Plenary Session 4: Revisiting Nutritional Biomarkers

Biomarkers – a pragmatic approach

NJ O'Callaghan
CSIRO Animal, Food and Health Sciences, Adelaide, SA

Currently there is a move towards investigating how diet can affect health, rather than disease. These may seem trivial differences, but it requires a fundamental shift in the approach used. Nutritional intervention studies have, and are currently, being used to investigate specific short term effects on a range of clinical (bio)markers of disease as well as other biological variables. Within nutritional science, it is now recognised that a multi-disciplinary approach is required to achieve an in-depth understanding of the dynamic, complex biological networks that are modulated by dietary factors. The areas of study required sit on two main axes: understanding the food and/or components and understanding the way the body responds to these inputs.

The aim of this presentation is to focus on biomarkers, reflecting on my own work in developing and evaluating a suite of robust biomarkers to underpin CSIRO's nutritional interventions and experiments.

The definition of "biomarkers" differs greatly between, scientists and scientific disciplines. In this presentation we will define biomarkers as "indicators of actual or possible changes of systemic, organ, tissue, cellular and sub-cellular structured and functional integrity.

We will explore (with examples):

- What is a biomarker?
- What makes a biomarker informative?
- How do we identify a useful biomarker?
- How do we use biomarkers to inform our science?

Plenary Session 4: Revisiting Nutritional Biomarkers

The importance of bioavailability and metabolism on the health benefits of dietary flavonoids – Advances in biomarkers of intake

Andrew M Jenner
Illawarra Health and Medical Research Institute (IHMRI)
School of Biological Sciences, University of Wollongong, Wollongong, NSW 2522, Australia.

Flavonoids and phenolic acids are classes of ubiquitous phenolic phytochemicals, which often occur in plants as glycosylated derivatives. They are widespread in human food, especially in fruits and vegetables, seeds, nuts, grains, and spices as well as beverages, such as wine and tea. Dietary total phenolic human intake has been estimated to range between 0.15 and 1 g/day, approximately 1/3 phenolic acids: 2/3 flavonoids. Flavonoids *in vitro* have powerful antioxidant activities and have been demonstrated to possess many other biological activities. Epidemiological studies associate foods and beverages rich in flavonoids with decreased risk of age-related diseases and experimental evidence indicates they may protect against many diseases, including cancer, cardiovascular disease and neurodegeneration. Thus, considerable attention has been paid to dietary flavonoids and their potential role against human disease. However, although flavonoids and their glycosides can be absorbed through the gastrointestinal (GI) tract their uptake is incomplete and circulating levels are low. Maximum plasma levels of individual flavonoids rarely exceed 1 uM after consumption of 10–100 mg of a single compound and they undergo rapid phase II metabolism in different tissues, generating methylated, glucuronidated and sulfated metabolites that have diminished antioxidant activity. Hence it is debatable whether plasma levels of flavonoids *in vivo* are sufficient to exert significant antioxidant effects. The exact mechanisms of flavonoid bioactivity in different body tissues are not fully understood and current research is examining whether specific phenolic metabolites may mediate some of the health benefits of flavonoids.

As a consequence of their poor absorbtion, flavonoids remain in the GI tract and enter the colon, where they may protect against constant exposure to toxins and reactive species, many from the diet. Gut bacteria efficiently metabolise flavonoids to form a range of simpler phenolic and aromatic compounds, particularly phenolic acids and human/animal studies demonstrate that there is significant uptake of these bacterial phenolic metabolites from the large intestine. These flavonoid-derived phenolic and aromatic gut microflora metabolites may contribute to the health benefits of flavonoid-rich food observed in epidemiological studies. Human phenolic acid levels in plasma and urine are typically much higher than flavonoids and are reduced in germ free animals and ileostomy patients. However, it is important to note that phenolic acids absorbed directly from the diet in the small intestine and endogenous metabolism also contribute significantly to this phenolic acid pool. Considerable research, demonstrates the importance of gut bacteria for overall host health, including obesity, ageing, cancer, infection and immunity. Evidence is now emerging that flavonoids and their metabolites may play an important role in promoting a healthy host microbiome.

In order to begin to assess the origin and mechanisms of flavonoid bioactivity, it is essential to examine flavonoid bioavailability and metabolism to understand their role in promoting health. It is also important to identify and measure their concentrations actually present *in vivo* to monitor flavonoid intake. Due to the diversity of flavonoid chemical structure, their complex metabolic pathways and their multiple metabolites, no single reliable biomarker of total phenolic intake exists. Several studies of specific flavonoid supplements have identified valuable biomarkers of intake, but these are of limited use when evaluating the several thousand phenolic compounds that may be consumed in normal human diet. In addition, the different rates of absorbtion, distribution, metabolism and excretion of flavonoids make single biomarker analysis very time dependent following meals. Therefore, in order to accurately assess dietary phenolic intake it is important to measure a range of different biomarkers *in vivo*. Liquid and gas chromatography (LC and GC) are able to resolve different flavonoids and phenolic metabolites during a single analysis and provide a specific and sensitive quantitative tool when coupled to mass spectrometry (MS) detection. LC-MS and GC-MS have been used extensively in metabolism studies as the gold standard, the former technique having the advantages of not requiring an analyte derivatisation step and an ability to measure larger, water soluble conjugates. Nevertheless, we have developed a reliable, sensitive GC-MS procedure for the accurate quantification of over 50 small phenolics and over 20 flavonoids that provides a targeted metabolomic coverage of common flavonoids and phenolic acids that originate from the diet. We have applied this technique to plasma, urine and fecal water to investigate the role of phenolic metabolism and establish the levels of a large range of phenolics. Further method development will enable larger analytical coverage of a wider range of phenolics that is necessary to fully investigate the long term effects of flavonoid consumption in a normal healthy diet.

Source of funding

The author is grateful for past support from NHMRC and BMRC Singapore and current research funding from IHMRI.

Plenary Session 4: Revisiting Nutritional Biomarkers

The impact of dietary interventions on vascular reactivity

SG West
Departments of Biobehavioral Health and Nutritional Sciences, Pennsylvania State University, University Park, PA, USA

Background

Nutrition research has traditionally focused on improving cardiovascular disease (CVD) risk through reductions in blood pressure (BP) and low density lipoprotein cholesterol, with some notable successes. However, traditional CVD biomarkers explain only a portion of the variance in cardiac events. Much recent work has been devoted to studying effects of foods, nutrients, and dietary patterns on dynamic measures of vascular function. This talk will describe recent clinical trials of vasoactive functional foods, with attention to methodology and the physiological relevance of available techniques

Objective

1) To discuss current methods for measuring vascular endothelial function, arterial stiffness, and peripheral vascular resistance response to stress.

2) To highlight recent clinical nutrition studies with vascular function as a primary outcome.

