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Plenary 4: Dietary proteins and carbohydrates for optimal health: towards consensus

The role of protein and carbohydrates for weight loss and maintenance: evidence from the Diogenes study

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Background
Obesity, the metabolic syndrome, pre-diabetes and type 2 diabetes are important risk factors for the development of coronary artery disease and stroke. Obesity, physical inactivity, diet composition, short sleep duration, and smoking are the most important risk factors for type 2 diabetes, and moderate alcohol and coffee consumption exerts a weak protective effect. Excessive body weight together with inactivity can account for almost 90% of all new cases of type 2 diabetes. So prevention and treatment of weight gain, excessive body weight and the metabolic syndrome are the cornerstones of prevention of type 2 diabetes.

Objective
It is well established that the dietary risk factors for weight gain are large portion sizes, sugar-rich soft drinks, high intakes of energy-dense foods poor in fibre and wholegrain, including low intakes of fruit and vegetables, but it is not known to what extent this diet, under *ad libitum* conditions i.e. with no "calorie counting", can control body weight.

Design
In the large-scale Pan-European randomised, controlled dietary intervention study Diet, Obesity and Genes study (DiOGenes), we enrolled families with at least one obese adult. Adults followed an initial 8-week 800 kcal/d weight-loss program, and were then randomised to one of five *ad libitum* diets (6-months intervention period) contingent upon a weight loss of ≥8%. The diets were Low Protein (LP)/Low Glycemic Index (LGI), LP/High GI(HGI), High Protein(HP)/LGI, HP/HGI or Control. A total of 780 adults were randomised to the diets and 559 adults completed the intervention period.

Outcomes
During the 8 weeks, mean weight loss was 11kg, and blood lipids, CRP and blood pressure improved substantially. During the subsequent 6 month weight maintenance phase, the HGI, LP and control diets gained most weight, whereas the HP and LGI diets did better, but only the HP/LGI maintained the weight loss without regain. The diets had no major effects on cardiovascular risk factors apart from CRP blood levels that further decreased by 20% in both LGI groups. Among the ~800 children the HP/LGI diet produced a highly significant 14% spontaneous reduction in prevalence of overweight and obesity.

Conclusion
The optimal diet for prevention of weight gain and weight re-gain provides 20-25 % of energy from protein (e.g. low-fat meat, dairy, fish, shellfish, game, protein from plants; peas, beans), 25-30 % of energy from fat (high ratio of polyunsaturated to saturated), and 45-55 % from fibre-rich, whole-grain carbohydrates characterised by a low glycemic index. Moderate amounts of alcohol from beer and wine contribute to the prevention of type 2 diabetes and CVD, but should be recognised and a contribution to total energy intake.

Source of Funding
Author is a member of the Communications and Scientific Advisory Board of The Global Dairy Platform, Chicago, IL; Kraft Foods Scientific Advisory Board, Glenview,IL, Danone Nordic Nutrition Advisory Board, Stockholm, Sweden, Beer Knowledge Institute, Amsterdam, Holland, Pathway Genomics, La Jolla, Cal., USA, and Jennie Craig, Carlsbad, CA; his department receives funding and food provision for an experimental supermarket from more than 100 food producers.

Macronutrient balance and energy intake: the protein leverage hypothesis

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Background

A significant contributor to the rising rates of human obesity is an increase in energy intake. The 'protein leverage hypothesis' proposes that a dominant appetite for protein in conjunction with a decline in the ratio of protein to fat and carbohydrate in the diet drives excess energy intake and could therefore promote the development of obesity.

Objective

To test the 'protein leverage hypothesis' by comparing energy intakes of humans on manipulated diets containing high, medium and low protein density.

Design

Energy intakes were measured for 22 lean subjects studied over three 4-day periods of in-house dietary manipulation. Subjects were restricted to fixed menus in random order comprising 28 foods designed to be similar in palatability, availability, variety and sensory quality and providing 10%, 15% or 25% energy as protein. Nutrient and energy intake was calculated as the product of the amount of each food eaten and its composition.

Outcomes

Lowering the percent protein of the diet from 15% to 10% resulted in a 12% higher total energy intake (P=0.02), predominantly from savoury-flavoured foods available between meals. In contrast, increasing protein from 15% to 25% did not alter energy intake

Conclusion

In our study population a change in the nutritional environment that dilutes dietary protein with carbohydrate and fat promotes over-consumption, thus enhancing the risk for weight gain.

Source of Funding

Australian National Health and Medical Research Council; National Research Centre for Growth and Development, New Zealand.

Protein and carbohydrate for weight control: what role for hunger and appetite regulation?

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Background

Long-term weight loss is notoriously difficult to achieve. While it is clear that maintaining intake below expenditure will lead to weight loss, the challenge is to understand how best to suppress intake long term. A wealth of data points to the suppression of appetite playing an important role in weight control, but whether weight gain is a result of poor satiety and constant hunger or whether sensory aspects of food (hedonics) and ready access overwhelm our regulation of appetite is poorly understood. Certainly many factors encourage over-consumption and we question how much hunger and satiety drive our eating anymore. Our environment is one of varied food choices, 'fast' foods, snack foods and food advertising. While the macronutrient content and composition of the diet still have an important role to play in the regulation of intake, many questions remain unanswered.

Outcomes

Any restrictive diet, given sufficient adherence, can be successful but most important to understand is whether there is an optimal composition that best suppresses food intake when eaten freely (*ad lib*). Recent studies have shown diets moderately high in protein and [low glycemic index (GI),] carbohydrate (CHO) may best promote weight loss. Whilst *ad lib* studies show higher protein diets suppress food intake, the role of CHO, and GI in particular, on appetite may be less clear. Also important is the issue of poor weight loss long term. Whether this is a decline in motivation and poor adherence to diet or a physiological adaptation of hunger to a diet-induced energy deficit is also unclear. Recent exercise studies are revealing. In some individuals hunger is stimulated in response to an exercise-induced energy deficit and these individuals fail to lose weight. What are the mechanisms, and who is most susceptible to success and who is susceptible to failure is not yet known.

Conclusion

Eating is a behaviour modified by both physiological (e.g. hunger, satiety) and psychological (e.g. hedonics, motivation) parameters. Targeting appetite suppression through high protein, high CHO (high fibre, low GI), lower energy-dense diets appears a good strategy but individual success may be variable and require changes in the wider food environment before such diets can be successful for all.

Funding Source

Not applicable

Lipidomic analysis of chylomicron response following ingestion of high fat dairy- and soy-based breakfasts in men with metabolic syndrome

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Background

Postprandial hyper-triglyceridaemia and delayed chylomicron (CM) clearance have been implicated as independent risk factors for CVD.

Objective

The aim of this investigation was to evaluate the effect of high fat breakfast meal (containing 54 g of fat from dairy foods or 54 g fat from soy-based foods) on postprandial TAG composition of CMs in men with or without MetS.

Design

A randomised crossover trial where a mixed breakfast with dairy foods or soy-based foods was compared. The molecular species of TAG and selected regioisomers of CM TAGs were measured by LC-MS/MS, and fatty acids by GC.

Outcomes

Postprandial CM TAG concentrations were significantly lowered in both control and MetS subjects fed the dairy breakfast relative to the soy-based breakfast at 3 hours. The chylomicrons from the dairy group at 3h contained two thirds of the 80 molecular TAG species found in the meal suggesting that most of the short and medium chain fatty acids were transported after absorption via the portal venous route. Long chain saturated TAG were also lost from the soy breakfast lipids in comparison with CM from the soy group.

Conclusion

Dietary TAG composition influences postprandial CM TAG levels. The lowered postprandial response observed after the dairy meal was likely a result of limited short and medium chain FA incorporation into CM suggestive of selective fatty acid and/or monoacylglycerol absorption, formation and/or clearance. The implications of the findings from this acute research study should be explored in longer-term studies.

Source of Funding

This research was supported by funding from Dairy Health & Nutrition Consortium, a consortium of Tatura Milk Industries & Bega Cheese, National Foods, Fonterra Australia, Parmalat Australia, Dairy Australia, Geoffrey Gardiner Foundation, Murray Goulburn Co-operative, Warrnambool Cheese & Butter Factory, and Dairy Innovation Australia.

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Added carbohydrates in children's milk products increase dietary glycaemic load

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Background

Milk is a staple food for children, delivering high quality protein, essential nutrients such as calcium, riboflavin, vitamin A and zinc. In Asian countries a new category of high value milk products for children, 'Growing Up Milks', is well established and these products are now appearing in New Zealand and Australia. Manufacturers often add additional carbohydrates, including sucrose, maltodextrins and corn/glucose syrups which theoretically contribute to a higher glycaemic index (GI) and glycaemic load (GL). Diets with a high GI/GL may increase the risk of developing obesity and type 2 diabetes in adulthood.

Objective

To survey growing up milk products in Malaysia and Indonesia to determine the content of added carbohydrate ingredients and to assess the impact on blood glucose responses.

Design

A total of 24 products from Malaysia and 32 from Indonesia were surveyed. The ingredient lists and nutrition information panels were used to calculate the percentage of declared carbohydrates coming from added sources, excluding fibre. A representative subset of products were tested for their GI according to International Standards Organisation methodology. The Glycaemic Load was calculated as GI x carbohydrate per serving/100.

Outcomes

The range of added carbohydrate content in the products ranged from 0 to 40% w/w. Milk powders without added sources of carbohydrate had similar GI values to liquid milk, ~30, and a low GL. Products containing maltodextrins and corn/glucose syrups increased the GI and GL by more than 2-fold.

