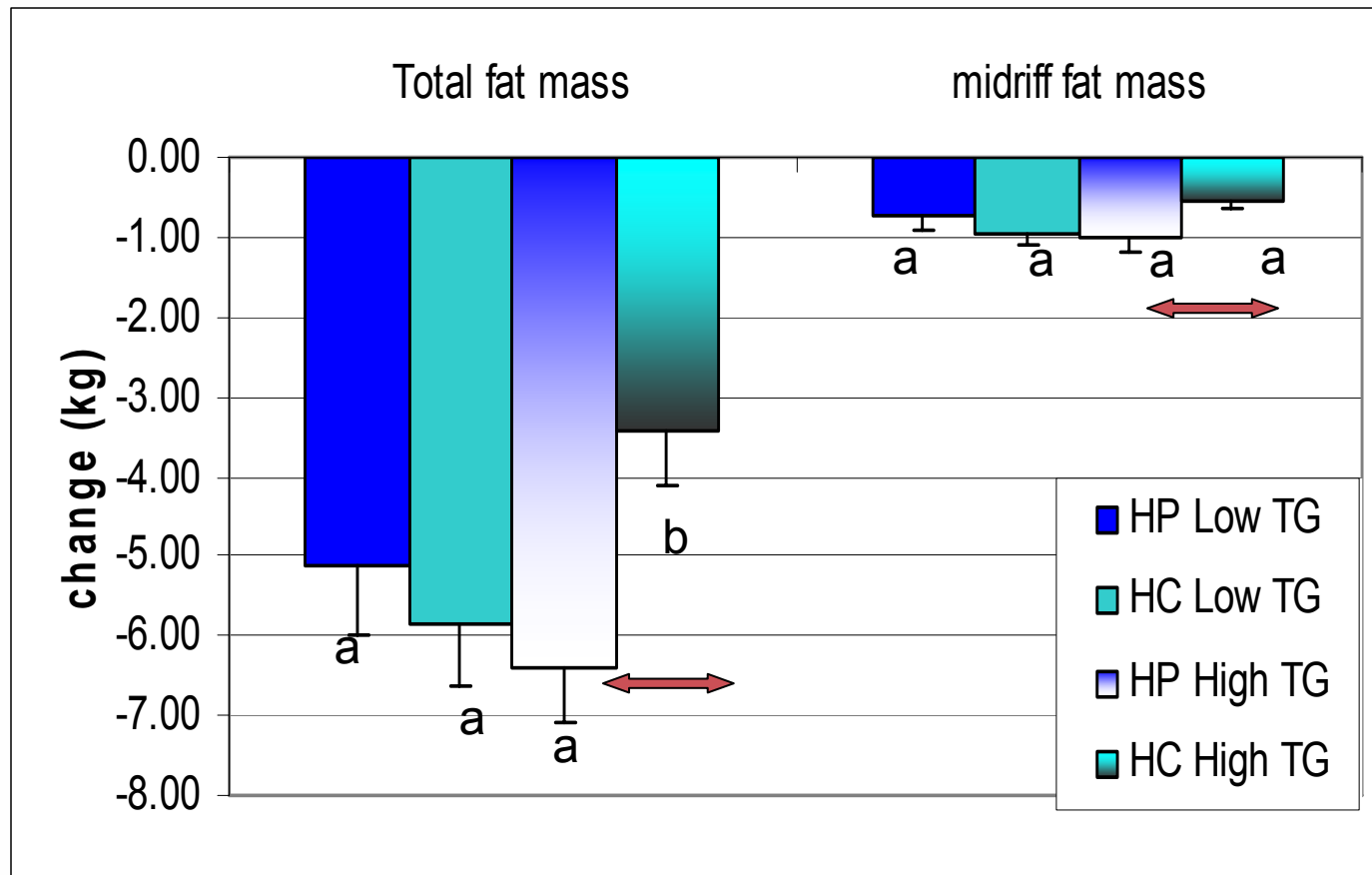
Completers analysis

- HP 7.6 ± 0.4 kg
- HC 6.9 ± 0.5 kg $P = 0.29$

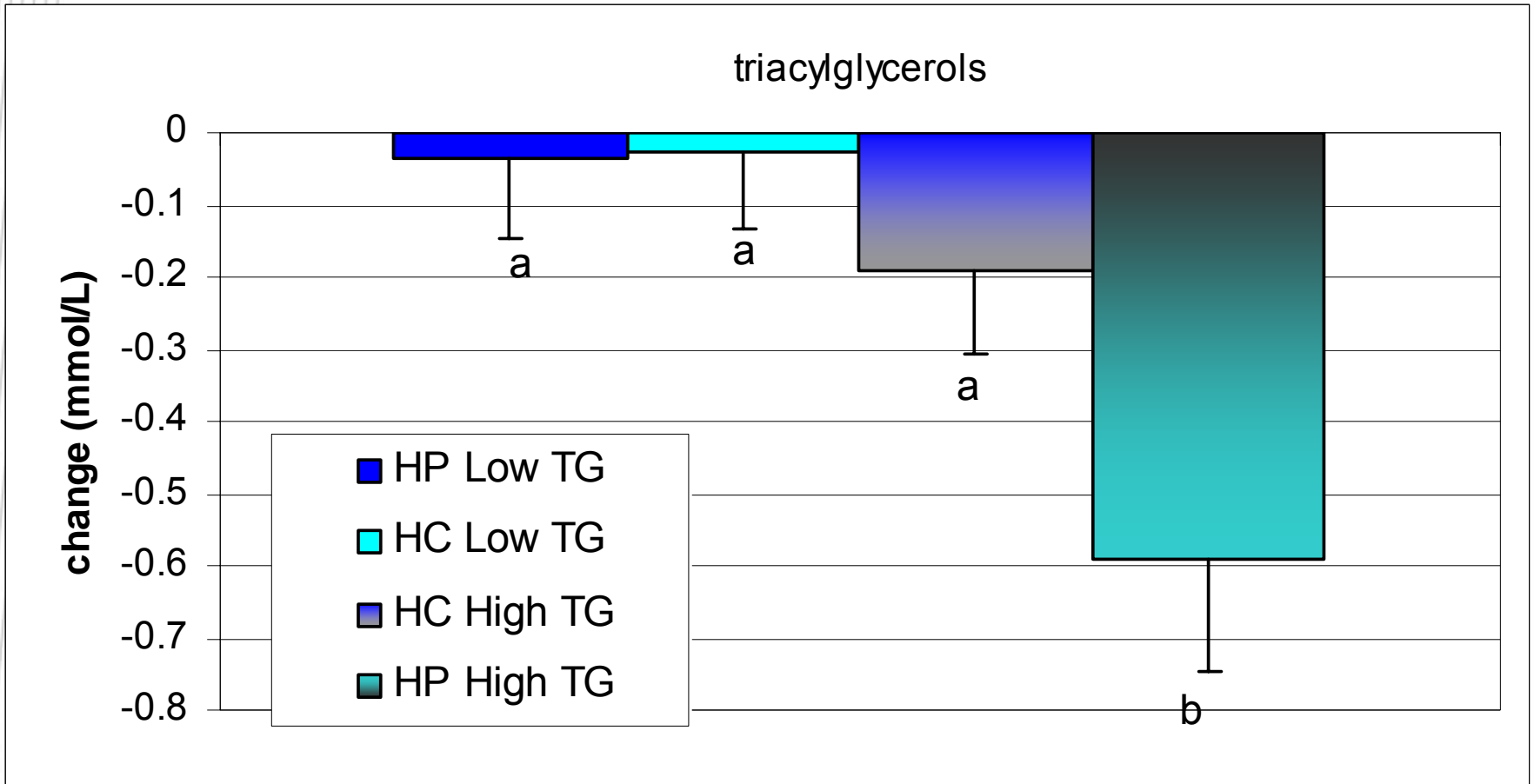
Weight Loss by Triglyceride Status



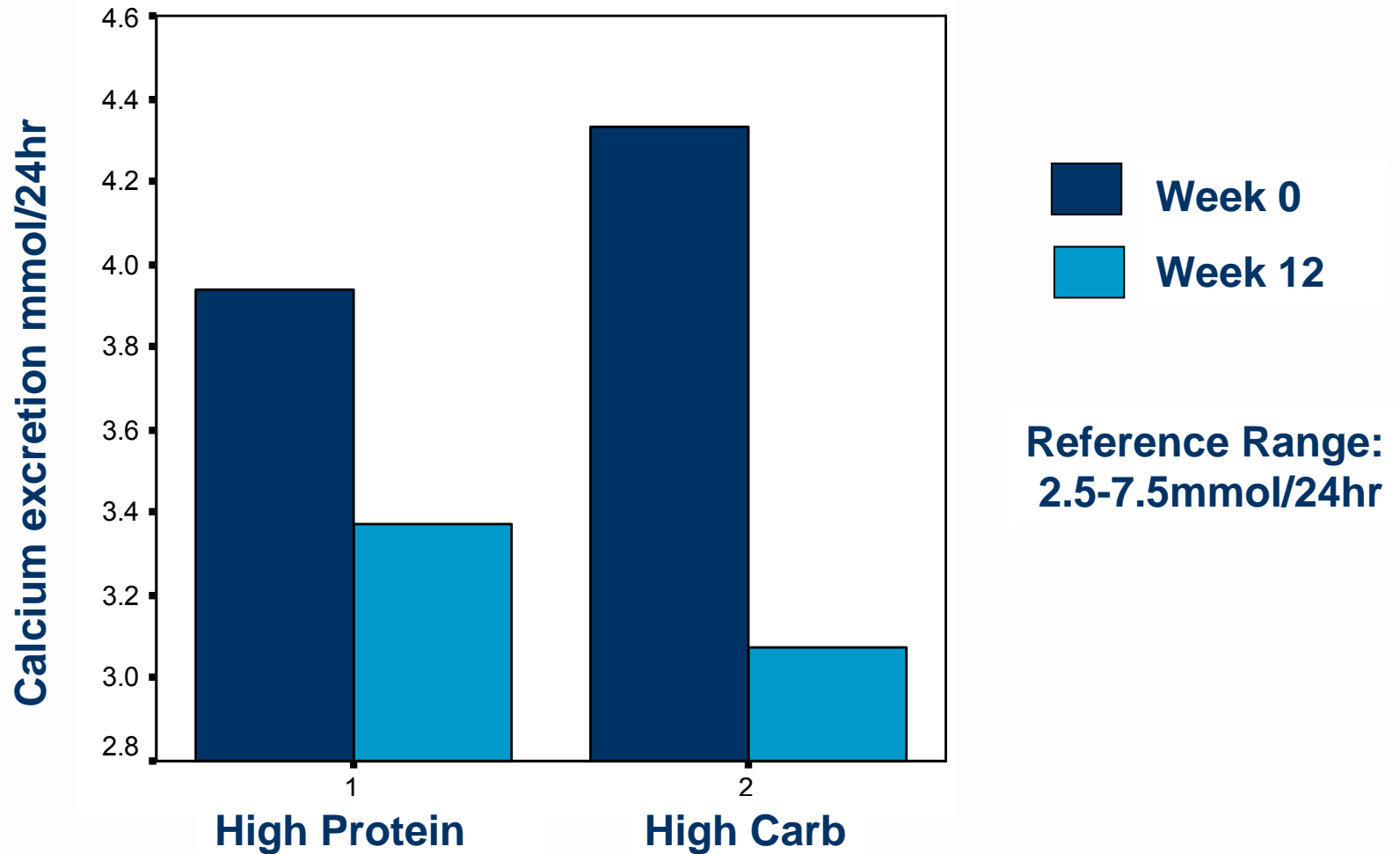
Greater fat mass change on high protein depends on triglyceride status



Greater triglyceride reduction on high protein depends on triglyceride status