Outcomes

Basic and translational studies have shown that a functioning endothelium (the single cell layer lining conduit arteries) plays a critical role in protecting the vascular wall from the early stages of plaque development. In the early 1990's Celermajer and colleagues at RPA hospital described a noninvasive ultrasound procedure for assessing endothelial function in the brachial artery. This test, called flow mediated dilation (FMD), involves the application and release of an occlusion cuff on the arm, while the magnitude of the dilation response is assessed. An adequate FMD response requires release of nitric oxide (NO) from the endothelium. Low FMD has shown impressive potential as an independent risk factor for CVD, and it is also modifiable by diet. This talk will discuss the measurement of FMD and unique challenges of employing this test in nutrition studies. Because of the expense of ultrasound, and the need for skilled operators and customized software, alternative methods have been proposed. One technique uses pulse amplitude tonometry to assess dilation of peripheral vascular beds during reactive hyperaemia (RH) which follows cuff release. This response (the RH index) appears to be partially endothelium-dependent, and some studies have shown that it is modifiable by changes in diet. In contrast to literature on FMD, there is limited (but supportive) evidence that low RHI predicts CV events over the long term.

My lab has developed protocols for evaluating whether changes in diet affect systemic vascular resistance during psychological stress. Exaggerated stress response has been proposed as a marker of CVD risk. We have shown that walnuts, pistachios, L-arginine, and high potassium diets reduce BP and systemic vascular resistance.

Conclusion

Including vascular measures to existing clinical nutrition studies could advance our understanding of how diet affects vascular function. Careful study design is essential, and use of these techniques requires control of background sources of variability (smoking, room temperature, recent exercise, use of stimulant medications, recent meal content, menstrual cycle hormone fluctuations, etc). Given the subtleties in application of these measurements, and the unique demands of nutrition research, interdisciplinary collaboration is essential for success.

Source of funding

Supported by: the Western Pistachio Association (now American Pistachio Growers), the California Walnut Commission, and US-NIH grant M01RR10732

Plenary Session 5: Food Matters

Part 1: Dairy Australia Lecture

Sponsored by Dairy Australia

Dairy food intake and incidence of metabolic syndrome and type 2 diabetes mellitus

VM Flood

School of Health Sciences, University of Wollongong, Wollongong, NSW, Australia

Background

Limited evidence suggests habitual dairy consumption to be protective against metabolic syndrome (MetSyn) and type 2 diabetes mellitus (T2DM) among older adults. However, the evidence has been inconsistent. In addition, there have been no longitudinal cohort studies of dairy consumption and MetSyn and T2DM in an older Australian population.

Objective

This research assessed the association of baseline consumption of dairy food products with the incidence of MetSyn and T2DM among a cohort of Australian adults aged 49 years and over.

Design

The study population is drawn from the Blue Mountains Eye Study, a population-based cohort study of common eye diseases and other health conditions in residents aged 49 years and over in the Blue Mountains area, west of Sydney, Australia. Baseline information was obtained during 1992 – 1994. A total of 3654 people participated in the baseline clinical examinations, and 3267 participants (89.4% of enrolled participants) attempted and returned the food frequency questionnaire (FFQ), of which 2900 were usable (79.3% of participants examined). The FFQ used to collect dietary information is a validated 145-item semi-quantitative FFQ. At ten-years, in 2002-04, 1824 people who provided complete FFQ data at baseline attended follow-up examinations including anthropometric and biochemical assessments, and were included in the present analysis. MetSyn was defined as obesity (BMI≥30) and at least two of the following: 1. elevated blood pressure (BP), systolic BP ≥ 130 mmHg or diastolic BP ≥ 85 mmHg, or on anti-hypertensive medications; 2. triglycerides ≥ 1.7 mmol/L; 3. HDL cholesterol < 1.29 mmol/L (females) or < 1.03 mmol/L (males); 4. fasting blood glucose > 5.6 mmol/L or diagnosed T2DM. T2DM was defined as self-reported physician diagnosis of T2DM plus taking medication for T2DM or fasting blood glucose ≥ 7mmol/L. Ten-year incidence of MetSyn and T2DM were obtained from 1807 and 1824 participants, respectively. Odds ratios (OR) were calculated by discrete time logistic regression modelling. Dairy food intake was investigated as total dairy serves, regular fat dairy (including whole milk, yoghurt, cheese and custard), and reduced / low fat dairy (including reduced fat/ skim milk, low fat yoghurt, reduced fat cheese).

Outcomes

In the ten years of follow-up, there were 155 cases of participants with incident MetSyn and 145 cases of T2DM. Compared with subjects in the lowest intake quartile of regular fat dairy products, those in the highest quartile (2 serves) had a 59% lower risk of MetSyn (multivariate adjusted OR: 0.41; 95% CI: 0.23-0.71; p_{trend} = 0.004), after adjustment for age, sex, smoking status, physical activity, fibre from vegetables, glycemic load, total energy, and family history of type 2 diabetes. The association remained after further adjustment for calcium (multivariate adjusted OR: 0.39; 95%CI: 0.22 – 0.70; p_{trend} = 0.004). There were no significant associations or trends between dairy consumption (total, low/reduced fat or regular fat) and risk of type 2 diabetes. Following stratification of the cohort by weight status (BMI<30; BMI≥30), participants with a BMI ≥30 were more likely to have an association between a high intake of regular fat dairy foods and reduced risk of type 2 diabetes (age and sex adjusted OR 0.37; 95%CI: 0.16-0.88; p_{trend} = 0.030), but the association did not persist after adjustment for additional confounders.

Conclusion

This research found an inverse association between regular fat dairy consumption and risk of metabolic syndrome among older Australian adults. Further studies are warranted to examine the association between weight status, dairy consumption and risk of type 2 diabetes mellitus.

Source of funding

This study was funded by National Health and Medical Research Council project grants and a grant from Dairy Australia. Dairy Australia had no influence on the conclusions drawn.

Plenary Session 5: Food Matters

Part 1: Dairy Australia Lecture

Sponsored by Dairy Australia

The impact of dairy food consumption on novel atherogenic and metabolic biomarkers

PJ Meikle[1], N Mellett[1], S Pally[1], G Wong[1], PJ Nestel[1],
[1]Baker IDI Heart and Diabetes Institute, Melbourne, Vic, Australia.

Background

Metabolic disorders that increase risk of type 2 diabetes and cardiovascular disease are characterized by inflammatory and oxidative processes that arise at different sites including liver, muscle as well as macrophages in the arterial wall and in vascular endothelium. These processes may be reflected in increased levels of circulating biomarkers of inflammation and oxidation.

A growing body of population based studies has demonstrated an association between the consumption of dairy foods and reduced risk of type 2 diabetes. Reports of increased circulating levels of inflammatory biomarkers after consumption of meals containing dairy foods suggest a possible link with CVD. However, more recent studies suggest that consumption of fermented dairy compared with non-fermented dairy products may lead to less cardiovascular disease.