Conclusion

Growing up milk products targeted at young children may contain excessive levels of added carbohydrates. Irrespective of chain length, they may increase the risk of overweight, obesity and diabetes.

Source of Funding

Funding for this work was provided by Fonterra Brands, Asia Middle East.

Potential healthcare savings from increased consumption of dairy products in Australia

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Background
With rising burdens of obesity and chronic disease, poor diet is of increasing public health concern. There is a growing body of evidence to support a reduction in the risk of several chronic metabolic and cardiovascular disorders in regular consumers of dairy foods, yet most Australians still consume less than their recommended targets for dairy food consumption and public health campaigns to improve nutrition rarely target consumption of dairy foods.

Objective
Our objective was to review the literature on the health effects of dairy consumption, and use the best available evidence to estimate the effects on burden of disease and direct healthcare expenditure (both positive and negative), if Australians were to increase consumption to recommended levels.

Design
We developed a new method of estimating population attributable fractions that approximates the treatment of the exposure/risk relationship as a continuous variable, and incorporated this into a cost-of-illness study. The approach was designed specifically for use with nutrition research.

Outcomes
We estimated that of the 2010-11 disease burden and expenditure in Australia, 76,086 disability-adjusted life years (DALYs) could have been prevented through increased consumption of dairy foods, with a saving to the health budget of AUD$2.6 billion (2.3%). Varying the core assumptions and statistical approach yielded corresponding estimates of 148,279–41,184 DALYs and AUD$1.7–3.8 billion (1.5–3.4%), respectively.

Conclusion
Public health campaigns that target healthy diet have potential for large reductions in burden of disease and healthcare expenditure, and there is strong justification for the development of cost-effective interventions that use dairy consumption as a vector for achieving these outcomes.

Source of Funding
This research was funded by Dairy Australia, who also provided some articles for review, but were otherwise not involved in the development or implementation of the analysis, or in any decision to submit for publication.

Circulating inflammatory and atherogenic biomarkers are not increased following single meals of dairy foods

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Background
Inflammation characterises obesity and circulating inflammatory and atherogenic biomarkers may increase after fatty meals indicating potential adverse metabolic effects.

Objective
To test whether meals consisting of specific full-fat dairy foods affect plasma levels of inflammatory and atherogenic biomarkers in overweight subjects and whether fermented and non-fermented dairy foods differ.

Design
Twelve overweight subjects participated in five test meals. Single breakfasts containing control low-fat milk or 45g fat from butter, cream, cheese or yoghurt were tested over 3 weeks in random order. Plasmas obtained 3 h and 6 h later were analysed for inflammatory markers (IL-6, IL-1β, TNF-α, hsCRP) and atherogenic markers (ICAM-1, VCAM-1, MIP-1α, MCP-1). In a further study of two four week test periods, one fermented dairy (cheese plus yoghurt) and one non-fermented (butter plus cream), 50 g fat in each phase, were compared for the above biomarkers in a cross-over design.

Outcomes
In the single meal study, none of the eight biomarkers rose significantly after any of the five meals either within group or between group analyses. Unexpectedly, several biomarkers fell significantly at 3 h (four inflammatory biomarkers after cream, butter and low-fat milk and three atherogenic biomarkers after cream; all $P<0.05$). In the longer 4 week studies, plasma levels of all eight biomarkers did not differ between fermented and non-fermented test dairy foods.

Conclusion
High-fat meals containing sequentially four different dairy foods did not raise eight inflammatory or atherogenic biomarkers over 6 h. We could not confirm the reported increments in inflammatory markers after fatty meals.

Source of Funding
Dairy Health & Nutrition Consortium, Dairy Innovation Australia.

Australian children who drink plain or flavoured milk have higher dietary micronutrient intakes

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Background

Older children are not meeting the estimated average requirement (EAR) for calcium. Milk is the largest contributor of calcium to the diets of children. Flavoured milk is highly palatable, has the same essential nutrients as plain milk and may assist children to meet calcium targets.

Objective

The purpose of this study was to determine the influence of milk consumption on nutrient intake and weight status among Australian children.

Design

Nutrient intakes reported via 24-hour recalls and anthropometric measurements collected from the 2007 Australian National Children's Nutrition and Physical Activity Survey were analysed. Children and adolescents (n= 4487, 2-16 y) were classified according to milk drinking: exclusively plain, flavoured and non-consumers. Total daily milk, energy and nutrient intake, body mass index (BMI) and waist circumference were compared between categories of milk drinking by anova models.

Outcomes

Plain milk and flavoured milk as a beverage accounted for 33% and 22% of total milk intake, respectively. Eleven percent of children were non-consumers of milk. Intakes of calcium, phosphorus, magnesium, vitamin A, protein, total and saturated fat (adjusted for age, gender and energy intake) were comparable between plain and flavoured milk drinkers and were significantly higher than that of non-consumers of milk ($P<0.05$). Flavoured milk drinkers had higher total milk, vitamin D, iodine, sugar and energy intakes than plain milk drinkers and non-consumers of milk ($P<0.05$), while BMI and waist circumference were comparable. Flavoured milk drinkers aged 9-16y had significantly higher calcium intakes than plain milk drinkers ($P<0.05$) and were six times more likely to meet the EAR for calcium than non-consumers of milk ($P<0.001$), while gender differences were not observed.

Conclusion

These findings demonstrate the importance of milk as a beverage in the diet of children. Drinking flavoured milk may help children in meeting their calcium requirements without impacting on body weight measures.

Source of Funding

Research grant from Nestlé Australia Ltd.

Microbial phytase improves bone mineral density (BMD)

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Background

Phytate is the major phosphorus store in plants. Phytate can bind complex compounds, particularly divalent cations, present in foods and feedstuffs thereby reducing the availability of dietary minerals and other nutrients when plant-based foods are consumed. Phytase hydrolyses phytate and microbial phytase is often included into pig and poultry diets to enhance nutrient availability.

Objective

To explore the impact of dietary microbial phytase supplementation on BMD and Ca retention in poultry.

Design

1-day-old broiler chickens (60 birds per treatment) were fed a corn-soya bean meal-based diet (CS) for 21 days. Treatments consisted of the CS diet and the CS diet supplemented with 1000 Units/kg of either microbial phytase A (expressed in *Aspergillus oryzae*) or phytase B (expressed in *Schizosaccharomyces pombe*). A Ca balance study was conducted over days 18 – 21 to determine Ca retention. On day 22 the birds were euthanized and the left leg removed for tibial BMD analysis.

Outcomes

The tibia BMD of the broilers fed the CS diet was 186mg cm^2. Dietary supplementation with either phytase A or B led to significantly ($P<0.001$) higher tibia BMD (225 and 210 respectively). Ca retention in the birds fed the CS diet was 50.4%. Ca retention was significantly ($P<0.001$) higher for the birds fed the phytase supplemented CS diets (56.6% and 54.7% for phytase A and B respectively). Dietary supplementation with phytase A led to significantly ($P<0.05$) higher Ca retention and BMD compared to phytase B.

Conclusion

Dietary supplementation with either microbial phytase improved Ca retention and BMD in the broiler chickens, but the extent of the improvement was phytase dependent. Other studies using pigs and rats have also reported improved Ca retention and BMD when receiving phytase supplemented diets. Studies have not yet been conducted exploring the impact of dietary microbial phytase supplementation in humans but supplementation may have a role in improving mineral availability and bone health in humans.

Source of Funding

Funding from DSM Nutritional Products, Switzerland.

Nutritional and environmental risk factors for young children in Auckland, New Zealand, developing community acquired pneumonia – a case-control study

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Background
New Zealand (NZ) has a high pediatric pneumonia hospitalisation prevalence rate (11 per 1000 in children less than five years) compared with other developed countries (0.1 – 2 per 1000). A number of risk factors have been identified in both developing and developed countries for contracting pneumonia; these include nutritional factors.

Objective
The objective of this study was to identify the nutritional and environmental risk factors associated with preschool aged children in NZ developing community-acquired pneumonia.

Design
We conducted a case-control study of children residing in Auckland, NZ, aged less than 5 years of age. The cases were children admitted to Starship Children's Hospital or presenting at the emergency department of the same hospital with pneumonia. The controls were randomly selected children living in the community. The children were matched for age and ethnicity. Data was collected by a face to face interview with the child's caregiver; this included a general questionnaire and a specific dietary questionnaire.

Outcomes
There were 856 children included in the analysis, 505 cases and 351 control children. The univariate analysis found a number of nutrition-related risk factors; no breastfeeding during infancy (OR 2.56, 1.54-4.25), no sunlight exposure in the previous month (OR 2.56, 1.63-4.02). In the over 2 year old children other risk factors identified were less than 2 serves of breads and cereals per day (OR 3.77, 1.40-10.18), and higher consumption of takeaway-type foods (OR 2.44, 1.05-5.55). In the under 2 year old children, consumption of fruit juice was also a risk factor (OR 1.46, 1.01-2.10). In the multivariate analysis, the only 2 nutrition-related risk factors to remain were no sunlight exposure in the previous month (OR 2.54, 1.47-4.39), and not having been breastfeed during infancy (OR 1.87, 1.02-3.41).

Conclusion
Identification of controllable risk factors can lead to improvements in policy, primary care and prevention of hospitalisation.

Source of Funding
HRC Research Grant, Top Doctoral Scholarship

General nutrition knowledge mediates parental influences on the diets of 2-5 year old children

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Background
Australian children are consuming too little fruit and vegetables and excess non-core food. During the early years, parents have a major influence on their children's diets, food choices and development of eating habits.