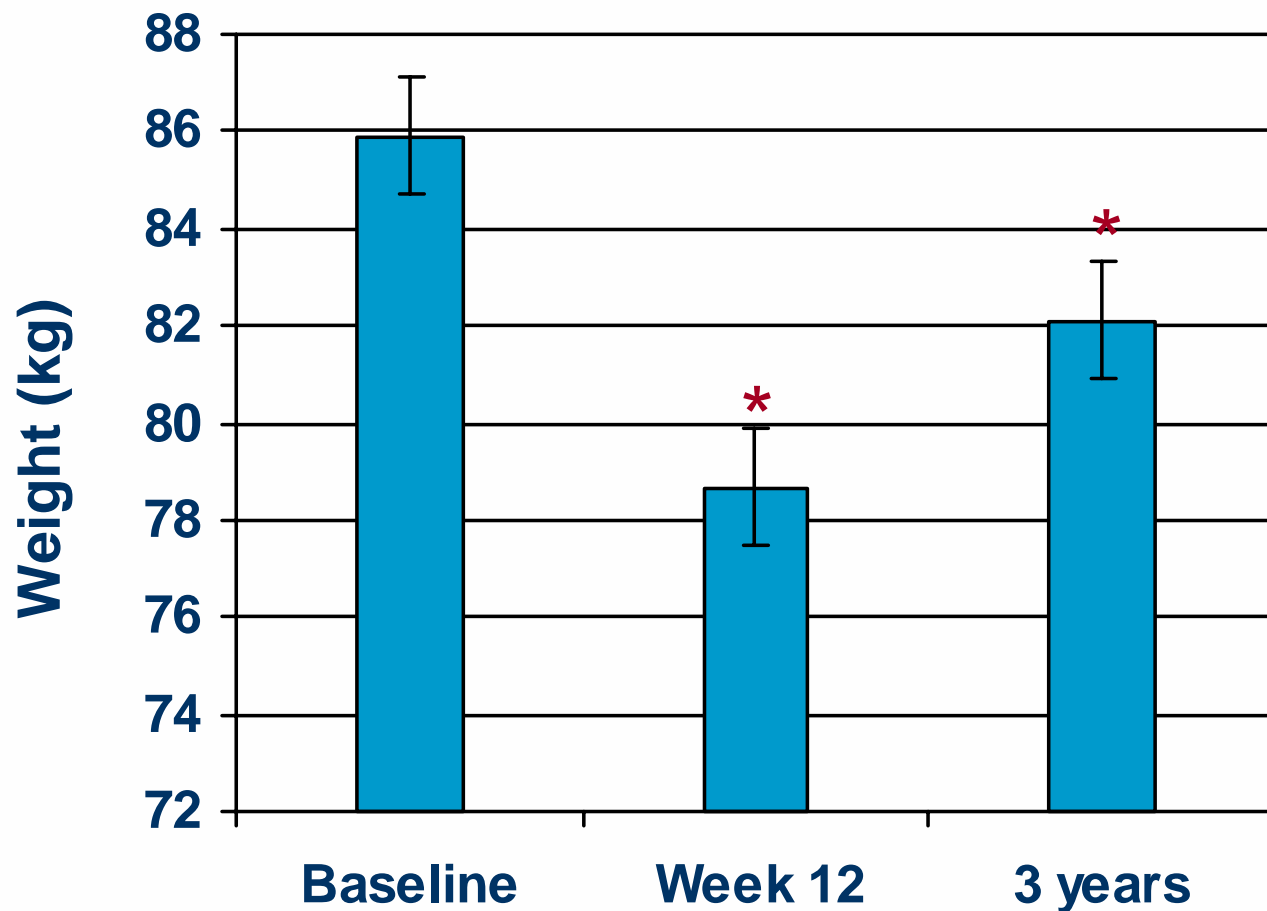
Calcium Excretion



Calcium excretion decreased on both diets

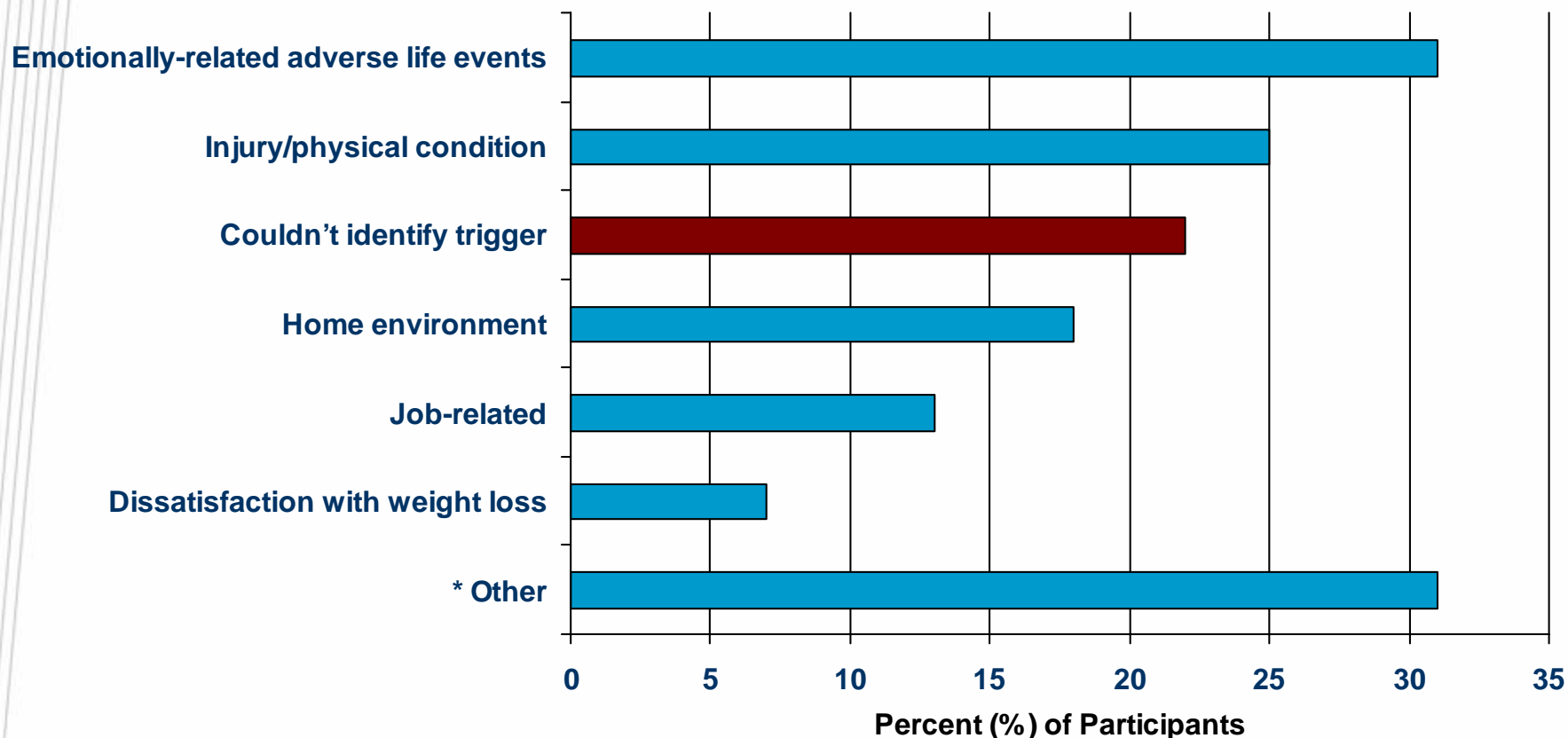
Weight outcome after 3 years in women

Net weight loss: $3.8 \pm 5.48\text{kg}$



Trend for weight loss during the 12-week program was associated with long-term weight loss [$r = 0.20$, $n = 81$, $P = 0.060$]