Objective

We sought to understand the relationship between dairy foods and dairy-based meals, based on fermentation status, and the level of circulating inflammatory, atherogenic and metabolic biomarkers. We tested the effects of five test meals (four dairy and a low fat control) and two diets rich in full-fat fermented (F) or non-fermented (NF) dairy products and a low fat (LF) control diet on eight protein biomarkers linked with inflammation, oxidative stress or atherogenesis. In addition, a detailed lipidomic analysis of over 300 plasma lipid species was performed.

Design

Single dairy meal study: 13 overweight subjects participated in 5 test meals. Breakfasts containing control low-fat milk or 45g fat either from butter, cream, yoghurt or cheese were tested over 3 weeks. Plasma obtained 0, 3 and 6 hr post meal were analysed for inflammatory markers IL-6, IL-1β, TNFα, hsCRP, and atherogenesis-related markers MCP-1, MIP1a, ICAM-1, VCAM-1. Plasma lipids (>300) were analysed by liquid chromatography-tandem mass spectrometry.

Dairy diet study: 12 overweight/obese subjects consumed, during 3 week periods, full-fat dairy products containing either yoghurt and cheese (F), or butter, cream and ice-cream (NF) with a low-fat diet (LF) as a further comparator. Inflammatory and atherogenic biomarkers were measured as well as plasma lipids (as described above).

Outcomes

In contrast to previous studies, our *single dairy meal study* did not show elevations in any of the inflammatory or atherogenic biomarkers. We did observe significant falls at 3 hr in four inflammatory markers after cream, butter and low-fat; and three atherogenesis-related biomarkers after cream. By 6 hr most values returned to baseline.

The postprandial lipemia following meals high in fat is thought to influence risk of cardiovascular disease but may also be related to risk of type 2 diabetes. To further investigate this we calculated the "diabetes risk" score using the plasma lipid profile at baseline and in the postprandial period for each participant with each meal. We had previously defined a diabetes risk profile from lipidomic analysis of the Australian Diabetes, Obesity and Lifestyle (AUSDIAB) cohort. We observed a decrease in risk following meals containing cream, butter and yogurt with the cream and butter meals reaching significance ($p < 0.01$).

In the *dairy diet study,* biomarker concentrations tended lower during the fermented than low fat periods with six of eight decreasing but only IL-6 was significantly lower with F than NF ($P<0.05$). Sphingomyelin concentration was higher with NF than LF ($P<0.02$); two plasmalogen classes (possible parameters of oxidant burden) were lower with F than LF ($P<0.001$ and <0.05). However plasma F_2-isoprostane concentrations did not differ among diets. Further analysis of the risk profiles associated with dairy diets is ongoing.

Conclusion

In conclusion, comparison of single meals and diets comprising predominantly fermented dairy or non-fermented dairy with low-fat diets, suggested a more favourable profile of inflammatory biomarkers and complex lipids with fermented dairy foods. Plasma concentrations of the inflammatory marker IL-6 tended to be lower as well as plasmalogens that may be associated with reduced oxidative stress.

Source of funding

This research was funded by the Dairy Health & Nutrition Consortium (Gardiner Foundation and its industry partners Bega Cheese/Tatura Milk Industries, Fonterra Australia, Murray Goulburn Co-operative, Lion (previously National Foods), Parmalat Australia, Warrnambool Cheese and Butter Factory, Dairy Australia and Dairy Innovation Australia).

Plenary Session 5: Food Matters

Part 2: Nutrition and Sustainability

Sponsored by The Primary Food Alliance: Australian Egg Corporation, Dairy Australia, Grains and Legumes Nutrition Council, Horticulture Australia and Meat and Livestock Corporation

3D Triple Bottom Line: Designing a Sustainability Scorecard

L Buys[1], K Mengersen[2], S Johnson[3], K van Megen[4], K Morris[5]
Queensland University of Technology, Brisbane, Qld, Australia

Background

Increasingly, there is public, industry and government demand for measurement and quantification of impact and demonstration of sustainability practice, across the entire spectrum of industries: including agriculture and commercial. Although there has been significant progress towards measuring and tracking a range of individual indicators, there is a need to understand the complexity of sustainability through an integrated framework.

Objective

The purpose of this project is to develop a Sustainability Scorecard to measure the current TBL performance of industry, and utilise this data to understand the future shape of sustainable practice in Australia. The Sustainability Scorecard measures the impacts of key social, economic and environmental variables from the perspectives of the farm, factory and consumer using the dairy industry as a case study.

The scorecard modelling offers stakeholders from differing perspectives a better understanding of the inter-relationships between key sustainability variables and the potential cause and effect impacts resulting from changes in key variables. This information gives the different stakeholders the opportunity to plan and develop strategies to:

- identify trigger points at which changes need to be instigated to mitigate potential negative impacts;
- put in place adaptation plans for the local industry and other key industries reliant on the industry; and
- Provide data to present to policy makers at all levels of government to guide decision making

We propose a sustainability scorecard model to measure the current Triple Bottom Line (TBL: economic, social and environmental) performance of the dairy industry (as a case study) using a Bayesian Network (BN) approach.

Design

The design of the proposed scorecard will collectively and individually measure the three domains of interest for stakeholders against TBL factors. A BN facilitates the integration of information at different scales and of varying quality within a sound statistical framework. Key sustainability influences and interactions are represented probabilistically in an acyclic graphical model as nodes and arrows, respectively. A BN model is able to capture the different perspectives of sustainability and is capable of sophisticated reasoning while taking uncertainty into account.

Outcomes

The sustainability scorecard is a conceptual model with five key indicators for each of the three TBL factors (social, economic and environmental), repeated for farm, factory and market. We illustrate the quantification of the BN models using one sub-indicator to inform each of the five key indicators from the vast number of documented indices. We include ratings from a stakeholder meeting to determine the relative importance of the TBL within farm, factor and market, before summarising them in the final overall sustainability score.

Conclusion

The proposed scorecard is a transparent and independent measure of change, illustrating the “ripple” effect of the “complex system” of indicators and interrelated impacts, identifying ways to increase overall sustainability while mitigating negative factors.

Source of funding

This research was funded by Dairy Australia.

Plenary Session 5: Food Matters

Part 2: Nutrition and Sustainability

Sponsored by The Primary Food Alliance: Australian Egg Corporation, Dairy Australia, Grains and Legumes Nutrition Council, Horticulture Australia and Meat and Livestock Corporation

Environmental sustainability and food security – a paddock to plate perspective

SG Wiedemann
FSA Consulting, Toowoomba, QLD, Australia

Background

The environmental sustainability of food production systems is fundamental to food security. Australian agriculture plays an important role in providing food for the domestic market and for export to the world. With substantial projected increases in food demand globally, agriculture faces a challenge to increase supply with sustainable production practices.

There is a growing need for all sectors of the food system to focus on sustainability as a core objective. Sustainability encompasses economic, social and environmental aims. Fundamentally however, economic and social sustainability rest on sustainability of the natural resource base. The ability of agricultural systems to maintain food production is a fundamental to stable society. This paper focuses on requirements to achieve and improve the environmental sustainability from production to consumption. This is considered in light of the imperative to maintain or increase food production.