Objective
After systematically reviewing cross-sectional research conducted with parents of children aged 2-5 years, the purpose of this study was to investigate parenting styles and feeding practices as predictors of young children's diets and whether nutrition knowledge mediated those influences.

Design
This study was a cross-sectional research design. Self-report questionnaires were completed by parents of children aged 2-5 years (*N*=269) measuring demographic and lifestyle variables, parent attitudes, child diet, parenting styles, feeding practices, family communication and general nutrition knowledge. Zero-order correlations were performed to explore variables of interest. STATA was used to test nutrition knowledge as a mediator of significant relationships between parenting variables and child diet (fruit and vegetable intake and non-core food consumption).

Outcomes
Significant relationships were found between a range of parenting variables and child diet. Parent nutrition knowledge significantly mediated the effects of various parenting and/or communication styles on child fruit and/or vegetable and non-core food intakes.

Conclusion
The findings of this study highlight that young children's diets may be improved by interventions targeting a broader range of positive and supportive parenting practices in combination with nutrition knowledge education in parents of young children. Further insights into how parents can positively influence children's diets will come from quality longitudinal research.

Source of Funding
Australian Postgraduate Award.

Improved iodine status of breastfeeding women a year after introduction of mandatory fortification

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Background
There has been little evaluation of the mandatory iodine fortification programme since its introduction in Australia and New Zealand in late 2009.

Objective
To determine the iodine status of breastfeeding women and to identify iodine- related knowledge and practices following introduction of the national fortification programme.

Design
A cross sectional study was undertaken at 4 early childhood centres in the Illawarra, NSW (n = 60 mothers in their first six months of breastfeeding) between August 2010 and February 2011. Mothers provided a casual urine sample for assessment of median urinary iodine concentration (UIC) (sufficiency: UIC≥100µg/L), completed a knowledge questionnaire and a validated iodine specific food frequency questionnaire (FFQ) and reported on supplement use.

Outcomes
Women had generally poor knowledge about dietary sources of iodine, with the exception of fish and seafood (75 % correctly identified). Confusion about health problems associated with insufficient iodine intake was evident. Mean reported dietary intake of iodine was 146µg/day (SD = 58; Range = 43-342µg/day; 80 % had intakes below EAR of 190µg/day) which increased (P<0.001) to 182µg/day (60 % below EAR), after accounting for fortification of bread. Median UIC indicated an adequate iodine status (123µg/L; IQR = 71-236µg/L) and was significantly higher in those taking iodine-containing supplements (206µg/L; n = 27) compared to those that were not (97µg/L) (P=0.029).

Conclusion
The combination of inadequate knowledge regarding iodine and the limited use of iodine supplements highlights a potential public health issue of concern. However, higher than previous reported UIC values indicates that mandatory fortification may be overcoming this knowledge and behaviour deficit.

Source of Funding
Not applicable.

Maternal dietary omega-3 PUFA intakes, food sources and comparison to recommended intakes

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Background
Omega-3 (n-3) PUFA are important for health especially during pregnancy and for the growing fetus. Little is known about maternal intakes, food sources and whether or not they're meeting recommended intakes.

Objective
To determine the median dietary intakes (inter-quartile range) and food sources of EPA, DPA, DHA and total long chain (LC) n-3 PUFA in a subset of pregnant women from the DOMInO trial. To determine if intakes from foods met recommended DHA intakes of 200mg per day.

Design
The DOMInO trial was a multi-centre, randomised placebo controlled trial. A subset of women (n=92) from the Campbelltown cohort was asked to complete a validated PUFA questionnaire which automatically estimates n-3 PUFA intakes and their respective food sources.

Outcomes
Pregnant women consumed 75mg (46-132) EPA, 77mg (50-123) DPA, 65mg (44-130) DHA and 237mg (165-368) total LC n-3 PUFA with no significant differences between the control and DHA groups. Even though fish and seafood is the richest source of LC n-3 PUFA, especially DHA, meat contributed twice as much LC n-3 PUFA than fish and seafood. One woman did not consume any LC n-3 PUFA and only 12 women (13%) met the recommended DHA intakes. Despite low DHA intakes, the cord blood levels in the control group were relatively high.

Conclusion
The majority (87%) of pregnant women did not meet the recommended DHA intakes probably due to low intakes of fish and seafood.

Source of Funding
DOMInO was funded by NHMRC grant. This study was funded by University of Wollongong.

Food intolerances: Possible role of poorly absorbed short chain carbohydrates (FODMAPs) in the genesis of colic in infants.

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Background
Infantile colic is the most common complaint for which parents seek professional advice during the first year of life. While its aetiology is still not fully understood, it is generally believed that the composition of the infant's diet plays an important role. Our research team has shown that poorly absorbed short chain carbohydrates - FODMAPs (Fermentable Oligo- Di- and Mono-saccharides And Polyols) can induce wind, bloating and abdominal pain in adults with irritable bowel syndrome (IBS). FODMAPs include fructans, galacto-oligosaccharides and polyols. A number of nursing mothers contacted our department after successfully trialling - in their infant with colic - our low FODMAP diet for controlling adult IBS.

Objective
To undertake a pilot study to explore the potential role of FODMAPs in the genesis of symptoms associated with infantile colic.

Design
Three small studies were undertaken. FODMAPs were quantified in (1) 13 infant formulae; and (2) in 10 common 'gas forming foods' that nursing-mothers are advised to avoid, also (3) a small pilot study in 5 breast-fed infants with colic was undertaken in which the nursing mother was supplied with a low FODMAP diet for 7 days.

Outcomes
FODMAPs are present in the diet of young infants firstly, (1) fructans were detected in a number of formulae (including some hypoallergenic formulae) and (2) gas forming foods (e.g onion, garlic, cabbage, broccoli, legumes) contained high levels of FODMAPs. (3) Our pilot study conducted in 5 breastfed infants found that the mean crying duration of infants reduced from 207±32 min to 141±34 min after the mothers consumed a low FODMAP diet for 7 days representing a mean lowering of daily crying of 66 min or 35% (P=0.001). Crying duration decreased in all infants. All mothers chose to continue the low FODMAP diet at the conclusion of the study.

Conclusion
Colic is a serious condition that can have detrimental effects on both mother and infant. The potential role of short chain carbohydrates in the pathogenesis of infantile colic has been poorly explored. The results from this preliminary study suggest a potential role of FODMAPs in infantile colic but this requires further study in well designed RCTs.

Source of Funding
Not applicable.

Micronutrient intake and supplement usage of pregnant and lactating women in New Zealand

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Background
Maternal nutrition status during pregnancy and lactation should be positively optimized to enhance nutritional support during fetal and infant growth and development.

Objective
This study explores a range of essential nutrient intakes and how dietary supplement usage impacts upon pregnant and lactating women in New Zealand.

Design
Qualifying women were recruited nationally. Face-to-face and telephone interviews provided individually three 24h dietary recalls. Dietary intake data from 66 pregnant (P) women (after 26 weeks gestation) and 88 lactating (L) women (21 days after delivery) was analysed by Foodworks 2009 and SPSS 17 Software.

Outcomes
Intakes of total folate (P: 67%; L: 49%), dietary fibre (P: 73%; L: 80%), selenium (P: 72%; l: 66%), iron (P: 53%), and vitamin D (L: 72%) were all below EAR levels. Two intakes were above the upper limit: total folate (P: 14%; L: 13%) and iron (P: 33%; L: 6%). Pregnant (47%) and lactating (42%) women used a range of supplements. Comparisons made between supplement and non supplement users during pregnancy gave statistically significant differences: vitamin D (6.77±5.67; 2.26±1.99, P=0.000), vitamin E (25.64±42.18; 9.99±7.25, P=0.036), total folate (746.22±488.44; 359.83±155.99, P<0.001), iron (82.52±68.67; 14.01±5.15, P<0.001) and selenium (56.59±49.79; 44.50±18.20, P=0.040). Lactating women, had similar results for vitamins D, E and iron, and also intakes of zinc (16.38±6.77, 12.26±3.76, P=0.002) and copper (14.70±75.60, 1.86±0.77, P=0.02) which were significantly different.

Conclusion
Almost half of all participants used supplements. Many women were either below EAR or above the Upper Limit for some micronutrients. Any potential risk during this critical period of human reproduction needs careful understanding prior to dietary supplement use. Enhanced public awareness of appropriate nutritional use of such supplements is essential for all pregnant and lactating women.

Source of Funding
Massey University Research Fund.

Methodology of the 2008/2009 New Zealand Adult Nutrition Survey

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Background

National nutrition surveys provide valuable information for comparing changes in the nutrition status of populations over time. The comparability of survey results depend on the methodology used. The 2008/09 New Zealand Adult Nutrition Survey (2008/09 NZANS) is the fourth population-based nutrition survey in adults.

Objective

To describe the methodology used in the 2008/09 NZANS, with reference to the unique aspects of the current survey compared with the 1997 National Nutrition Survey (1997 NNS).

Design

The 2008/09 NZANS was a nationally representative, cross-sectional survey of 4,721 adults 15 yrs and over. Participants were recruited using a three-stage, stratified approach, with oversampling of Māori, Pacific, and individuals under 19 yrs and over 70 yrs. Interviews were conducted within the participant's home. A computer-assisted, multiple-pass 24 hr recall was used to collect dietary data. Information on dietary habits, nutrition-related health and food security were obtained through interviewer-administered questionnaires. Height, weight, waist circumference and blood pressure measurements were taken for consenting participants. Blood and urine samples were collected at local clinics from 3,348 and 3,315 participants, respectively.