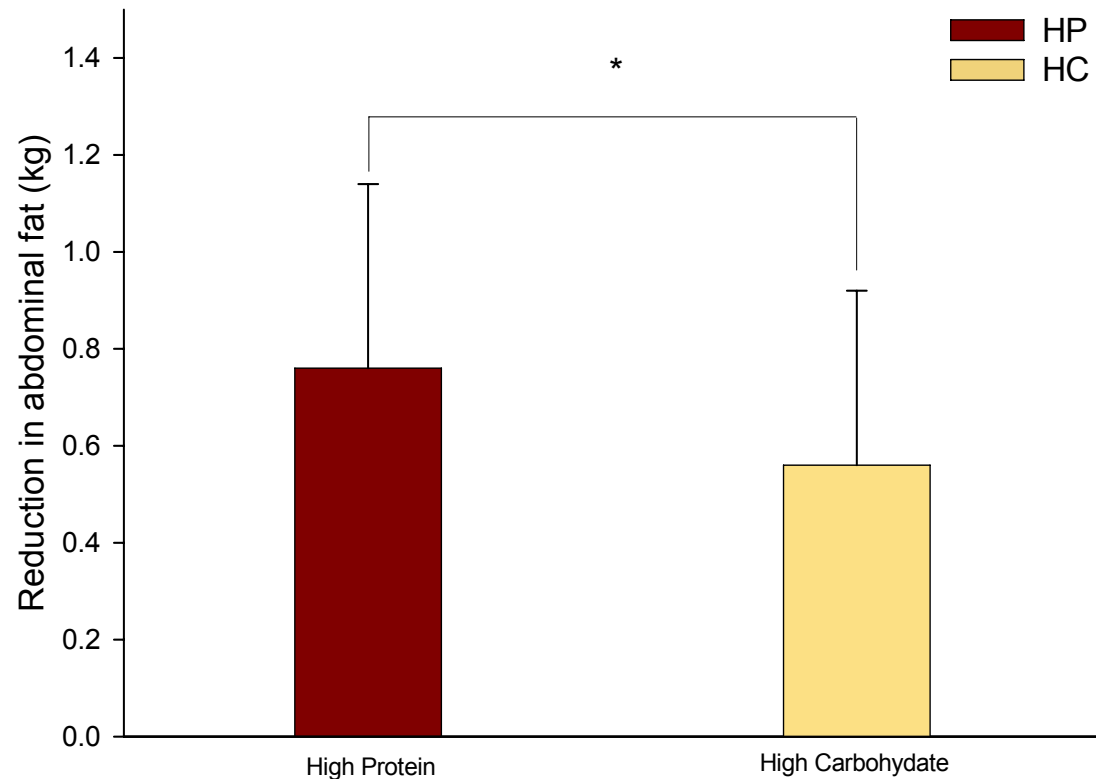
Perceived triggers for weight regain in women



- *Other is comprised of 8 other factors - development of medical condition related to weight gain, commencing medication with weight gain as a side effect, decrease in exercise, dissatisfaction with study meal plan, pre/post pregnancy, lack of support following program completion, development of illness, limited time for food preparation.

Higher protein diet – greater reduction in abdominal fat mass in men

* $P < 0.02$ significant difference between groups.

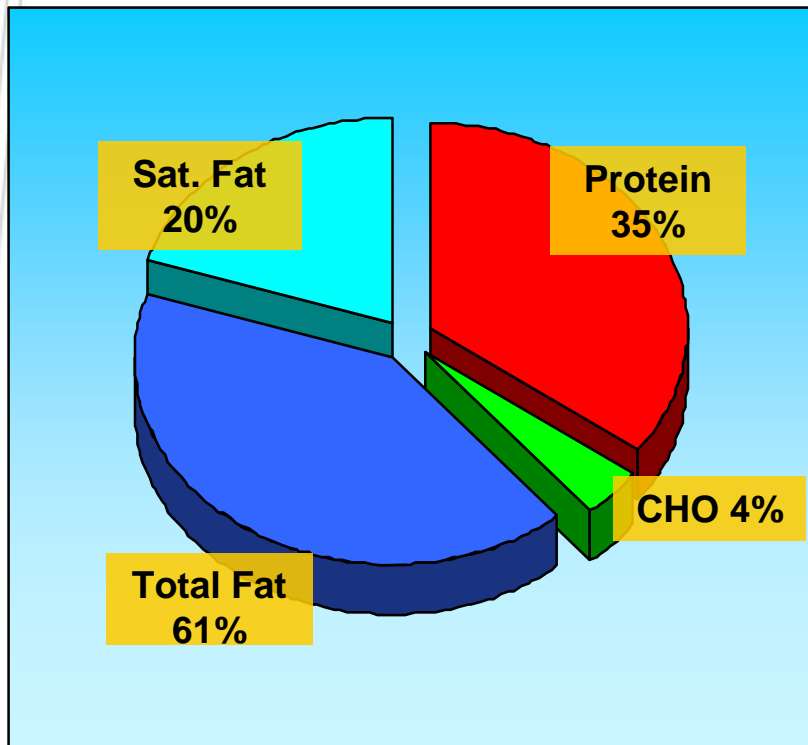


HP (n=48, 132g protein)

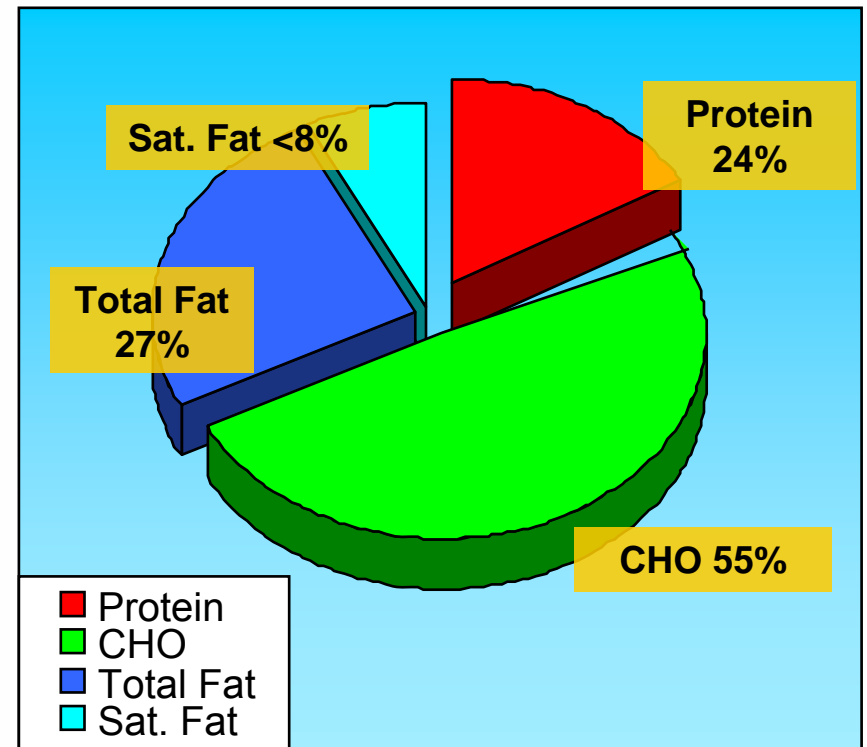
HC (n=53 82g protein)