Objective

For sustainability to be a serious goal it must be defined using a framework of quantifiable and robust terms, measures and indicators. This framework must be applicable to agriculture, food processing, retail and consumption to avoid the risk of improvements being made in one section of the food chain only to be lost in another. The objective of this study was to determine the key elements of this framework, and to investigate its application across the primary food system.

Life cycle assessment (LCA) is a suitable framework which has been widely used in the food sector to date. LCA uses a full supply chain approach and accounts for multiple environmental impact areas, which is essential for research in such a diverse field where numerous trade-offs exist between impacts. LCA research is focused on the impacts associated with producing, consuming and disposing of a product, or more precisely, of the function a product performs.

Design

Evidence from Australian agricultural LCA studies of livestock products was used as a basis for the analysis. These assessments were extended to the point of retail. Consumption and disposal phases were not analysed.

The analysis addressed three issues: Firstly, a tiered approach was used to prioritise environmental sustainability impacts relevant to the agriculture and food sectors. Secondly, we propose some key principles for improving the sustainability of food production that address food security challenges. Thirdly, a number of methodological challenges have been identified for consideration in future research.

Outcomes

The following first tier sustainability issues were identified:

- Energy and water use/water stress,
- Land use and stress on land resources, incorporating land capability and productivity potential.
- Grain use.
- Land use impacts (soil loss, nutrient and organic matter depletion, soil acidification, biodiversity and ecosystem services)
- Greenhouse gas (GHG) emissions.

The analysis highlighted the importance of production efficiency as a driving factor behind improving resource use efficiency and environmental sustainability. A comparison of caged and free range eggs showed lower GHG emissions, water use and energy use for the caged egg system compared to free range, mainly because of the more efficient feed conversion ratio. Such findings were not universal however; highlighting the need for robust, systems analysis. Reducing waste was another key element to improving system efficiency and reducing environmental impacts. Systems to generate bio-energy from waste and undigested feed at piggeries resulted in a 30% reduction in energy demand and a 55% reduction in GHG. Waste reduction is also critical through the manufacturing and consumption phases, where improvements could result in substantial reductions in resource use and environmental impacts.

Methodological issues to be addressed include assessment methods for sustainable land resource use and correct classification of the function of food within diets, which may be informed by nutrient density.

Conclusion

Maintaining and increasing food production from sustainable systems is critical for Australia and the global community. Methods to assess this, using appropriate indicators, are essential to measured improvement and reduction of impacts right across the food supply chain. While specific knowledge and research is required to inform this, the common theme of improving biological and system efficiency is relevant to all industries and all sectors of the food supply chain. Waste minimisation is another key efficiency measure to be addressed from production to consumption.

Source of funding

Funding provided by Rural Research and Development Corporation and Meat and Livestock Australia

Plenary Session 5: Food Matters

Part 2: Nutrition and Sustainability

Sponsored by The Primary Food Alliance: Australian Egg Corporation, Dairy Australia, Grains and Legumes Nutrition Council, Horticulture Australia and Meat and Livestock Corporation

Dietary strategies to achieve environmental and public health outcomes

M Noakes[1]

[1] *CSIRO Animal Food and Health Sciences, Adelaide, South Australia*

Background

The environmental impact of food is topical and controversial but is not synonymous with sustainability. Human consumption in all its forms contributes to greenhouse gas emissions (GHG), their potential impact on global warming and ultimately climate change with its projected adverse impacts. However, the depletion of natural resources which in part are used to produce food may result in an untenable ecosystem for human survival in future generations. Both of these challenges dovetail to determine what will and will not be a sustainable system for human survival and wellbeing for future generations. This paper will make the case for reducing overall human consumption of nutrient poor foods, wasting less, and prioritising nutrient dense foods in amounts in accordance with dietary guidelines. This is argued as a means of achieving improved public health and lower environmental impacts.

Overconsumption

In Australia, agriculture was responsible for 78.1 Mt CO2-e of a total of 546.3 Mt CO2-e, or 14.3% of total GHG in the last quarter of 2011. Agricultural emissions were down 0.9% from the previous year.

It has been suggested that overweight and obesity has implications for the environment, as well as for health. Gryka et al have estimated that compared with a normal weight population, a population with 40% obese requires 19% more food energy. GHG emissions from this extra food production in addition to car travel per 1 billion people was estimated to be between 0.4 and 1.0 Giga tonnes of CO2-e per year. Therefore, achieving and maintaining a healthy weight could have important environmental benefits. However, if we examine the changes in body mass index over the last decades, it is clear that the whole population has become heavier at the same age. This suggests that even those within the normal weight range, are heavier than they may have been in former generations.

Therefore framing the environmental debate around the obesity issue alone may be counterproductive and may obscure the fact that there has been an overall societal shift in body weight. Indeed Vieux et al have shown that there is a strong positive association between diet associated GHG emissions and total food and kilojoules consumed (r-squared = 0.57, p = < 0.0001).

Foods, Dietary Patterns and Nutrient Density

In Australia, 36% and 41% of total kilojoules consumed by adults and children respectively came from non-core foods. The Australian Dietary Guidelines recommend higher intakes of the nutrient dense core foods (except red meat for men) and reductions in non-core foods to <17% of energy intake. Smedman et al have attempted to model the GHG emissions of beverages and adjusted for nutrient density of those drinks. Their findings illustrate that under the assumptions made in their model, the nutrient density adjusted GHG impact is very high for sugar sweetened beverages, and lower for dairy beverages. This underscores the need to consider the nutritional value of foods in the environmental impact debate.

Food Waste

Food waste at all levels of the food value chain from production to consumption represents the waste of natural resources. Food waste at the consumer level represents an element of dietary behaviour that can further be modified to reduce the environmental impact of agriculture. Australia wastes more than $5.2 billion in food a year. The chart above shows how much that works out per person and household for each state. These amounts were calculated from a survey, carried out by The Australia Institute, of 1603 main grocery buyers in October 2009.

The United Nations Environment Programme estimates that total production is around 4,600 Kcal/person/day, but what is available for human consumption is around 2,000 Kcal/person/day. The Food and Agriculture Organisation (FAO) suggests that a 50 per cent reduction of losses and wastage in the production and consumption chain is a necessary and achievable goal.

Conclusion

Total food consumption and waste are major drivers of the environmental impact of the food system.
To achieve better health and sustainability goals, more efficient food consumption involves consuming a dietary pattern which prioritises nutritious foods, minimise waste and reduces overconsumption specifically of nutrient poor foods.