Outcomes

The 2008/09 NZANS achieved a higher response rate (61%) and greater numbers of Māori (*n*=1,040), Pacific (*n*=757), under 19 yr (*n*=699) and over 70 yr (*n*=1,065) participants than the 1997 NNS. In the survey reports, the categorisation of ethnicity and definitions of overweight and obesity for Māori and Pacific differed. Differences in the Estimated Average Requirement for some nutrients influenced the calculation of the prevalence of inadequate intakes between the surveys.

Conclusion

The methodologies used for the 2008/09 NZANS and 1997 NNS were largely similar, although some differences exist which should be considered when comparing and interpreting the results from the reports.

Source of Funding

The Ministry of Health, New Zealand, funded the 2008/09 NZANS and the 1997 NNS.

Disentangling the obesity epidemic: Results from the 2008/2009 New Zealand Adult Nutrition Survey

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Background

Obesity rates continue to increase worldwide. Documenting and explaining national prevalence rates is necessary in order to find solutions to the problem.

Objective

To report current prevalence of overweight and obesity in New Zealand, changes in rates since the 1997 National Nutrition Survey (1997 NNS), and to examine relationships with energy intake.

Design

Secondary analysis of the 2008/2009 New Zealand Adult Nutrition Survey (2008/09 NZANS) and the 1997 NNS. The same BMI cut-offs were used and prioritised ethnicity.

Outcomes

The overall age-standardised prevalence of obesity is significantly higher in the 2008/09 NZANS (27.1%, 95%CI: 25.1, 29.1) than in 1997 (19.1%, 95%CI: 17.6, 20.6). Overweight and obese adults now account for 62% of the total population over 15 yrs compared with 52% of the population in 1997. Increases have occurred in NZ European/Other (NZEO) men (13.2 to 25.2%), Māori women (35.5 to 49.3%) and NZ European/Other women (17.9 to 22.8%). While the prevalence of obesity is highest in Pacific (58.4% versus 45.4% in Māori and 24% in NZEO), 72.1% of all obese adults are NZEO. Mean reported energy intakes appear to have declined. Significant decreases have occurred only in normal weight men and women, and overweight men. There has been no change in reported energy intakes among obese adults. There is no relationship between energy intake and BMI in the NZ population. However when only considering data from those predicted to be reliable reporters (using the McCrory method), total mean energy intakes remain unchanged and there is a clear positive relationship between energy intake and body weight status.

Conclusion

The greatest increases in prevalence of obesity have occurred in NZEO men and Māori women and the vast majority of obese New Zealanders continue to be of NZEO ethnicity. The apparent decline in reported energy intakes has occurred in non-obese adults only. Our in-depth analysis of the data provides some evidence that energy intake contributes to increased rates of obesity.

Source of Funding

The Ministry of Health, New Zealand, funded the 2008/209 NZANS and the 1997 NNS.

The prevalence of diabetes and pre-diabetes in New Zealand – will the health system cope with demand?

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Background

Diabetes is pandemic and the prevalence of diabetes continues to increase worldwide. To date, national diabetes prevalence data for New Zealand have used self- reports of diagnosed diabetes, which underestimate prevalence.

Objective

To describe the epidemiology of diabetes and pre-diabetes for New Zealand adults using data from the 2008/09 New Zealand Adult Nutrition Survey (2008/09 NZANS).

Design

Diabetes was defined as self-reported diabetes, undiagnosed diabetes as HbA1c ≥ 6.5% but not self-reported, and prediabetes as HbA1c between 5.7% and 6.4% but not self-reported. Collectively diabetes (self-reported and undiagnosed) and pre-diabetes were described as glucose metabolism disorders. Data were weighted, and proportions and age-standardised (WHO) rates were calculated.

Outcomes

The prevalence of self reported diabetes was 6.0% (95% CI: 4.5, 7.5) among men and 4.0% (95% CI: 3.1, 4.8) among women. The prevalence of undiagnosed diabetes was 2.3% (95% CI: 1.3, 3.2) among men and 1.6% (95% CI: 1.1, 2.1) among women. The proportion of both males and females with diabetes or pre-diabetes increased with increasing age so that prevalence of a glucose metabolism disorder increased from 5.9% in adults 15-24 yrs to 59.3% in adults 75+ yrs among males, and from 3.5% to 58.0% among females. Diabetes (self-reported and undiagnosed) was more common among Maori men (8.8%) and women (9.8%), and Pacific men (15.7%) and women (14.2%), compared with New Zealand European/Others men (7.6%) and women (4.5%). Prevalence of diabetes was higher among the obese (14.2%) compared with the normal weight (2.4%) group, as was prediabetes - 25.3% v 13.5%.

Conclusion

Both diabetes and prediabetes are very common in the New Zealand population. The current level of diabetes service provision is unlikely to meet the increasing burden of disease, given the high prevalence of glucose metabolism disorders.

Source of Funding

The Ministry of Health, New Zealand, funded the 2008/09 NZANS.

How much sodium are we eating? Estimates of New Zealand population sodium intake from the 2008/09 New Zealand Adult Nutrition Survey

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Background

Spot urinary sodium represents a practical alternative to the 'gold standard' of 24-hour urinary sodium excretion, especially in large population samples.

Objective

To quantify estimated population dietary sodium intake in a representative sample of New Zealanders, and compare population sodium intake with nutrient reference values.

Design

The 2008/09 New Zealand Adult Nutrition Survey (2008/09 NZANS) analysed sodium excretion from spot urine samples from a representative sample of 3315 adults aged 15 years and over. Results were converted into estimates of 24-hour sodium excretion using WHO formulae. These estimates are compared with dietary sodium intake estimates from 24-hour recall assessment. 24-hour population urinary sodium excretion estimates are analysed by demography, and self-reported dietary habits using regression analysis.

Outcomes

Mean estimated population 24-hour urinary sodium excretion was 3544 mg/day (4013 mg/day for men, and 3116 mg/day for women), which reflects a mean dietary intake of approximately 3900 mg sodium per day. Sixty five percent of New Zealanders had an estimated 24-hour sodium excretion that exceeded the recommended Upper Level of 2300 mg sodium/day (74% of men and 57% of women). There are significant differences in mean excretion by age and sex, but not by prioritised ethnicity, or level of deprivation. Mean estimated sodium intake by dietary recall assessment was 2504 mg/day (2953 mg/day for men and 2094 mg/day for women) and is likely to be an underestimate

Conclusion

Spot urinary sodium assessment is a useful way to estimate dietary sodium intake in large representative population samples. New Zealand's mean sodium intake is in excess of current nutrient reference values. Public health interventions to reduce population sodium intake in New Zealand are warranted.

Source of Funding

The Ministry of Health, New Zealand, funded the 2008/09 NZANS. Dr McLean is funded through the Health Research Council of New Zealand.

Folate and iodine status of adults prior to fortification of bread: results from the New Zealand 2008/2009 Adult Nutrition Survey

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Background
Additional folic acid consumed peri-conceptionally reduces the risk of neural tube defect-affected pregnancies. The New Zealand population also has a documented history of mild iodine deficiency. For these reasons, the New Zealand government mandated fortification of bread with folic acid, scheduled for early 2012, and iodine, introduced late 2009.

Objective
To assess the folate and iodine status of a nationally representative sample of New Zealand adults, prior to the introduction of mandatory fortification of bread.

Design
Serum and erythrocyte folate concentrations were measured in non-fasting blood samples collected from 3348 participants of the 2008/09 New Zealand Adult Nutrition Survey (2008/09 NZANS). Median urinary iodine concentration was measured in 3315 survey participants, from a spot urine sample.

Outcomes
In total, 1.6% (95%CI: 1.1, 2.2) of participants had serum folate concentrations <6.8 nmol/L, and 2.2% (1.4, 2.9) of participants had erythrocyte folate concentrations <317 nmol/L indicative of deficiency. Mean (95%CI) red blood cell folate concentration amongst women aged 16 to 44 yrs was 796 nmol/L (758, 834); 27.4% (23.0, 31.7) had erythrocyte folate concentrations ≥ 906 nmol/L. The median urinary iodine concentration of males was 55 µg/L and of adult females was 50 µg/L, which indicates mild iodine deficiency. There were no differences in median urinary iodine concentration by age or NZDep2006 quintile.

Conclusion
The prevalence of folate deficiency was low. However, more than two thirds of women of child-bearing age had folate status associated with higher risk of neural tube defect-affected pregnancies. Mild iodine deficiency was prevalent. Mandatory fortification of bread with iodine and folic acid may have public health benefits.

Source of Funding
The Ministry of Health, New Zealand, funded the 2008/09 NZANS.

Food security as a predictor of body weight status: results from the 2008/2009 New Zealand Adult Nutrition Survey

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Background
Food security and body weight status are each growing concerns for many New Zealanders. The 2008/09 NZANS allows us to assess food security status in relation to weight status.

Objective
To determine household food security status within NZ and its relationship to body weight status.

Design
Data from the 2008/09 NZANS determined household food security status from responses to eight statements, later collapsed into three categories: fully/almost fully food secure: moderately food secure; low food security status. Body weight status was determined by BMI (weight/height^2) and obesity (BMI≥30 kg/m^2). Using multivariate analysis, the relationship was explored between food security status and BMI/obesity, adjusted for age, sex, ethnicity, NZDep2006, education, income and household size. Survey weights were used.