Very Low Carbohydrate High Protein Diets

Very Low Carb



Low Fat High Carb



Brinkworth et al

Very Low Carb High Protein Diets

•VLC Diet 6000KJ

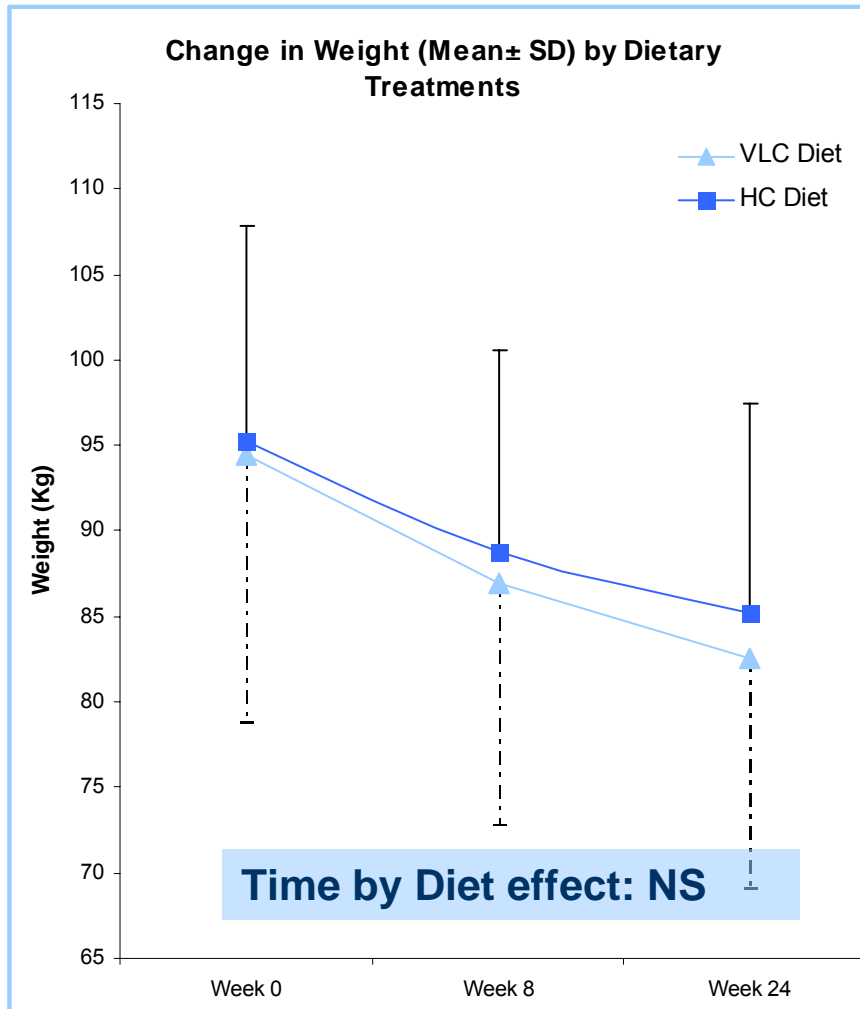
- 125ml milk
- 70g full fat cheddar cheese
- 100g (cooked weight) ham, tuna, beef, chicken, turkey
- 300g (raw protein food) beef, chicken, fish
- 1 medium (50-55g) egg
- At least 2.5 cups green vegetables
- 25g (5tsp) oil/butter
- 40g raw, unsalted mixed nuts
- 2 standard alcoholic drinks/week (optional)

•HC Diet 6000 KJ

- 40g high fibre cereal e.g. Fibre Plus, All Bran
- 2 slices wholegrain bread (35g)
- 300ml skim milk
- 20g reduced fat cheese (2/7)
- 300g fruit
- 150g raw meat, beef, chicken, pork, lamb (5/7)
- 150g fish (1/7)
- At least 2.5 cups vegetables
- 1 medium potato (3/7)
- 100g (dry wt) pasta/rice (4/7)
- 100g beans/ lentils (2/7)
- 20g raw unsalted nuts
- 50g tinned fish (3/7)
- 5tsp polyunsaturated margarine/ oil
- 200g diet yoghurt (3/7)
- 2 standard alcoholic drinks/week (optional)

Brinkworth et al

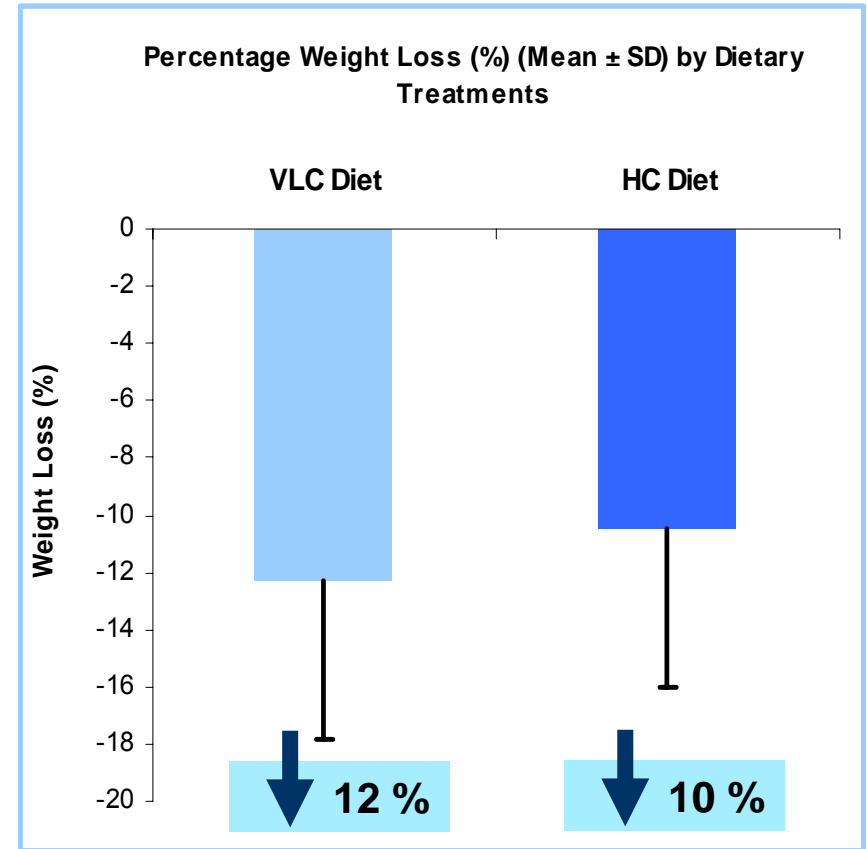
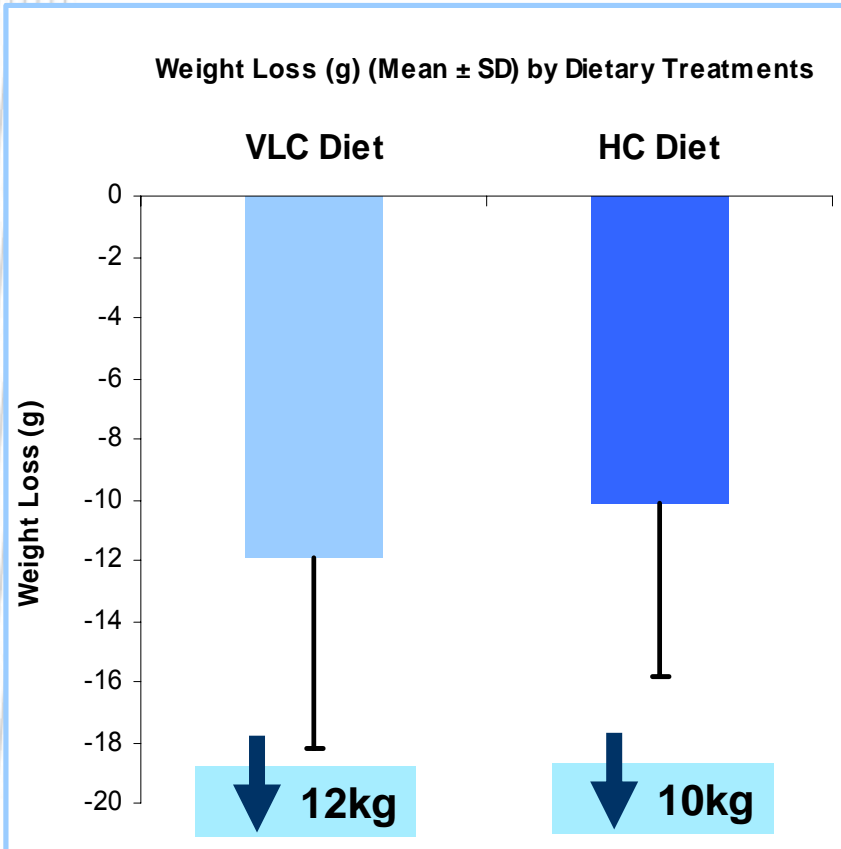
Weight Loss on Low Carb - Isocaloric



- Intention to Treat Analyses
 - NS difference in weight loss between groups
 - Baseline weights carried forward (P=0.226)
 - Last follow up visit carried forward (P=0.472)