Funding Source

Meat and Livestock Australia

Concurrent Session 10: Healthy Ageing

A high prevalence of malnutrition in acute geriatric patients predicts adverse clinical outcomes and mortality at 12 months

KE Charlton[1], MJ Batterham,[1] S Bowden,[2] A Ghosh,[1] K Caldwell,[1] J Potter,[2] B Meyer,[1] L Barone,[2] M Mason,[2] M Milosavljevic[2]
[1]University of Wollongong, Wollongong, NSW, [2] Illawarra Shoalhaven Local Hospital District, NSW Health, NSW

Background
Older malnourished patients experience increased length of hospital stay and greater morbidity compared to their well nourished counterparts.

Objective
To assess whether nutritional status at hospital admission predicted clinical outcomes at 12 months follow-up.

Design
A retrospective analysis undertaken in an acute tertiary hospital in New South Wales in N = 2602 patient admissions (65 + y) between March 2003 and Dec. 2008. Outcomes at 12-mths were analysed for a sub-sample of n = 774. Nutritional status was determined within 72 hrs of admission using the Mini Nutritional Assessment (MNA). Outcomes, obtained from electronic patient records included hospital readmission rate, total Length of Stay (LOS), change in level of care at discharge, and mortality. Major Disease Classification and age were controlled for in analyses.

Outcomes
A third (34 %) of patients were malnourished and 55 % at risk of malnutrition. Using a cox proportional hazards regression model, patients at risk of malnutrition were 2.46 (95%CI: 1.36, 4.45; *p*=0.003) times more likely to have a poor clinical outcome (mortality/discharge to higher level of care), while malnourished patients had a 3.57 (95%CI: 1.94, 6.59; *p*=0.000) times higher risk.

Conclusion
Even accounting for underlying diagnosis and age, being malnourished carries a substantially greater risk of death and/or loss of dependency in older adults. Interventions to improve the nutritional status of patients during their hospital stay, and following discharge back to the community, are needed to lower the risk of adverse outcomes.

Source of Funding
Illawarra Health & Medical Research Institute grant.

Dairy intake, muscle health and risk for falls in older community-dwelling women

S Radavelli-Bagatini[1,2], K Zhu[1,2], JR Lewis[1,2], SS Dhaliwal[3], RL Prince[1,2]
[1] Department of Endocrinology and Diabetes, Sir Charles Gairdner Hospital, [2] School of Medicine and Pharmacology, University of Western Australia, [3] School of Public Health, Curtin University, Perth, WA

Background
Impaired muscle function has been demonstrated to be an important predictor of fracture and frailty in the elderly. There are limited data on dairy intake and muscle health in older women.

Objective
The aim of this study was to evaluate the association between dairy intake and lean body mass, physical performance and risk of falls in older women.

Design
1,456 older women recruited for the Calcium Intake Fracture Outcome Study were included in this analysis. Assessments include dairy consumption by a validated food frequency questionnaire, body composition by DXA (dual-energy x-ray absorptiometry), physical performance including hand grip strength and Timed Up and Go (TUG) test, self-reported number of falls and serum Insulin-like growth factor 1 (IGF-1).

Outcomes
The mean age was 75.2 ± 2.7 years and BMI 27.2 ± 4.7 kg/m^2. Women were categorized according to tertile of dairy intake as first tertile (<1.5 serve/day), second tertile (1.5-2 serves/day) and third tertile (≥2 serves/day). Compared to those in the first tertile of dairy food intake, women in the third tertile had significantly higher whole body lean mass (34.0 ± 4.0 vs. 33.0 ± 4.0 kg, P=0.010) and appendicular skeletal muscle mass (15.2 ± 2.2 vs. 14.6 ± 2.2 kg, P=0.039), greater hand grip strength (20.4 ± 4.7 vs. 19.9 ± 4.6 kg, P=0.007), better TUG test performance (9.3 (7.9, 11.0) vs. 9.5 (8.2, 11.3) secs, P=0.049), and increased levels of serum IGF-1 (83.0 ± 36.8 vs. 76.7 ± 30.4 ng/mL, P=0.011). Women who consumed ≥1.5 serves of dairy per day had fewer falls in the previous three months compared to those consumed <1.5 serves/day (10.7% vs. 15.1%, P=0.018). These effects remained after adjustment for age, BMI, energy intake and physical activity level, except for TUG test.

Conclusion
Higher dairy intake is associated with greater lean body mass, better physical performance and reduced risk of falling in older women. Increased dairy intake could benefit muscle health and improve quality of life in older people.

Source of funding
Supported by grants from the Australian National Health and Medical Research Council and the Dairy Health and Nutrition Consortium.

Concurrent Session 10: Healthy Ageing

Consuming two additional serves of dairy food a day significantly improves energy and nutrient intakes in ambulatory aged care residents: A feasibility study

S Iuliano[1], J Woods[2], J Robbins[3]
[1] Department of Endocrinology, [2] Department of Nutrition and Dietetics, Monash University, [3] Judy L Robbins Consultant Dietician, [1]University of Melbourne / Austin Health, West Heidelberg, Victoria

Background
Low-level aged care residents are at high risk of malnutrition. Oral supplements and fortified foods are used to overcome malnutrition in the elderly but require special preparation and administration by staff, over and above standard food and beverages served.

Objective
We proposed that increasing current dairy food intake in residents from two to four serves per day would improve energy and nutrient intakes and prevent malnutrition.

Design
This was a prospective intervention feasibility study involving 68 residents (78% female, mean age 86.5 years) in 2 low-level aged care facilities in Melbourne, Australia. Menus were modified to include at least two additional serves of dairy food per day. Mean macro- and micro-nutrient intakes before and after intervention, recorded using observed intake (food served minus waste) were reported and compared using paired t-tests.

Outcomes
Following intervention, daily increases in mean energy intake (900 kJ, P<0.001), protein intake (+25 g, P<0.0001), proportion of energy from protein (+4%, P<0.0001) and proportion of estimated energy requirements (+18%, P<0.0001) were observed, while proportion of energy from fat decreased (-3%, P<0.0001). Increases in mean daily micronutrient intakes were observed for numerous nutrients including calcium (+679 mg, P<0.0001), vitamin D (+1.4 μg, P<0.0001), phosphorus (+550 mg, P<0.0001), and zinc (+2.8 mg, P<0.0001), with recommended intake levels achieved on the higher dairy diet. Mean sodium intakes remained unchanged.

Conclusion
Two additional serves of dairy food can significantly improve nutrient intake in aged care residents and its ease of provision makes it a viable option to potentially prevent malnutrition.

Source of funding
Dairy Australia

The association between body composition and physical function in healthy older adults

J Lateo, P Lyons-Wall, KE Charlton, K Eisenhower, N Green
School of Health Sciences, University of Wollongong, Wollongong, NSW

Background
Impaired strength adversely influences an older person's ability to perform activities of daily living and predisposes them to increased dependency.

Objective
To assess the association between body composition and upper and lower body strength and endurance in older adults.