Outcomes
For the NZ population, 59.1% were fully/almost fully food secure, 33.8% moderately food secure and 7.1% of low food security status. Compared with females of fully/almost full food security, females of moderate food secure status had a higher BMI (28.3 kg/m^2 cf 29.4 kg/m^2, P<0.05) while low food secure females had a higher likelihood of obesity (OR=1.87). Compared with fully/almost fully food secure females, those of moderate food security had a higher BMI for NZEO (26.8 kg/m^2 cf 27.8 kg/m^2, P<0.05) and Maori (30.3kg/m^2 cf 32.0kg/m^2, P<0.05). NZEO and Pacific females of low food security were over twice as likely to be obese as the fully food secure (OR=2.16 & OR=2.61). Compared with Maori and Pacific males of fully/almost full food security Maori males of moderate food security (29.5 kg/m^2 cf 31.3 kg/m^2, P<0.05) and Pacific males of low food security (30.8 kg/m^2 cf 33.3 kg/m^2) had a higher BMI. Maori males of moderate food security status compared to fully/almost full secure males were over twice as likely to be obese (OR=2.15).

Conclusion
Food security is an important public health issue in NZ. Both low and moderate food security status for females of all ethnicities and among Pacific and Maori males is associated with a higher body weight status.

Source of Funding
Ministry of Health

New science in sports nutrition

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Background
Research in sports nutrition is rapidly evolving. This presentation will aim to showcase current research which provides insight into key mechanistic or clinical issues in sports nutrition.

Objective
Current research on a range of topical sports nutrition issues was evaluated to determine presentation content. Data from the authors research team, some of which is as yet unpublished will be highlighted.

Design
The following questions or issues were identified for inclusion: Do low glycaemic index pre-event meals enhance exercise performance? Are current guidelines for carbohydrate consumption during exercise outdated? Cool beverage ingestion during exercise, does it work and why? Intense exercise training: reasons why it could make you iron deficient? Does ergogenic use of caffeine give athletes insomnia? Do athletes have sound nutrition knowledge and does this knowledge influence dietary intake?

Outcomes
Insight into the impact of low glycaemic index meals and current guidelines for carbohydrate consumption will use recent systematic reviews to evaluate what is known in these areas. Scientific manuscripts and unpublished research data from the author's research group will be used to provide insight into the potential benefits of cool beverage consumption, exercise and iron deficiency, ergogenic use of caffeine and insomnia, nutrition knowledge and dietary intake.

Conclusion
Recent changes in sports nutrition research demonstrate the importance of practitioners adapting guidance to optimise performance.

Source of Funding
Not applicable

Caffeine and sport - when two addictions collide

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Since 2004, caffeine has been removed from the WADA prohibited substances list. The change in prohibition status prompted renewed interest in caffeine's potential to influence sports performance. Approximately 100 published investigations exploring the optimal conditions under which caffeine may influence performance are now available. The focus of this research has been on factors such as the type of exercise task, the dose of caffeine and the timing of caffeine intake relative to the performance task. The vast majority of these research studies are undertaken using a relative ($mg.kg^{-1}$ BW) caffeine dose of pure anhydrous caffeine provided to participants who have undertaken a period of caffeine withdrawal and prior to controlled exercise within a laboratory.

For an athlete, the findings of these studies need to be interpreted in the context of significant changes to the availability of caffeine containing foods and beverages and a changing social environment. These changes include the introduction of greater varieties of caffeine containing products (e.g. energy drinks, energy shots) and the increasing access and popularity of commercial coffee.

Our recent caffeine research attempts to investigate a variety of issues associated with the practical aspects of working with the popular stimulant. The results from these studies are designed to improve the "ecological validity" of recommendations that can be provided to athletes regarding the use of caffeine for exercise performance improvement.

Source of Funding
All studies are funded by Griffith University.

Ergogenesis in sport: chasing the drug cheats

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Background

Drug misuse in sport, with strong historical roots, rose to public prominence following the dismissal of Canadian track athlete, Ben Johnson at the 1988 Seoul Olympics. The Government of Canada invoked a national inquiry into sports drug misuse that was to redefine international anti-doping policy for sport.

Objective

This presentation will sketch a background to anti-doping strategies in sport, highlight some historical landmarks and reflect on current trends including “designer” drugs and the market for sports supplements. It will also consider the plight of the athlete for whom an existing medical condition may legitimately demand the use of a banned substance.

Outcomes

Rich rewards from success in sport have created a ready market for performance-enhancing substances. Today the World Anti-Doping Agency (WADA) represents the allegiance between international sporting federations and governmental agencies that oversees anti-doping policy for major sporting codes. The vision of WADA is “a world where all athletes compete in a doping-free sporting environment”.

Baseline sympathetic nervous system activity predicts dietary weight loss in obese metabolic syndrome subjects

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Background

The sympathetic nervous system (SNS) is an important physiological modulator of both basal and postprandial (facultative thermogenesis) energy expenditure.

Objective

To investigate whether the variability of dietary weight loss attained relates to individual differences in baseline resting sympathetic drive and nutritional SNS responsiveness.

Design

Untreated obese subjects (n=42, 26M/16F, BMI 32.1 ± 0.5 kg/m^2), aged 57 ± 1 yr, with ATP III metabolic syndrome participated in a 12-wk weight loss program using a modified DASH diet (30% fat, 22% protein, 48% CHO). Muscle sympathetic nerve activity (MSNA) was measured by microneurography at rest and in a subset of 15 subjects during a standard 75-g oral glucose tolerance test.

Outcomes

Weight loss (-7.1 ± 0.5 %) was independently predicted by baseline resting MSNA burst incidence (r=0.38, P=0.019) which accounted for 14.3 % of the variance after adjustment for age and baseline weight. Weight loss 'resistant' (WLR) subjects in the lower tertile of weight loss (-3.4 ± 0.4 %), had significantly blunted MSNA responses to oral glucose at baseline compared with 'successful' weight loss (SWL) subjects (-8.9 ± 0.8 %). Absolute Δ MSNA at time 30, 60 and 90 min post-glucose averaged -7 ± 2, -6 ± 5 and -3 ± 3 bursts/100 heartbeats in the WLR group. Corresponding values in the SWL group were 9 ± 3, 12 ± 3 and 15 ± 4 burst/100 heartbeats; time x group interaction P=0.004). The nutritional sympathetic responses to glucose at times 60 min and 90 min were significantly and positively associated with weight loss attained (r=0.53, P=0.04 and r=0.78, P=0.002 respectively).

Conclusion

These findings indicate that pre-treatment sympathetic drive and nutritional sympathetic responsiveness may be important prognostic biological markers for weight loss outcome during dietary intervention programs.

Source of Funding

Supported by grants from Diabetes Australia and the National Health and Medical Research Council.

Metabolic responses to high-fat diets rich in n-3 or n-6 long-chain polyunsaturated fatty acids in mice selected for either obesity or leanness

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Background

Increasing evidence suggests that diets high in n-3 polyunsaturated fatty acids (PUFA) confer health benefits by improving insulin sensitivity and lipid metabolism.

Objective

The aim of the present study was to investigate the metabolic responses and insulin signalling pathways to high-fat diets rich in either n-3 or n-6 PUFA in mice with a predisposition for obesity or leanness. We hypothesised that genetic predispositions for obesity or leanness may favour specific metabolic pathways of lipid or carbohydrate metabolism.

Design

We examined the effect of feeding n-3 and n-6 PUFA rich high-fat diets in mice selected for either high body weight gain (DU6), obese phenotype, or for high running performance (DUhTP), lean phenotype. At 29 days of age the mice were fed standard chow (7.2% fat), or a high-fat diet rich in n-3 (27.7% fat) or n-6 PUFA (27.7% fat) for 8 weeks.

Outcomes

The metabolic responses to diets enriched with n-3 or n-6 PUFA differed markedly between the two selection lines. Plasma leptin and insulin were higher (P<0.01) in DU6 compared with DUhTP mice. The high-fat diets increased (P<0.01) leptin levels, body fat and metabolic parameters of adiposity in DU6 mice. In both mice lines, n-3 PUFA feeding reduced (P<0.01) hepatic insulin receptor beta protein concentration, suggesting decreased insulin action in the liver. In contrast, protein kinase C zeta expression increased (P<0.01) in abdominal fat of n-3 PUFA fed DUhTP mice, indicating enhanced insulin sensitivity in adipose tissue.

Conclusion

Health benefits of dietary n-3 PUFA may be explained, at least in part, by changes in insulin action and lipid metabolism. However, important genotype - diet interactions draw attention to the biological importance of genetically determined pathways that contribute to obesity.

Source of Funding

Ministry of Food, Agriculture and Consumer Protection Germany, German Research Foundation, Health Research Council of New Zealand.

Pre-supplementation with LCn-3PUFA for weight loss and improved blood biomarkers

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Background
Recent studies have reported lower levels of LCn-3PUFA in obese compared to healthy individuals. However, there are conflicting reports on the effectiveness of supplementation with LCn-3PUFA for weight loss when given as an adjunct to a weight loss diet.

Objective
To determine whether pre-supplementation with LCn-3PUFA would assist in weight loss and improved blood biomarkers when participants subsequently followed a very low energy diet (VLED).

Design
A double blind randomised control trial with two parallel groups. Both groups followed their usual diet for 4 weeks with Group 1 (Placebo Group) consuming 6x1g capsules/d monounsaturated sunola oil (n=19), and Group 2 (Fish Oil Group) consuming 6x1g capsules/d fish oil (n=20). Continuing with supplementation, both groups followed a 3000kJ/d VLED for 4 weeks. Fasting blood samples and anthropometric measures were collected at baseline, beginning and end of weight loss.