Brinkworth et al

Weight Loss on Low Carb – Isocaloric -6months

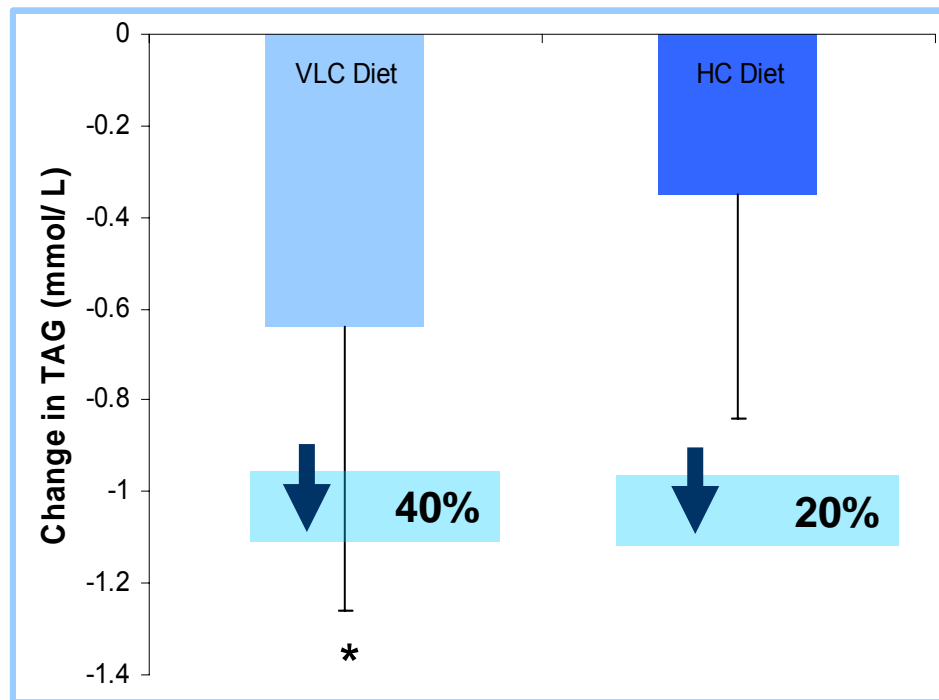
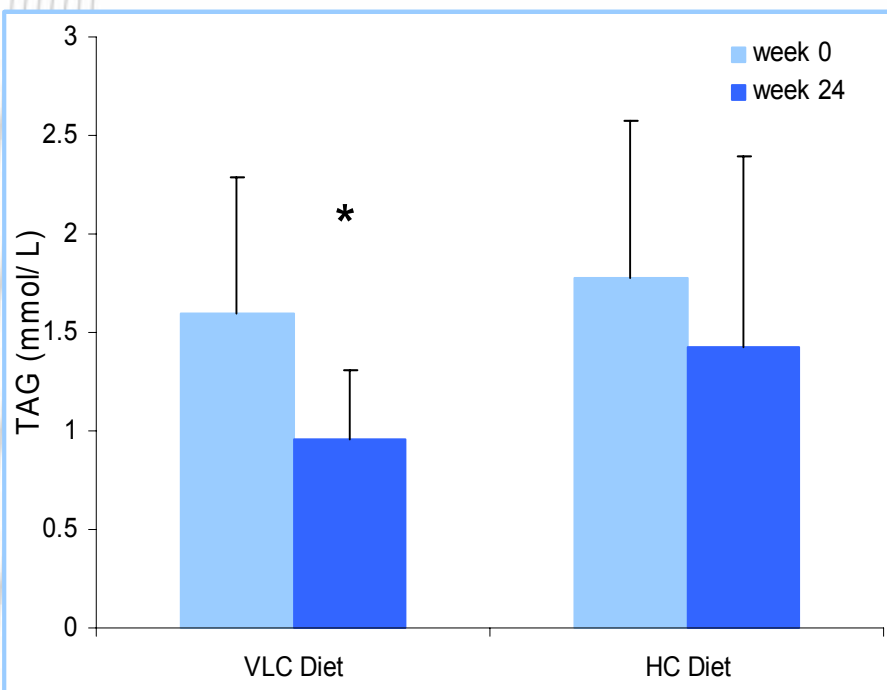


•Percentage weight loss from baseline similar between diets (P=0.137)

Brinkworth et al

Low Carb and Triglycerides

Significant Time by Diet effect: $P < 0.01$



Data are means \pm SD

* Significant Time by Diet Interaction ($P < 0.01$)

Brinkworth, Tay, Noakes et al

Structured Diet Approaches More Effective

- ***Anderson AJCN 2001***

Long-term weight-loss maintenance: a meta-analysis of US studies.

Very Low Energy Diets successful up to 5 years followup

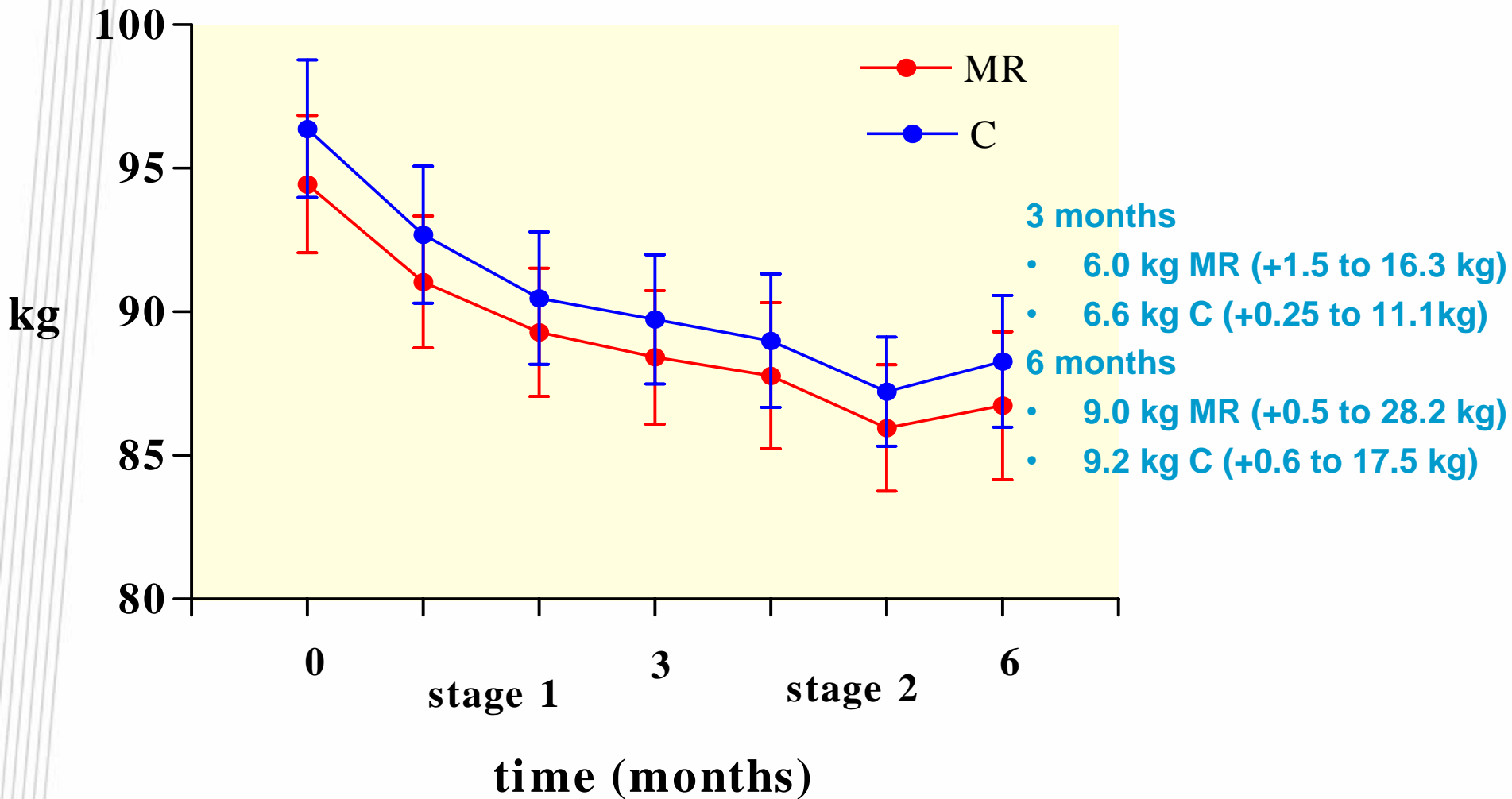
- ***Wing RR Int J Obes Relat Metab Disord. 1996***

Food provision vs structured meal plans in the behavioral treatment of obesity. **Providing structured meal plans and grocery lists improves outcome in a behavioral weight control program; no further benefit is seen by actually giving food to patients.**

Structured Diet vs Liquid Meal Replacement

Meal plan	MR	C
<i>breakfast</i>	Meal replacement (<i>shake</i>) Fresh fruit	High fibre cereal Sultanas Skim milk
<i>snack</i>	Fresh salad/dip	Fresh fruit
<i>lunch</i>	Meal replacement (<i>bar</i>)	Wholegrain cheese salad sandwich
<i>snack</i>	Fresh fruit	Fresh fruit
<i>dinner</i>	Main low fat meal Vegetables – Salad/cooked	Low fat meal Vegetables – Salad/cooked
<i>snack</i>	Biscuits	Low fat biscuits