Design
Cross-sectional study of 51 independently living and aged care residents (age = 69.7±9.0 y; BMI = 26.1±3.5 kg/m^2). Body composition was measured using multifrequency bioelectrical impedance. Handgrip strength and the sit-to-stand test were used to assess upper and lower body strength, respectively. Muscular endurance was assessed using a 6-minute walk test. The Minnesota leisure time physical activity questionnaire estimated habitual physical activity. Nonparametric data were log transformed and Pearson's correlations performed. Multivariable regression modelling controlled for age, gender and physical activity.

Outcomes
Men performed better than women on all tests (P<0.05) and had a higher % fat-free mass (FFM) (P<0.001). Handgrip strength decreased with age for both men (r=-0.77; P<0.001) and women (r=-0.66; P<0.001). Body fat percentage was inversely associated with upper body strength (r=-0.60, P=0.01) and lower body endurance (r=-0.79, P=0.04) in males and with lower body endurance in females (r=-0.55, P=0.04). In females, fat-free mass was associated with upper body strength (r=0.40, P=0.02), lower body strength (r=0.35, P=0.05) and lower body endurance (r=0.69, P=0.01). In the regression model, age and gender predicted 78% of variability in maximum handgrip (P<0.001), while age predicted 16% of variation in sit to stand measurements (P=0.03).

Conclusion
Strategies to prevent fat gain with age in men, and to maintain muscle mass in older women may preserve upper and lower body strength and endurance, thereby beneficially impacting on functionality.

Source of funding
No funding received

Concurrent Session 10: Healthy Ageing

Risk factors associated with food insecurity after 10 years in older adults

J Russell[1], V Flood[1], H Yeatman[1], P Mitchell[2]
[1] School of Health Sciences, University of Wollongong, Wollongong, NSW, [2] Centre for Vision Research, University of Sydney, Westmead, NSW

Background
The number of older people is increasing. There is a growing concern in relation to maintaining the food security, nutrition and health status of this population group. However, little is known regarding the factors associated with food security over time in older adults.

Objective
The aim of this study was to determine risk factors that may impact food security status after 10 years.

Design
A cohort of older Australians (n=898), who participated in the Blue Mountains Eye Study at two time points, in 1997-2000 and 2007-2009, completed both lifestyle and health questionnaires as well a 12-item food security survey. Logistic regression models were created to determine which socio-demographic and health factors were associated with subjects who remained food insecure at both time points or moved from being food secure at baseline to food insecure after 10 years. These were compared to subjects who reported being food secure at both time points.

Outcomes
The proportion of subjects reporting food insecurity decreased from 10.5% at baseline to 7.8% after 10 years. Among those who were food insecure at baseline, renting accommodation compared to owning a home (OR: 9.99 95% CIs: 2.26, 44.12), a BMI greater than 30 (OR: 3.73 95% CIs: 1.22, 11.44), and being female (OR 3.36, 95%CIs: 1.05, 10.8) were significant predictors for remaining food insecure. Among people who were food secure at baseline but reported being food insecure after 10 years, similar OR risks to those who remained food insecure were found for renting accommodation and BMI greater than 30, compared to those who were food secure at both time points.

Conclusion
Our findings provide evidence that food insecurity is an issue in sub groups of older adults. Limited research exists relating to the risk factors for food insecurity over time in this population. There is a need for ongoing research to ensure older adults have appropriate access to safe, nutritious and affordable food to remain living independently in the community.

Source of funding
The Blue Mountains Eye Study was supported by the Australian National Health and Medical Research Council (Grant Nos. 974159, 211069, 457349)

Longitudinal associations of fish consumption and depression in adults under 40 years

KJ Smith[1], K Sanderson[1], SA McNaughton[2], T Dwyer[3], AJ Venn[1]
[1] Menzies Research Institute Tasmania, Hobart, TAS, [2] Centre for Physical Activity and Nutrition Research, Deakin University, Burwood, VIC, [3] Murdoch Childrens Research Institute, Parkville, VIC

Background
Cross-sectional studies have indicated fish consumption is negatively associated with the prevalence of depression. In the few studies that have examined longitudinal associations, the findings have been inconsistent.

Objective
To examine longitudinal associations between fish consumption and depression in a population-based national sample of Australian adults.

Design
In 2004-06, a sample of 515 men and 734 women aged 26-36 years old completed a 127 item food frequency questionnaire, which included nine fish and seafood items. Fish intake was converted to weekly equivalents and examined continuously (serves/week) and dichotomised (reference group: <2 serves/week). During 2009-2011, the lifetime version of the Composite International Diagnostic Interview was administered by phone interview. Depression was defined as having DSM-IV major depression/dysthymic disorder since baseline versus no lifetime history of depression/dysthymia. BMI was calculated from self-reported height and weight. Relative risks were calculated using log binomial regression or Poisson regression with robust standard errors.

Outcomes
Mean follow-up time was 4.82 (2.52) years. During follow-up 71 (13.8%) men and 150 (20.4%) women had experienced depression. For women, after adjusting for age, marital status, smoking, BMI and physical activity, each additional serve of fish consumed per week at baseline decreased the risk of having a depressive episode by 7% (adjusted RR:0.93; 95%CI:0.87, 0.99). For women who ate fish at least twice per week at baseline, the risk of depression during follow-up was 27% lower than those who ate fish less than twice per week (adjusted RR:0.73, 95%CI:0.55, 0.96). Fish consumption was not associated with depression in men (for each additional serve/week adjusted RR:1.03; 95%CI: 0.96, 1.10; and ≥2/week adjusted RR:1.18; 95%CI: 0.75, 1.88).

Conclusion
Fish consumption was associated with a significantly reduced risk of depression in women but not men. The National Heart Foundation recommendation of eating at least two servings of fish per week may be beneficial for women's mental health.

Source of funding
NHMRC, National Heart Foundation, Tasmanian Community Fund and Veolia Environmental Services.

Concurrent Session 11: Omega-3 Fatty Acids

Pre-eclampsia is associated with compromised maternal synthesis of long chain PUFA leading to offspring deficiency: a potential explanation why fish oil supplementation is ineffective

BJ Meyer[1], VA Mackay[2], SS Huda[2], FM Stewart[2], K Tham[2], LA McKenna[2], I Martin[2], F Jordan[2], EA Brown[2], L Hodson[3], IA Greer[2], DJ Freeman[2]
[1] School of Health Sciences, University of Wollongong, Wollongong, New South Wales, Australia, [2] University of Glasgow, [3] University of Oxford, United Kingdom