Outcomes
Plasma levels of DHA and EPA increased almost two-fold (P<0.001) in the Fish Oil Group, indicating compliance with capsule consumption. There was a significant reduction in mean weight and fat mass (-5.79±1.90kg and -4.46±1.64kg respectively) for Placebo (P<0.001 for both) and (-6.12±1.52 kg and -4.36±1.29kg respectively) for Fish Oil (P<0.001 for both), with no significant differences between the groups. There were significant improvements in the blood biomarkers triglycerides, TC, HDL-C, LDL-C and leptin from baseline within each group but there were no significant differences between the groups. No correlation was apparent between the reduction in body weight and plasma EPA or DHA levels following LCn-3PUFA pre-supplementation.

Conclusion
Pre-supplementation with LCn-3PUFA does not assist weight loss however it is possible that small benefits expected from LCn-3PUFA consumption were obscured by the effectiveness of the VLED.

Source of funding
Not applicable

A one year high protein, low fat weight loss diet improves body composition and cardiometabolic risk factors in overweight males with features of the metabolic syndrome

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Background
A high protein, low fat weight loss diet may be advantageous for improving cardiometabolic health outcomes and body composition. To date only limited research has been conducted in male participants.

Objective
To evaluate the long-term effects of two energy-matched, low fat, hypocaloric diets differing in carbohydrate to protein ratio, on body composition and cardiometabolic health outcomes in overweight and obese males with features of the metabolic syndrome.

Design
120 males (mean±SD: age 50.8±9.3 years, BMI 33.0±3.9 kg/m^2) were randomly assigned to consume a low fat, isocaloric, energy restricted diet (7MJ/day) with either high protein (HP; protein:carbohydrate:fat % energy, 35:40:25) or standard protein (SP; 17:58:25). Body weight, body composition, and cardiometabolic risk factors were assessed at baseline and after 12 and 52 weeks.

Outcomes
68 participants completed the study (HP n=33; SP n=35). At one year both groups experienced similar reductions in body weight (HP -12.3±8.0 kg [-12%]; SP -10.9±8.6 kg [-11%], P<0.001 time; P=0.83 time x group). Participants who consumed the HP diet lost less fat-free mass (-2.6±3.7 kg [-4%] vs. -3.8±4.7 kg [-6%]; P<0.001 time; P<0.01 time x group) and tended to lose more fat mass (-9.9±6.0 kg [-27%] vs. -7.3±5.8 kg [-22%]; P<0.01 time; P=0.11 time x group). Both groups experienced a similar overall increase in HDL cholesterol (8%) and reductions in total cholesterol (-7%), LDL cholesterol (-9%), triglycerides (-24%), glucose (-3%), insulin (-38%), blood pressure (-7/-12%) and C-reactive protein (-29%), (P<0.01 time; P≥0.14 time x group).

Conclusion
In overweight and obese males, a HP and SP diet similarly reduce body weight and improve cardiometabolic health outcomes. A HP diet was more effective for improving body composition compared to an SP diet.

Source of Funding
This work was supported with a project grant from Meat and Livestock Australia.

High-protein, weight loss down-regulates gene expression involved in fatty acid and mitochondrial energy metabolism

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Background
Excess body fat is a major risk factor for metabolic syndrome, cardiovascular disease, and type 2 diabetes. Low-fat diet interventions are successful at reducing total body weight. However, loss of fat-free mass (FFM) is frequently observed. Therefore high-protein diets may be more effective in offsetting a reduction in FFM during weight loss. Evidence suggests in females that the substitution of carbohydrate with protein in low-fat diets may be more effective in promoting weight loss and have been shown to have beneficial effects on body composition and cardiovascular disease risk factors. However, the genes that regulate these effects remain largely unknown.

Objective
To determine differential gene expression (DGE) in fatty acid and mitochondrial energy metabolism pathways as a result of weight loss in overweight/obese females.

Design
Overweight & obese females (n=14; mean age 52 yrs, mean BMI 33 kg/m^2) were randomised to a high-protein (HP) or standard-protein (SP), hypocaloric diet intervention. Weight, body composition, waist circumference, lipids, glucose, insulin, and insulin sensitivity were assessed. RT^2 Profiler qPCR array profiling and Taqman qPCR analysis were conducted on skeletal muscle and adipose tissue samples collected at baseline, week 2 and week 12 of the diet intervention. Repeated measures ANOVA and paired analyses were used to determine significance ($P \leq 0.05$).

Outcomes
Both diets resulted in a mean weight loss of 7.54 (± 2.73, HP) and 6.46 (± 4.76, SP) kg, although there was no statistical difference between the diets. The analyses indicate that a number of genes are significantly differentially expressed ($P<0.05$) as a result of weight loss and diet type including ACAA2 and ACOT1, as well as NDUFA5 and NDUFB6.

Conclusion
Results indicate DGE exists in skeletal muscle and adipose tissue during weight loss. Our preliminary analyses of DGE during weight loss appears dependent on diet composition.

Source of Funding
CM McIver is supported by a CSIRO Office of the Chief Executive (OCE) Postdoctoral Fellowship

Susceptibility to weight gain: the role of appetite regulation

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Background
Susceptibility to obesity varies despite comparable environmental pressures.

Objective
To assess the role of appetite regulation in the characterisation of a phenotype susceptible to over-eating, and to create screening tools to identify this susceptibility.

Design
A randomised, single-blind, cross over trial was carried out in 27 healthy participants and included both lean (L_n, n=17) and overweight (O_W, n=10) individuals characterised by BMI 18-25 and >25 kg/m^2 respectively. Subjects arrived fasted and were given high (HE) and low energy (LE) breakfasts which varied in fat content (high/medium/low fat, HF/MF/LF) at 8.30am, followed by an *ad libitum* lunch meal at 12pm. The 4 breakfasts comprised: (i) HE/HF (2.5MJ; 50en%fat), (ii) HE/LF (2.5MJ; 25en%fat), (iii) HE/MF (2.5MJ; 37.5en% fat), and (iv) LE/MF (0.5MJ; 37.5en%fat). Electronic VAS were used to measure subjective appetite ratings, and energy intake (EI) was measured at the lunch meal.

Outcomes
When all treatments were combined there was no difference in feelings of hunger or fullness between the L_n and O_W groups (all, ns), yet EI at the *ad lib* lunch was greater in the O_W (all, +12%, $P<0.05$). The HE breakfasts induced a greater suppression of hunger compared with LE in both groups (iAUC, both, $P<0.05$), yet neither L_n nor O_W detected the isoenergetic change in %fat (both, ns). When matched for %fat, there was an indication that suppression of hunger by the LE breakfast was greater in the L_n (36%) than in the O_W (12%) (LE/MF vs HE/MF: L_n, ns; O_W, $P<0.05$). *Ad lib* intake was not altered by the increase in % fat (25 vs 37.5 vs 50%) in either group and, whilst the increase in energy content (0.5 vs 2.5MJ) tended to suppress intake at lunch in L_n (-13%) compared to O_W (-3%), acute energy compensation was poor for both groups (20 vs 6%, P=0.06).

Conclusion
Despite a comparable appetite response to the 4 breakfasts, *ad lib* intake was greater in O_W. Isoenergetic changes in %fat did not alter appetite or energy intake in either L_n or O_W, whilst the HE breakfast suppressed hunger in both groups greater percentage compensation at lunch occurred in L_n.

Source of Funding
This study was conducted by CM as part of a BSc (Hons) program.

Estimation of individual classes and total antioxidant intake of Australians

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Background

Antioxidant (AOX) consumption has reported health benefits such as reducing cardiovascular disease risk factors, improving endothelial function and delaying age-related cognitive decline. However there is little information available on the dietary intake of total and individual classes of AOXs of Australians.

Objective

To estimate the total dietary AOX intake of 1183 South Australians in a cross-sectional study.

Design

Pre-existing data collected through electoral roles from 1183 middle aged (51±6yr) men and women was used to estimate total antioxidant intake. AOX intake including vitamin A, C, E, carotenoids, flavonoids, isoflavones and selenium was estimated using a validated FFQ. Reported intakes were converted to serves per day using serving sizes described for relevant foods in Foodworks Professional (Xyris). AOX content of foods was determined using a combination of Foodworks Professional and the USDA Antioxidant Databases (USDA 1998, 2004, 2007, 2008). One-way ANOVA was undertaken to examine differences between genders for AOX intake (SPSS V17.0).

Outcomes

Estimated total antioxidant intake (sum of vitamin A, C, E, selenium, carotenoids, flavonoids and isoflavones) was 831±597mg/d. Men and women consumed 766±578mg and 868±605mg of total AOX per day, respectively. Flavonoids was the major AOX consumed (623±579mg/d) of which thearubigin, was the major polyphenol (364±395mg/d). There was no difference between gender for the consumption of vitamin A, C or isoflavones, however men consumed more vitamin E, and selenium (P<0.0001) than women and women consumed more carotenoids, total flavonoids and thearubigins (P<0.01) than men. Of the flavonoid class, men consumed more flavanones than women (P=0.01) whereas women consumed more anthocyanidins (P<0.0001), flavan-3-ols, flavones and flavonols (all P<0.05).

Conclusion

Gender differences in AOX intakes appear to reflect difference in dietary habits. These data indicate that flavonoids, mainly from black tea, are the main AOX consumed by Australians. To our knowledge this is the first detailed study to estimate intakes of total AOX and individual classes of AOX for men and women.

Source of Funding

None.

Transtheoretical model mediators of fruit and vegetable intakes in the 5+YourWay study

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Background

The 5+YourWay® Study is a randomized controlled trial testing the effectiveness of Transtheoretical Model-based, computer-tailored communications among a nationally representative sample of low fruit and vegetable consumers ages 25 to 60 years.