Weight loss on structured diet vs meal replacement



Noakes et al 2005

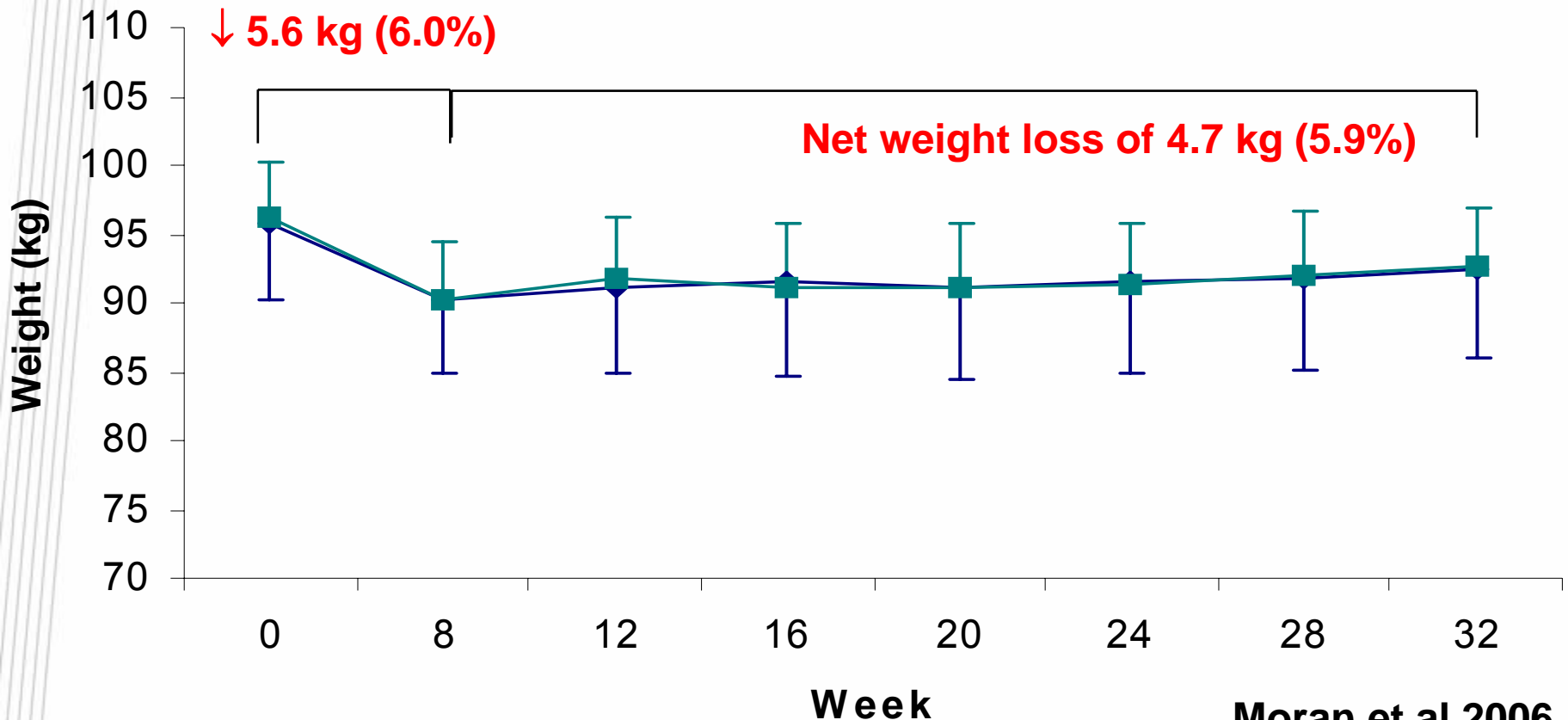
Weight loss in PCOS

Weight loss
Meal replacements



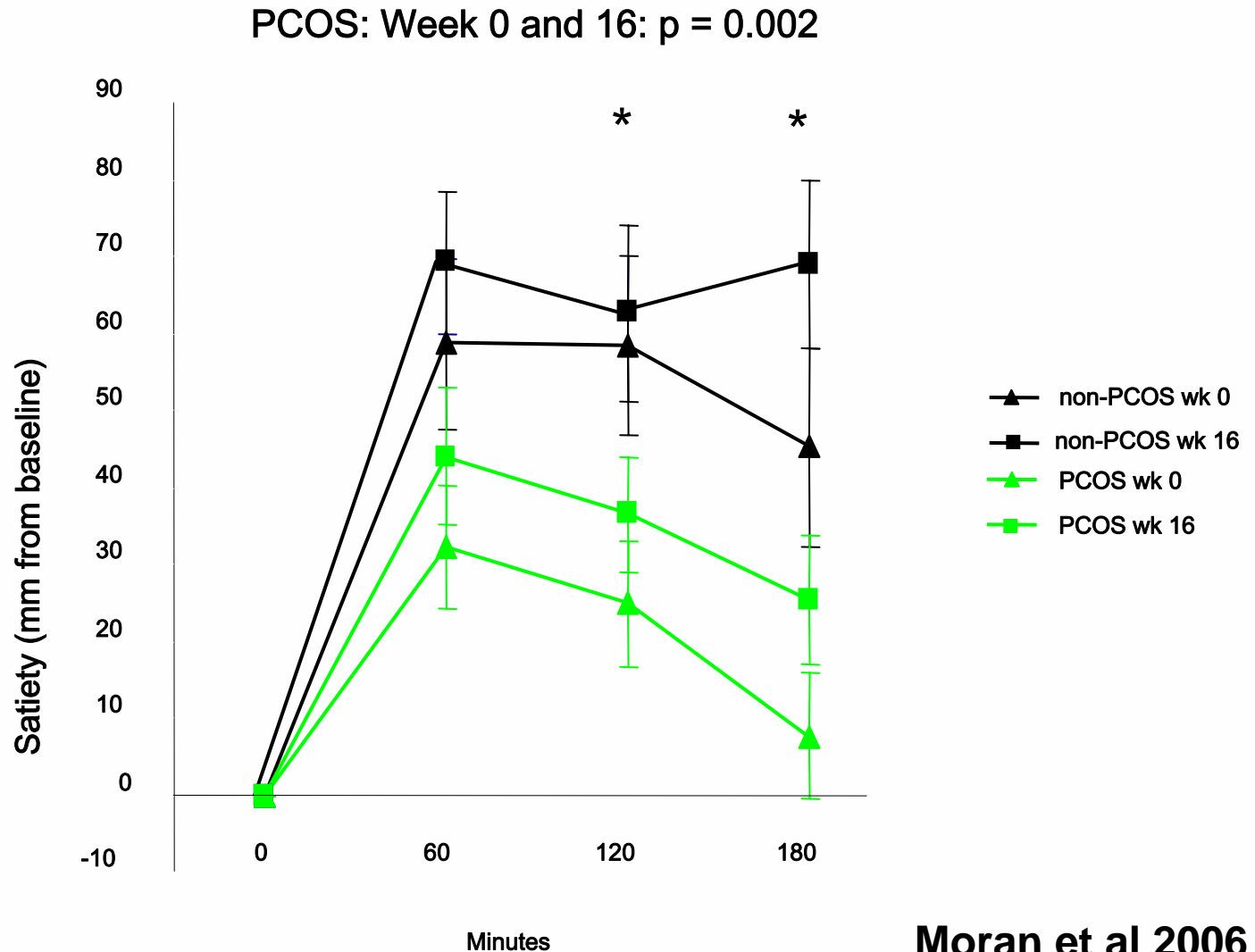
Weight maintenance: Monthly follow-up

Fat counting: < 50g/day
Carb counting: < 120g/day



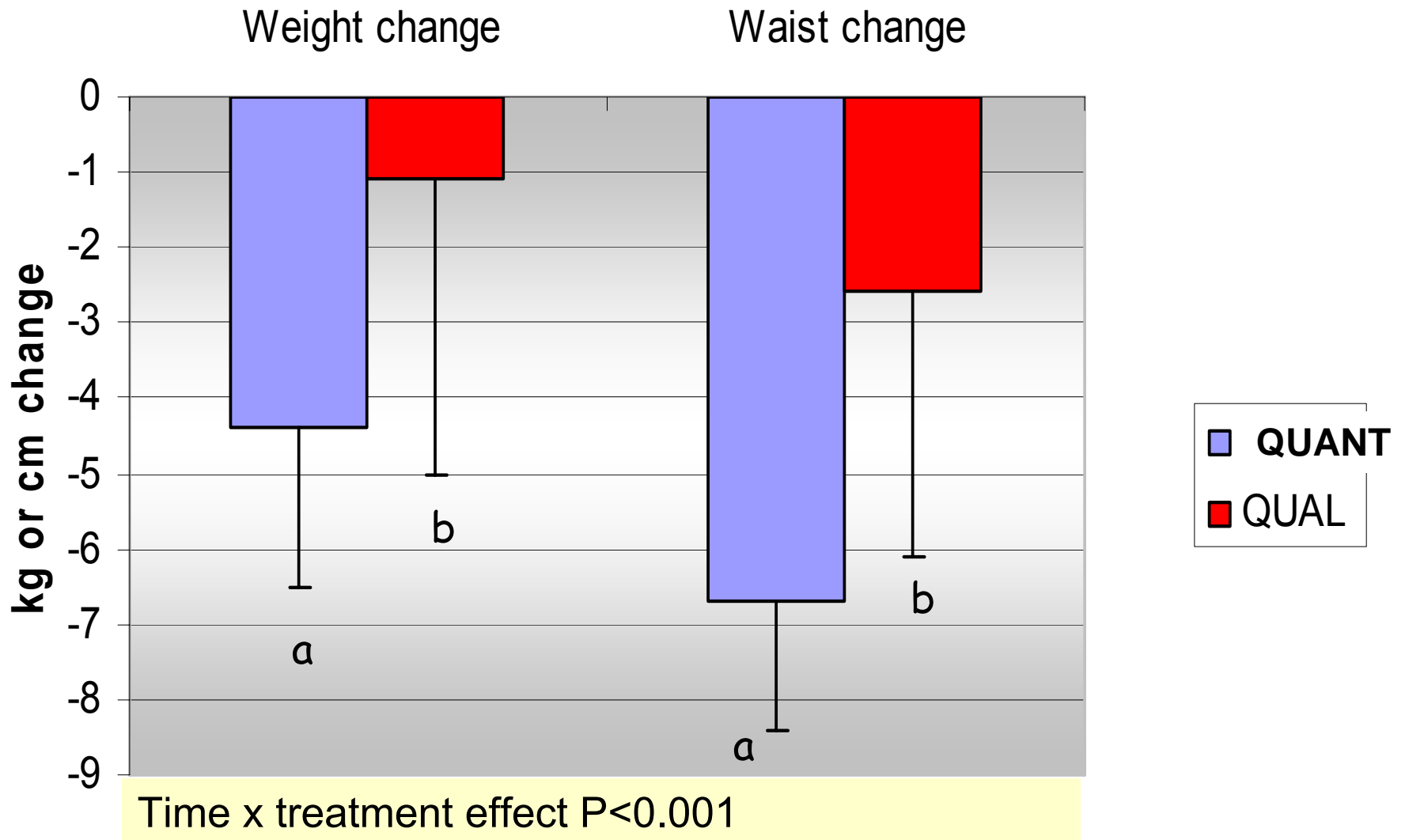
Moran et al 2006

Results: Post-prandial satiety is impaired in PCOS

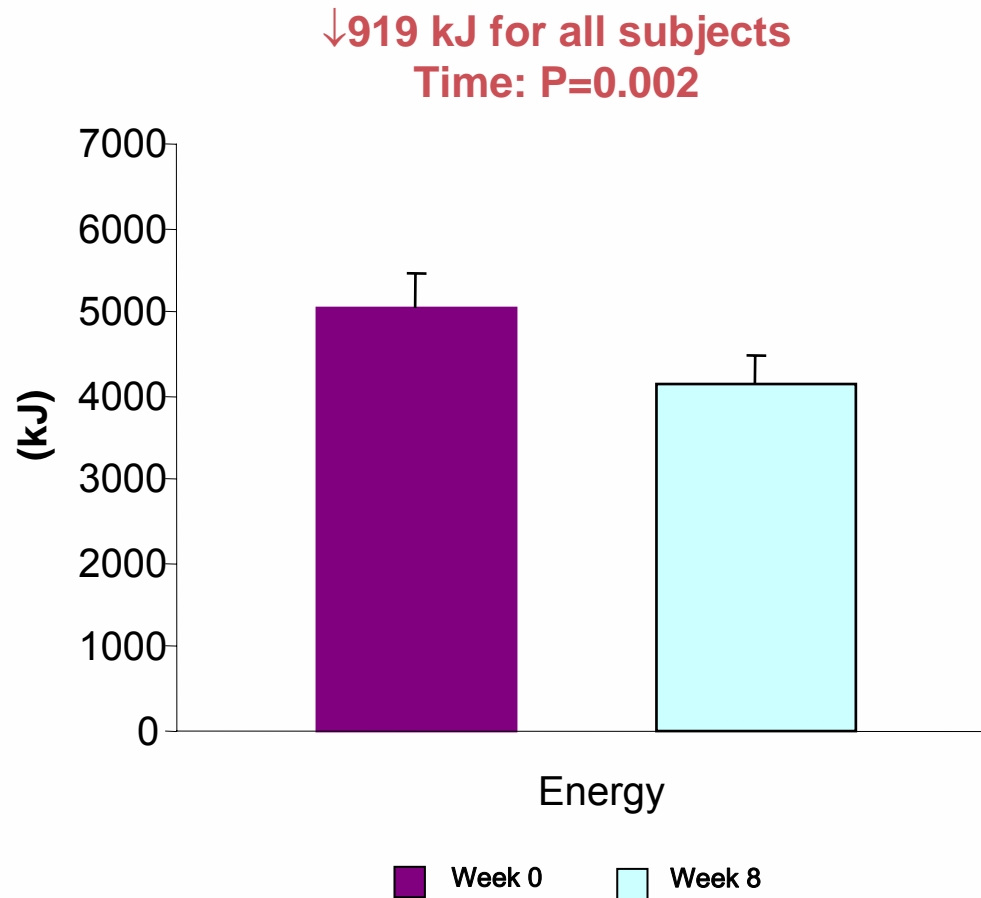


Moran et al 2006

Qualitative advice vs Quantitative advice



Ad libitum energy intake lower after weight loss