Background
Obesity and excessive lipolysis are implicated in preeclampsia (PE). Intrauterine growth restriction (IUGR) is associated with low maternal body mass index and decreased lipolysis.
Objective
Our aim was to assess how maternal and offspring fatty acid metabolism is altered in mothers in the third trimester of pregnancy with PE (n=62) or IUGR (n=23) compared to healthy pregnancies (n=164).
Design
Markers of lipid metabolism and erythrocyte fatty acid concentrations were measured. Maternal adipose tissue fatty acid composition and mRNA expression of adipose tissue fatty acid metabolizing enzymes and placental fatty acid transporters were compared.
Outcomes
Mothers with PE had higher plasma triglyceride (21%, $p<0.001$) and non-esterified fatty acid (50%, $p<0.001$) concentrations than Controls. Concentrations of major n-6 and n-3 long chain (LC) PUFA in erythrocytes were 23-60% lower (all $p<0.005$) in PE and IUGR mothers and offspring compared to Controls. Subcutaneous adipose tissue Δ-5 and Δ-6 desaturase and very long chain fatty acid elongase mRNA expression was lower in PE than Controls [Control 3.38(2.96) vs PE 1.83(1.91), $p=0.030$; 3.33(2.25) vs 1.03(0.96), $p<0.001$; 0.40 (0.81) vs 0.00 (0.00), $p=0.038$].
Conclusion
At birth, the offspring of PE and IUGR pregnancies are deficient in essential LC PUFA which may have long term consequences for their development. The mechanisms by which these deficiencies arise differ between PE and IUGR and suggest different interventions. In IUGR LC PUFA supplementation may overcome the lack of maternal fatty acid mobilization. In PE low maternal and fetal LC PUFA concentrations may be due to decreased maternal synthesis. This may arise from the increased NEFA flux to the liver saturating the VLDL synthesis pathway, leading to ectopic fat accumulation analogous to non-alcoholic fatty liver disease. In PE insulin-sensitizing treatments such as metformin may reduce ectopic fat accumulation & upregulate LC PUFA synthetic pathways.
Source of funding
SCPMDE Clinical Research Fellowship, British Heart Foundation (PG/03/147/16351 and PG/02/167/14801).

Maternal DHA supplementation during pregnancy and cognitive development: a randomised control trial and an assessment of attention, working memory and inhibitory control at 2 years of age

JF Gould[1, 2], MM Makrides[1, 2], LG Smithers[1]
[1] University of Adelaide, Adelaide, SA, [2] Women's and Children's Health Research Institute, Adelaide, SA

Background
Docosahexaenoic acid (DHA) is an omega-3 fatty acid that accumulates in the hippocampus and frontal lobes of the fetal brain in the second half of pregnancy.
Objective
The aim of this study is to examine the effect of maternal DHA supplementation during the second half of pregnancy on the functioning of the hippocampus and frontal lobes in the offspring.
Design
Children whose mothers were enrolled in the DOMInO trial (DHA to Optimise Mother and Infant Outcomes) were followed-up in a nested study. The DOMInO trial is a double-blind, randomised controlled trial in which pregnant women were randomly assigned to consume capsules containing 800mg/d of DHA (treatment) or vegetable oil (control) supplement from ~20 weeks until birth. The development of the frontal lobes and hippocampus was measured at 2 years of age using three assessments of Attention and one of Working Memory and Inhibitory Control (WMIC) in a subset of children born >37 weeks gestation and >2.5 kg. The primary outcomes were average latency for a child to be distracted when attention had been focused (Attention) and accuracy of finding a hidden toy during Test Trials (WMIC).
Outcomes
Assessments were completed by n=81 treatment and n=77 control group children. The primary outcomes for both assessments showed no effect of supplementation. There were no differences between the groups on all secondary outcomes (n=46) except for one secondary comparison and this could have been due to chance. Associations between assessment outcomes and cord blood DHA were inconsistent, hinting at no association.
Conclusion
The results do not support the hypothesis that maternal DHA supplementation during pregnancy enhances Attention or WMIC in otherwise well nourished, term-born children.
Source of funding
NHMRC grant # 349301 funded the intervention trial.
Channel 7 Children's Research Foundation Grant funded the follow-up assessment.

Concurrent Session 11: Omega-3 Fatty Acids

Postprandial metabolism of docosapentaenoic acid (DPA, 22:5n-3) and eicosapentaenoic acid (EPA, 20:5n-3) in humans

AJ Sinclair[1], KM Linderborg[2], E Miller[1], A Larsen[1], G Kaur[3], PJ. Meikle[4], D Cameron-Smith[5]
[1] Deakin University, [2] University of Turku, [3] Victoria University, [4] Baker IDI, [3] Auckland University, Geelong, Victoria, Australia

Background
The study of the metabolism of docosapentaenoic acid (DPA, 22:5n-3) in humans has been limited by the lack of availability of pure DPA and the fact that DPA is found in combination with eicosapentaenoic acid (EPA, 20:5n-3) and docosahexaenoic acid (DHA, 22:6n-3) in natural products.

Objective
To compare the postprandial incorporation of DPA and EPA into chylomicrons in female volunteers.

Design
Pure DPA and EPA were incorporated in meals served to healthy female volunteers, n=10, in a double blind cross over study. High pressure liquid chromatrography/mass spectrometric and gas chromatographic methods were used to study the chylomicron triacylglycerol (TAG) molecular species and fatty acid composition of chylomicron TAG and phospholipids (PL).

Outcomes
Both EPA and DPA were incorporated into chylomicron TAG, while only EPA was incorporated into chylomicron PL. Lipidomic analysis of the chylomicron TAG revealed the dynamic nature of chylomicron TAG. The main TAG species that EPA and DPA were incorporated into were EPA/18:1/18:1, DPA/18:1/16:0 and DPA/18:1/18:1. There was very limited conversion of either DPA and EPA to DHA and no retroconversion of DPA to EPA during the 5 hour postprandial period.

Conclusion
EPA and DPA showed different patterns of incorporation in the chylomicron TAG and PL and molecular species of TAG.

Source of funding
Equateq Ltd (UK) is acknowledged for the generous provision of the pure supplements. Meat & Livestock Australia and Deakin University Strategic Research Centre for Molecular Medicine are acknowledged for financial support. Osk. Huttunen Foundation and Finnish Food Research Foundation are acknowledged for support to Dr Linderborg. Finally we wish to acknowledge and thank Dr Andrew Garnum (Deakin University) and the study participants.

Dietary modelling of omega-3 long chain polyunsaturated fatty acid (n-3 LCPUFA): effect of replacement of bread, egg, milk and yogurt with n-3 enriched for these foods on n-3 LCPUFA intake of Australian children

S Rahmawaty[1,2], P Lyons-Wall[3], K Charlton[2], , BJ Meyer[1,2]
[1] Metabolic Research Centre and [2]School of Health Sciences, Faculty of Health and Behaviour Sciences, University of Wollongong, NSW, [3]School of Exercise and Health Sciences, Edith Cowan University, WA

Background
In countries with traditionally low fish consumption such as Australia, foods enriched with omega-3 long chain polyunsaturated fatty acids (n-3 LCPUFA) may play an important role in meeting n-3 LCPUFA intakes for optimal health.

Objective
The aim of the present study was to assess the effect of replacement of bread, egg, milk and yogurt with n-3 enriched of these foods on total n-3 LCPUFA intake in Australian children's diets.

Design
Dietary modelling was undertaken using survey data from a nationally representative sample of 4487 children (2249 boys, 2238 girls) aged 2-16 years. Fifteen models were constructed in which reported consumption of bread, egg, milk and yogurt was replaced with n-3 enriched alternatives that are commercially available.