Objective

This study investigates whether there is a mediating relationship between decisional balance and self-efficacy and fruit and vegetable intakes in The 5+YourWay Study.

Design

Validated instruments measured fruit and vegetable intakes, decisional balance and self-efficacy. Screening survey data (n=2132) was used to explore, confirm and validate separate fruit scales and vegetable scales. Multivariate analysis of variance assessed changes in intake across the 12-month study in tailored, generic and control groups (n=384-6). Mediation was tested using structural equation models, the Baron and Kenny causal steps methods and the Sobel method.

Outcomes

In the tailored group, 0.6 and 0.5 daily serving increases in fruit intake and vegetable intake at three months were maintained at 12 months. Pros and cons did not mediate the effect the intervention had on intake. Fruit self-efficacy accounted for 15% and 31% of the intervention effect on intake at three and six months. “Main meal” self-efficacy accounted for 13% of the intervention effect on vegetable intake at three months, while “other occasion” self-efficacy accounted for 24% and 45% of the intervention effect on vegetable intake at six and 12 months.

Conclusion

5+YourWay-generated tailored communications significantly increased fruit and vegetable intakes in this sample. Self-efficacy partially mediated increases in intake, so it should be targeted in future interventions. Pros and cons had no mediating effect, although these subscales had marginal validity.

Source of Funding

This research was funded by a grant from the Heart Foundation of New Zealand with support from the University of Otago.

Acceptance of health promoting brassica vegetables: the influence of taste perception, information and attitudes

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Background

B*rassica* vegetables (B*rassica oleracea*) contain compounds that benefit health including organosulferous compounds; however, these same compounds can have undesirable sensory characteristics and tend to be disliked.

Objective

To determine the trade-off consumers make between the taste and the health properties of *Brassica* vegetables (broccoli, red and green cabbages, broccolini, cauliflower, Brussels sprouts).

Design

As part of a larger study (including chemical and sensory descriptive analysis), adults (n=200), all reporting medium-high physical activity (as a marker/control of health behaviour) and reporting either low (≤2 portions/d) or high (≥3 portions/d) vegetable intake. Half the low (Li group) and half the high vegetable participants (Hi group) received cancer protection information or not (Ln and Hn groups) before hedonic (9 point), perceived taste and flavour impact responses (100 mm scales) to samples of six *Brassica* vegetables were elicited. Additionally, attitudes towards foods for health, pleasure and reward, socio-demographics, intentions to consume the vegetables in the near future and recall of health information were also measured.

Outcomes

Information groups Li and Hi reported specific cancer protection information knowledge in contrast to Ln and Hn groups ($P<0.000$). Information independently influenced responses to (the least liked) Brussels sprouts only. Multivariate regression analysis found sensory perception tended to predict liking and intentions to consume *Brassica* vegetables. For example, broccoli hedonics (adjusted R^2 0.37) were predicted ($P<0.05$) by bitterness (β -0.38), flavour (β=0.31), sweetness (β=0.17), female gender (β=0.19).

Conclusion

Addressing taste dimensions (whilst retaining healthy compounds) may be more important than promoting health information in order to increase the popularity of *Brassica* vegetables.

Source of Funding

This project has been funded by HAL using the vegetable industry levy and matched funds from the Australian Government.

Out of the box: factors preventing households from eating more fruit and vegetables

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Background

Low-income families tend to eat less healthy diets than families with higher incomes. However, cost is only one of a number of resources that can influence whether a household eats healthily or not. Only New Zealand data from this multi-country study is presented.

Objective

To explore the breadth of resources necessary for households to eat more fruit and vegetables and identify strategies for resource distribution.

Design

An adapted ethnographic approach of qualitative research was used to observe twenty households in their natural setting for three months. An even number of low- and high-income households representing a range of family types were recruited from across New Zealand. Each household received a free box of fresh fruit and vegetables each week, delivered to their home, and were home-visited on two occasions each week by a researcher. Observations, discussions and interventions were documented using field notes and digital technology. Expanded field notes were coded manually to identify themes.

Outcomes

Preliminary analysis suggests human, social, natural, financial and physical resources all play a role in food choice decisions. Households with a greater range of resources, especially human and social resources, appear to make better use of the box contents than those with a narrower range of resources. All households require motivation, basic knowledge and skills, and confidence to overcome barriers to make use of the free fruit and vegetables. These human resources seem to develop over time through social learning experiences beginning in childhood.

Conclusion

These preliminary findings suggest deficits in a range of resources, not simply financial, contribute to the social gradient in healthy eating. Ongoing analysis will reveal household-tailored strategies needed to make necessary resources available.

Source of Funding

The 5+ A Day Charitable Trust, vegetables.co.nz, and the University of Otago funded this research.

Kiwifruit proteases enhance digestion of common protein-based foods under simulated gastric and small intestinal conditions

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Background
Kiwifruit consumption has long been thought to assist in the digestion of foods by hydrolysing proteins more completely and more rapidly than mammalian digestive enzymes alone. However there is little published evidence for this.

Objective
To investigate the effect of kiwifruit proteases (actinidin) on the digestion of a range of common protein-based foods under *in vitro* gastric and small intestinal conditions.

Design
Protein foods including meat and fish muscles, eggs, tofu, cottage cheese, and yoghurt were incubated in the presence or absence of Hayward kiwifruit extract using an *in vitro* digestion model (incubation with pepsin followed by pancreatin, simulating gastric and small intestinal digestion in humans). The digests were subjected to gel electrophoresis (SDS-PAGE) to assess loss of intact protein and the appearance of peptides (>3 kDa) during digestion.

Outcomes
Kiwifruit extract improved the digestion of the proteins with molecular weights above 30 kDa, β-casein and β-lactoglobulin in yoghurt; and tropomyosin- β chain, troponin T, tropomyosin-α chain in chicken muscles during the simulated gastric digestion phase. Similarly, the digestion of other food proteins was also enhanced under both gastric and small intestinal digestion conditions. In particular, enhanced digestion of hoki, tuna and cottage cheese was observed in the simulated gastric digestion system; and enhanced digestion of chicken, cottage cheese and to some extent yoghurt was observed in the simulated small intestinal system. Kiwifruit extract alone (in the absence of other digestive enzymes) resulted in greater solubilisation of the proteins and was capable of digesting some proteins present in foods, particularly yoghurt, cheese, fish and raw eggs.

Conclusion
This study provides clear evidence that Hayward kiwifruit can increase the extent of the digestion of food proteins in an *in vitro* digestion system and lends support to a role for dietary kiwifruit as a digestive aid.

Source of Funding
Supported by grants from ZESPRI (New Zealand) and Ministry of Science and Innovation (New Zealand) under Future Foods research program.

Psychosocial determinants of fruit and vegetable consumption among New Zealand university students: results of focus group interviews

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Background
University students living away from home for the first time are particularly susceptible to making poor dietary choices. This includes low fruit and vegetable consumption, and may have long-term health implications.

Objective
To utilise focus groups in order to identify psychosocial determinants associated with fruit and vegetable consumption among university students in New Zealand.

Design
Twenty-nine university students, aged 18-24 years old, studying health-related and non-health-related subjects volunteered for the study. Participants took part in one of six focus group interviews, all of which were transcribed verbatim and analysed by thematic analysis.

Outcomes
Taste, perceived health consequences, social influences/skills and barriers, abilities, habit, and (lack of) awareness of risk behaviours were brought forward during the interviews as the most important determinants of fruit and vegetable consumption for the selected population.

Conclusion
This preliminary study revealed that a number of different issues seemed to be important for determining the consumption of fruit and vegetables among university students in New Zealand. Consequently, interventions aimed at increasing their consumption need to incorporate these different factors. Interventions proposed by participants included: cooking sessions providing quick, easy and cheap recipes; providing new and more varied information about fruit and vegetables; developing 'made-to-measure' interventions; making students aware of cheaper food sources; and increasing availability of an interesting variety of appealing, inexpensive single pieces of fruit. For successful implementation, motives including food habits should be considered, whilst a variety of different media could be utilised to deliver targeted interventions. Additional research is suggested among other groups of young adults, so that promotional strategies can be specifically targeted.

Source of Funding
Not Applicable.

Have we changed? National adult nutrition surveys from 1997 to 2008/09

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Background
The Ministry of Health has funded two national nutrition surveys in New Zealanders aged 15 years and over; the 1997 National Nutrition Survey (NNS) and the 2008/09 New Zealand Adult Nutrition Survey (NZANS).

Objective
To monitor the food and nutrient intake and nutritional status of the New Zealand adult population over time.

Design
The 2008/09 NZANS consisted of a 24-hour diet recall and questionnaires, anthropometric and biochemical measurements. Indicators that were considered comparable across the 1997 NNS and the 2008/09 NZANS were compared by gender, using the same definitions and cut-offs. A significant difference was determined by non-overlapping, 95% confidence intervals.

Outcomes
From 1997 to 2008/09, the following changes were statistically significant for males and females. Reported nutrient intakes showed a decline in energy intake (males only); a decline in the proportion of energy from saturated fat; an increase in the proportion of energy from protein; a decline in median vitamin A, zinc and potassium intake; and an increase in median vitamin B_6 and selenium intake. There was an increase in the prevalence of obesity; a decrease in mean total blood cholesterol; an increase in mean HDL cholesterol; and an increase in the prevalence of iron deficiency (females only). The proportion of households classified as having low food security increased. There was an increase in the proportion of New Zealanders who reported eating the recommended number of servings of fruit per day.

Conclusion
There have been some positive nutrition-related changes in the New Zealand adult population between 1997 and 2008/09 however the surveys also identified areas of concern and areas for further analysis.