Lower energy intakes necessitate more protein foods for nutritional adequacy

❖ The lowest energy intake at which it was possible to simulate a diet conforming to all RDIs was ~5000 kilojoules but this had a % protein of 37-40% energy

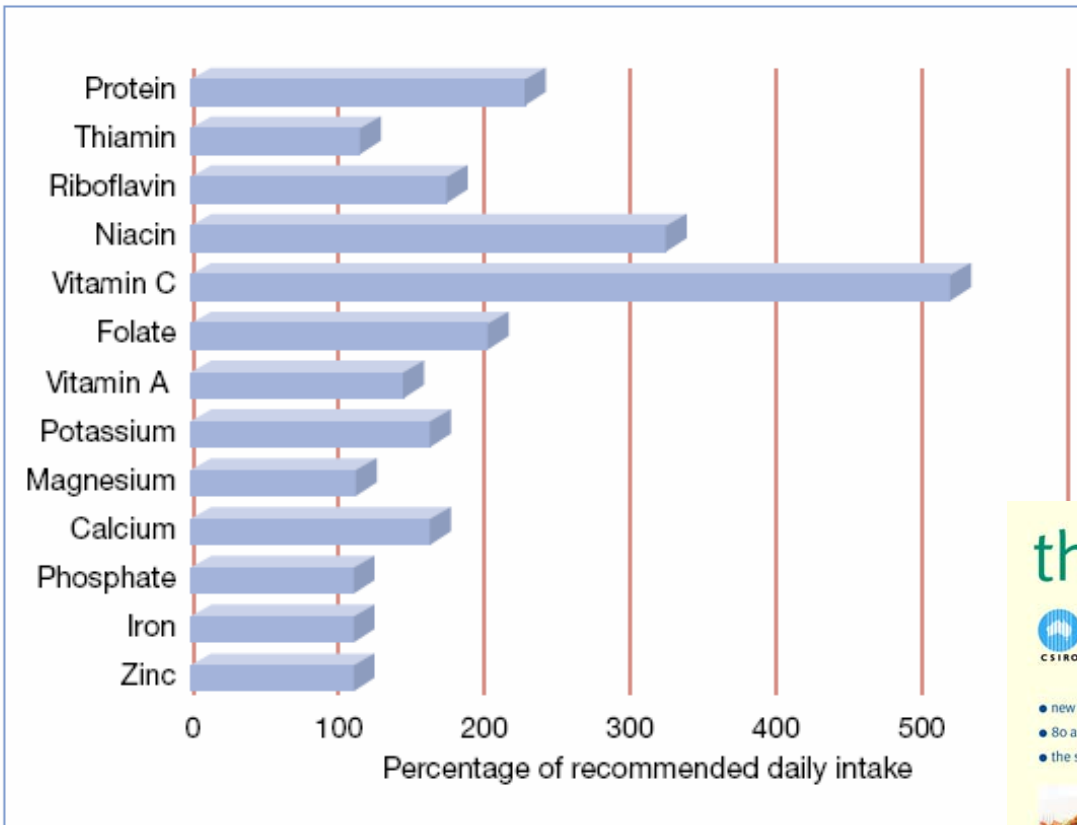
❖ In these diets actual g/day protein was about 110g.

❖ Lowest kilojoule solutions had the highest % protein

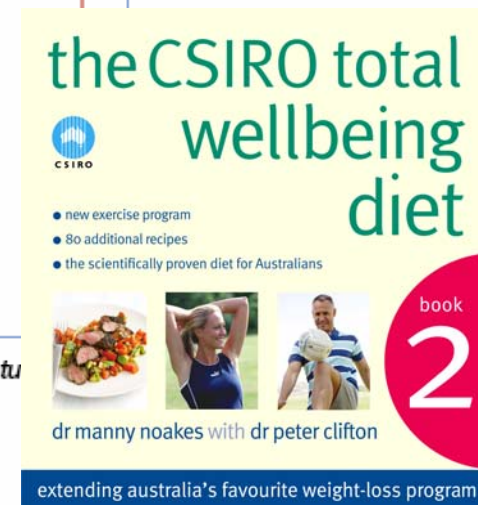
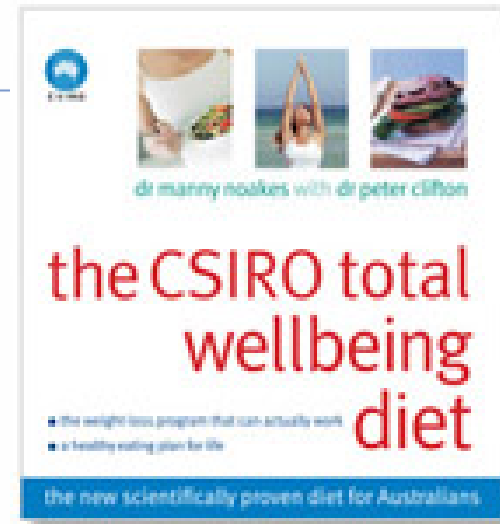
❖ Key limiting factor - zinc followed by LC omega 3 both of which are associated with higher protein foods.

Baghurst and Baghurst 2006

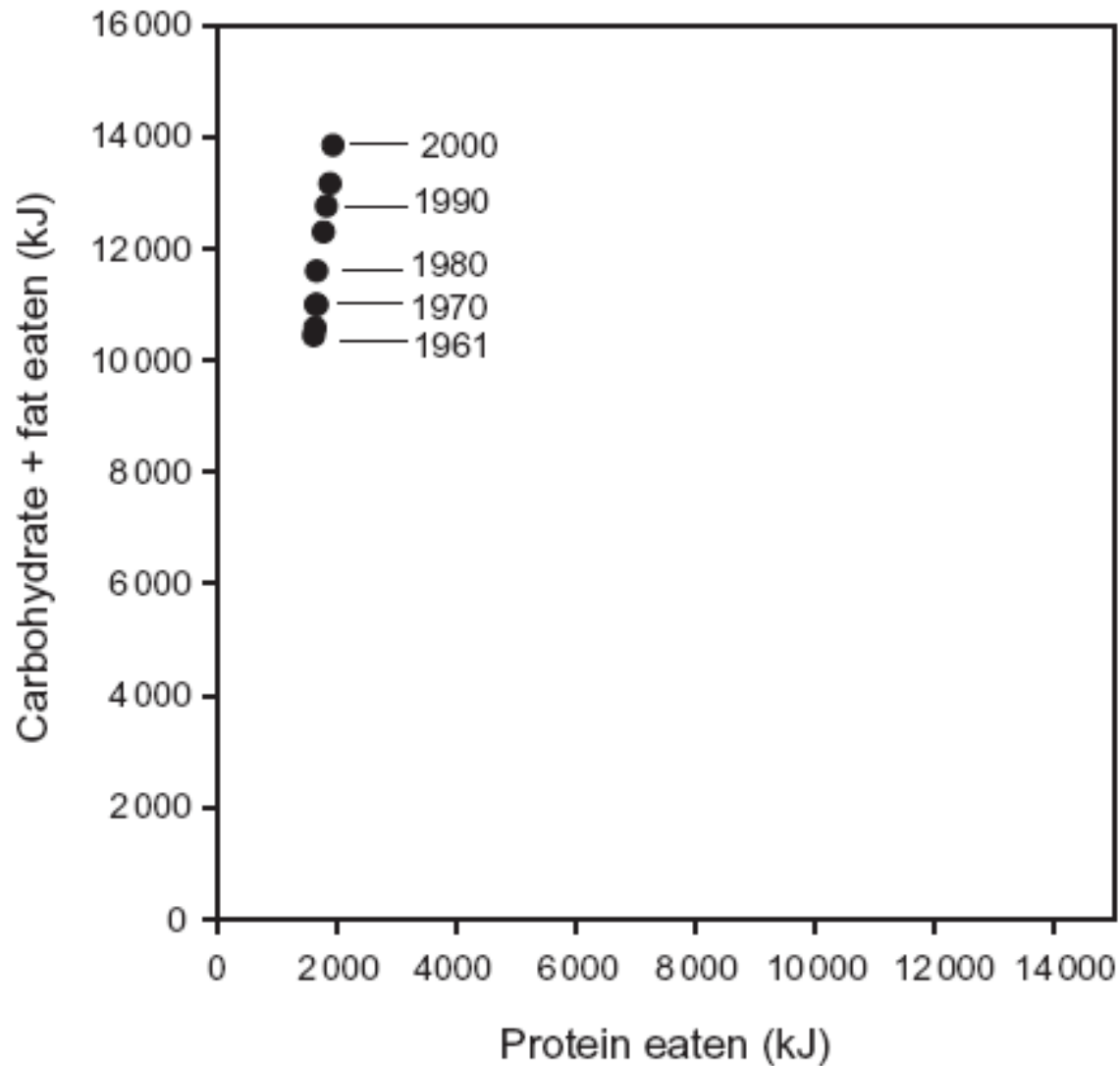
Maximum Nutrition



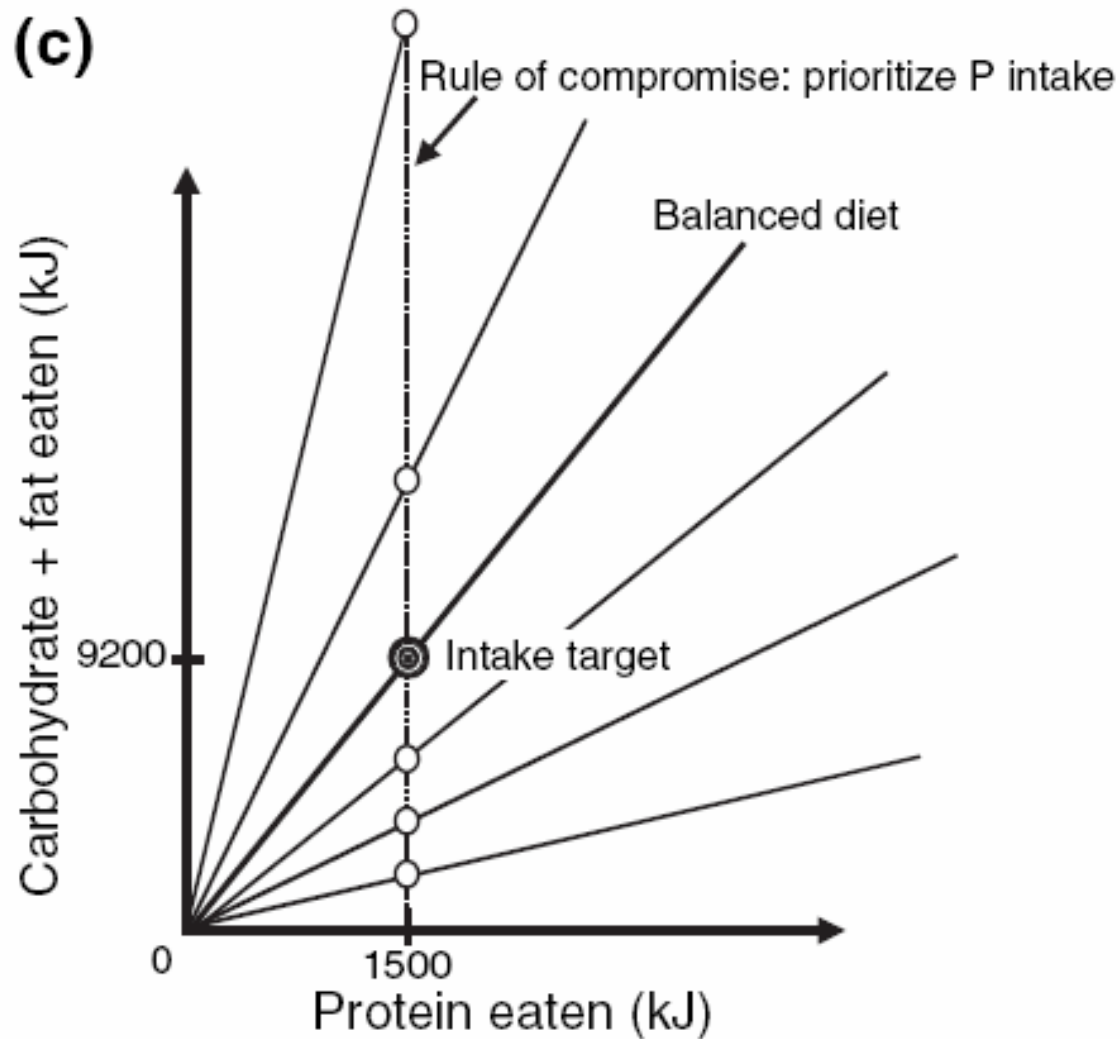
Nutrient density of a typical higher protein weight reducing diet (based on CSIRO stu



Protein intake has remained stable despite increased kilojoules



Behavioural Ecology – Obesity and the Protein leverage Hypothesis



Many valid approaches in diet for weight management

- **Structured diets (reliably lower KJ and address nutrition)**
 - **High protein lower carbohydrate provide complete nutrition and may assist in appetite control, and body composition**
 - Meal replacements (supplements or whole meals)
 - Traditional high carbohydrate diets
- **Ad libitum approaches (may or may not improve nutrition, lower KJ and result in weight loss)**
 - Fat, counting
 - Kilojoule counting
 - Counting Points
- **Qualitative approach suggesting gradual change – low efficacy in motivated individuals)**
- **Long term weight control more related to environmental cues and support.**

Acknowledgements – Project Team

- Dr Peter Clifton: Obesity Theme Leader
- Dr Carlene Wilson: Principal Research Scientist and Psychologist
- Dr Grant Brinkworth: Research Scientist and Exercise Physiologist
- Dr David Cox: Research Scientist
- Dr Phil Mohr: Research Scientist
- Ms Jennifer Keogh
- Ms Xenia Cleanthous Dietitian
- Ms Belinda Wyld/Mr Adam Harrison TWD Project Officer
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Thank you

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