Source of Funding
Ministry of Health

Microbial saccharolytic enzymes, dietary fibre, and gastrointestinal health

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Background
Dietary fibre–enriched foods confer health benefits to the consumer due to their resistance to digestion, and the resulting stimulation of anaerobic microbial fermentation of the undigested carbohydrate. This fermentation results in the production of short chain fatty acids (SCFA: acetic, butyric, lactic and propionic acids) that play an important role in gastrointestinal health.

Objective
To measure changes in microbial saccharolytic degradation enzyme activities and SCFA concentrations over time in the caecum of rats fed cellulose, inulin or resistant starch.

Design
Male Sprague Dawley rats (3 weeks of age) were fed diets containing 2.5% cellulose, 5% cellulose, 5% inulin, or 5% maize resistant starch. The rats (n=8) were euthanised at 0, 24, 48, 72, 144, and 168 hours after consuming the experimental diets and caecum digesta removed for microbial saccharolytic enzyme activity and SCFA analyses.

Outcomes
There was a significant effect of diet on microbial saccharolytic enzyme activity and SCFA content of the caecum digesta. Rats fed the inulin diet had significantly greater ($P<0.05$) α-arabinopyranoside, α-galactopyranoside, and β-glucopyranoside activity than the rats fed the cellulose and resistant starch containing diets. There was no effect of time on most of the carbohydrate enzyme activities. Short chain fatty acid concentrations were significantly different between the diets. Lactic and succinic acids were higher ($P<0.05$) and isobutyric lower in the caecum digesta of the inulin fed rats. Formic, propionic and butyric acids were significantly ($P<0.05$) higher for the rats fed the inulin and resistant starch diets compared to the cellulose diets. There were some changes in SCFA concentrations over time.

Conclusion
Short chain fatty acid concentrations and microbial enzyme activities were significantly different for the rats fed inulin, a well known prebiotic. These measures may be useful experimental biomarkers in future studies evaluating prebiotic effects in new foods or food components.

Source of Funding
This study was funded by the New Zealand Foundation for Research, Science and Technology (C02X0703).

Energy and macronutrient intake among those susceptible or resistant to obesity

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Background
Despite living in an obesogenic environment not all individuals become overweight/obese; some remain lean with relative ease. Others report having to consume smaller amounts of food to maintain a healthy body weight. Information from the former group may allow us to develop novel strategies to benefit those who continually struggle with weight management.

Objective
To examine the energy and macronutrient intake of expenders (self-defined as 'eating as much as they wish without weight gain' versus conservers (self-defined as 'eating small amounts in order to manage their weight').

Design
Expenders (n=32) and conservers (n=25) completed a four day weighed food record. Nutrient composition was calculated using nutrient analysis software and New Zealand food composition data. Body composition was measured using dual-energy x-ray absorptiometry (DXA). Participants also completed the Three Factor Eating Questionnaire (3FEQ).

Outcomes
When expressed relative to body weight and lean body mass (LBM) respectively, conservers reportedly consumed significantly less total energy ($P<0.001$, $P<0.001$), protein ($P<0.001$, $P=0.033$), fat ($P=0.001$, $P=0.002$), and carbohydrate ($P<0.001$, $P=0.001$). This observation is in agreement with the conservers' self-reported need to consume small amounts of food to maintain a healthy body weight. Dietary restraint ($P<0.001$) and disinhibition ($P<0.001$) were significantly higher among conservers. Food variety and eating frequency will be explored.

Conclusion
Despite having similar LBM and a significantly higher body fat, conservers still reported consuming less total energy. The lower than predicted energy intake in conservers may be due to prolonged periods of dietary restraint followed by episodes of potentially obesogenic disinhibition. Managing energy intake by promoting intuitive eating and maintaining satiation may aid these individuals in achieving weight control.

Source of Funding
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Eicosapentaenoic acid in the treatment of skeletal muscle wasting in cancer cachexia

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Background
Cancer cachexia is a profound wasting condition affecting approximately 50% of cancer patients, for which there is no globally effective treatment. Skeletal muscle atrophy is a consequence of cachexia, however the mechanisms of wasting are yet to be elucidated. Systemic inflammation and oxidative stress are thought to play key roles in disease progression.

Objective
This study used a mouse model of cancer cachexia to investigate eicosapentaenoic acid (EPA; Anti-inflammatory/Superoxide Dismutase agonist) as a treatment to attenuate muscle wasting in cancer-associated cachexia.

Design
Female nude mice were inoculated with MAC16 cell line, which produces cancer cachexia, then randomised into 2 groups – EPA treatment (0.4 g/kg), or no treatment (control). Animals were euthanised 29 days post-inoculation and muscle tissues harvested for analysis. Gene expression and enzyme activity analyses were carried out on frozen gastrocnemius muscle.

Outcomes
There was no change in food and water intake between groups. The control group showed significant weight loss compared to initial weight from day 17 ($P<0.01$). EPA treatment group showed no significant weight loss compared to starting weight, and weight was significantly higher, compared to the control group, for a total of 15 days. There was no significant change in gene expression of antioxidant components EcSOD, MnSOD, CuZnSOD, CAT, and NOX2 compared to controls. GPx expression was increased in the EPA treatment group ($P<0.05$). There was no significant change in activity of SOD, CAT, or GPx, and a significant increase in XO activity compared to controls ($P<0.05$).

Conclusion
Whilst EPA continues to show promise as a treatment in animal models, it does not appear that attenuation of weight decline is caused by increased antioxidant capacity. Increased XO activity in EPA treated mice indicates that it may potentially play a role reducing weight-loss in cancer cachexia, and warrants further investigation.

Source of Funding
Ms Vaughan is the recipient of the Victorian Cancer Agency Palliative and Supportive Care Scholarship through the Victorian Cancer Agency, and the Bellberry Support Scholarship through Bellberry Ltd.

Changes in dietary habits in men after consultation based on the nine-step New Zealand Heart Foundation guidelines

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Background

Dietary modifications and changes in dietary habits are essential in reducing cardiovascular disease risk and have been shown to improve dyslipidaemia.

Objective

To investigate changes in dietary habits following consultations using the New Zealand Heart Foundation nine-step heart-healthy eating guide in hypercholesterolaemic men participating in a fruit intervention study.

Design

Hypercholesterolaemic men (n=79) participated in an eight week randomised cross-over fruit intervention study requiring a four week healthy diet run-in period. Fasting plasma lipids and % body fat (BodPod) were assessed at baseline (B1) and after 4 weeks (B2 – before starting the fruit intervention). Dietary intake was assessed using estimated food records, followed by individualised nutrition consultations aimed at achieving the nine heart-healthy guidelines. During the last visit the men self-assessed their achievement of each guideline using a questionnaire and a qualitative interview.

Outcomes

Lipid profiles and % body fat improved significantly between B1 and B2 (plasma total cholesterol:high-density lipoprotein cholesterol ratio: -0.29 (SD: ±0.52) mmol/L (P<0.001); % body fat: -0.62 (SD: ±0.41) % (P=0.001)). The mean (SD) percentage of energy from saturated fat and the median (25, 75 percentile) dietary cholesterol decreased from 12.8±3.66 to 9.97±2.67% and 327 (225-464) to 237 (182-337) mg/day, respectively; fibre and vitamin C intakes increased from 25.6 (21.1-32.9) to 27.9 (23.4-31.8) g/day and 111 (78.5-164) to 202 (171-256) mg/day respectively. In terms of the men's perceptions in meeting the guidelines, best achieved were fruit and vegetable guidelines improving in 43.1% of the men, takeaway guidelines in 40.4% men, milk and spreads/nuts guidelines in 30.4% men each. Many men (60%) ate high fat / sugar / salt snacks at B1, however improvements in choices of snacks (fruit, vegetable, dairy, nuts) were apparent in the following dietary evaluations.

Conclusion

Focusing on these identified strategies would assist men to enhance adherence to heart healthy eating and to achieve dietary goals to improve heart health. It may also improve the risk factors for heart disease over the short term.

Source of Funding

None.

Psychological distress, obesity and co-morbidities among Australian farmers

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Background

Worldwide, depression is the second largest contributor of years of life lost due to premature death and disability and affects 1 in 5 Australians. Rural Australians face higher mental health burdens due to social isolation, socio-economic constraint, poor diet, substance abuse, lack of exercise and lifestyle diseases.

Objective

To report baseline findings on psychological distress, obesity and co-morbidities among Australian farmers.

Design

For this quasi-experimental controlled intervention study, overweight (Body Mass Index (BMI)≥25 kg/m^2) farm men and women were recruited from the National Centre for Farmer Health's Sustainable Farm Families™ programs in Victoria. Anthropometric, dietary, physical activity, blood pressure, depression, anxiety and stress (DASS-21) scores and plasma lipids were collected at baseline, 3 months and 6 months. The intervention group received a farmer specific exercise program.

Outcomes

At baseline, 43 men and 29 women completed the study with mean±SD values for age 51.7±10.5 yr, BMI 31.3±3.6 kg/m^2, fasting blood glucose 5.1±0.8 mmol/l, cholesterol 5.8±1.0 mmol/l, triglycerides 1.6±0.6 mmol/l, HDL-cholesterol 1.5±0.4 mmol/l, LDL-cholesterol 3.6±0.9 mmol/l. According to the DASS-21, 23.9% of participants reported elevated levels of at least one of depression, anxiety or stress.

Conclusion

Australian farmers experience high rates of psychological distress and lifestyle disease co-factors. Interventions focused on promoting physical and mental well-being among this group are needed.

Source of Funding

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