Outcomes
Mean ± SD and median (IQR) intakes of n-3 LCPUFA gradually increased from 79.2 ± 173.1 to 104.6 ± 178.3 mg/d and 28.9 (10.9-21.8) to 51.4 (25.7-109), respectively, after the modelling (p = 0.001 for each model). Median (IQR) intake of total LCPUFA's in non-fish eaters and fish eaters were 20.8 (8.1-42.7) and 150 (76-308) mg/d and these increased by 19.0 mg (91%) to 39.8 (22.5-73.6) and 33 mg (22%) to 183 (97.7-332) mg/d respectively after replacement of all four items. The proportion of children that met the adequate intake (AI) and the suggested dietary target (SDT) for n-3 LCPUFA increased by 15.2% and 0.4%, respectively.

Conclusion
Replacement of four commonly consumed food items with n-3 enriched for these foods would result in doubling the n-3 LCPUFA intakes in Australian children, without major changes to their current food habits.

Source of funding
PhD funding: Directorate General of Higher Education Indonesia through the University of Muhammadiyah Surakarta.

Concurrent Session 11: Omega-3 Fatty Acids

Differential effects of eicosapentaenoic and docosahexaenoic acids on platelet aggregation and hemostatic markers in male versus female subjects

M Phang[1], LF Lincz[2], ML Garg[1]
[1] School of Biomedical Sciences & Pharmacy, University of Newcastle, [2] Hunter Haematology Research Group, Newcastle Mater Hospital, NSW

Background
Consumption of long chain omega-3 fatty acids (LCn-3PUFA: eicosapentaenoic acid, EPA; docosahexaenoic acid, DHA) are known to reduce platelet aggregation and offer protection from heart attack and stroke; however the available evidence is equivocal. We have previously demonstrated that the acute (24h) effects of LCn-3PUFA supplementation on platelet aggregation in human subjects are gender-specific.

Objective
To determine if gender bias on platelet aggregation is maintained during long term LCn-3PUFA supplementation and if this translates to other hemostatic markers.

Design
A double-blinded placebo controlled trial was conducted in 94 healthy male and female adults. Platelet aggregation, plasma TXB_2, P-selectin, vWF and PAI-1 were measured at baseline and 4 weeks post-supplementation with EPA or DHA-rich oil capsules. LCn-3PUFA and platelet activity was examined according to gender vs. treatment.

Outcomes
In males, only EPA effectively reduced platelet aggregation by -18.4±3.2% compared to a reduction of only -2.7±2.8% in the males taking placebo and -5.5 ±3.1% in females taking the same EPA supplement (P = 0.011). In contrast, in females only DHA decreased platelet aggregation with a -18.9±2.9% overall reduction compared to only -2.1±2.9% in the females taking placebo (P= 0.001) and -9.0±3.5% in the males consuming the same DHA supplement (p=0.017). Plasma DHA levels were increased significantly more in females (148%±25.1) compared to males (64.4%±18.7) in the high DHA treatment group (P=0.028). Plasma TXB_2, vWF activity, P-selectin and PAI-1 levels did not significantly change compared to placebo however when stratified by gender, a significant effect was only observed in PAI-1 levels after EPA treatment, (-5.3±2.0% for males vs. 7.3±5.5% for females, P = 0.046).

Conclusion
Significant gender x treatment interactions exist to influence hemostatic parameters and plasma LCn-3PUFA uptake differentially between men and women. With respect to thrombotic disease risk, men are more likely to benefit from supplementation with EPA while women are more responsive to DHA.

Source of funding
Not applicable

Evaluating changes in body weight gain, nutrient digestibility, inflammatory gene expression and RBC FA following DHA- rich fish oil supplementation in two dog breeds

D Purushothaman[1], WY Brown[1], S-B Wu[1], BA Vanselow[2]
[1] Animal Science, [2] NSW Dept of Primary Industries, University of New England, Armidale, NSW,

Background
Previous studies have demonstrated that DHA n-3 FA can reduce obesity by inhibiting adipocyte differentiation.

Objective
To investigate the potential of a DHA rich supplement (fish oil; FO) over non DHA (sunflower oil; SF) to reduce weight gain in dogs, when the animals were fed increased dietary energy intakes above maintenance levels (iso-caloric in both groups). The transcriptional, metabolic and phenotypic responses in two dog breeds were assessed.

Design
Six beagles and greyhounds were divided equally into two treatment groups (FO and SF). During four weeks, energy intake was increased 20-80% above maintenance level achieved by feeding basal diet (kibble), coconut fat and supplement (FO or SF). Changes to body weight gain (BWG), apparent nutrient digestibility (Dry Matter, Fat, and Gross Energy), red blood cell (RBC) FA levels, White Blood Cell (WBC) inflammatory gene expression levels (HSP90, HSP70 and IL1β) were measured twice: at days 0 and 28. A paired t-test was used to determine significance between time periods, treatments or breeds.

Outcomes
BWG in beagles fed FO were significantly higher (P<0.05) than those fed SF. No significant differences in BWG in greyhounds or between breeds were shown. Differences were not seen in apparent nutrient digestibility. HSP90 gene expression was up-regulated in the beagles fed FO (P<0.05), while HSP70 gene down-regulated for both breeds fed SF (P<0.05). A significant breed difference was observed for HSP70 fed SF (P<0.05). RBC EPA levels significantly increased in both breeds fed FO (P<0.05) with no significant difference in DHA levels. Only beagles fed SF showed significant increase in LA, AA (P<0.05). Both breeds fed SF showed significant decrease in GLA (P<0.05). Significant breed differences (P<0.05) were found in RBC FA levels of EPA (FO), LA, GLA and AA (SF).

Conclusion
Results from the four weeks trial do not support the potential of DHA n-3 FA to reduce BWG. However, within the same time frame, WBC inflammatory gene expression and RBC FA levels showed differences between treatments and breeds. Therefore breed differences warrant further investigation and future studies should be designed for extended periods with larger datasets.

Source of funding
Supported by UNE postgraduate fund.

Concurrent Session 12: Clinical Nutrition

Not all protein hydrolysates promote recovery of muscle strength following muscle damage induced by eccentric exercise

MJ Dale[1], RL Thomson[1], AM Coates[1], PRC Howe[1], A Brown[2], P Hobman[2], JD Buckley[1]
[1]Nutritional Physiology Research Centre, University of South Australia, South Australia, [2]MG Nutritionals, Parkville, Victoria

Background
We have previously shown that an hydrolysate of whey protein isolate (NatraBoost XR, MG Nutritionals, Parkville, Australia) can speed recovery of muscle strength following muscle damage induced by eccentric exercise. It is not clear whether this effect is common to all protein hydrolysates, or a unique property of this particular hydrolysate.

Objectives
To determine whether different hydrolysates of whey protein all improve recovery from muscle damage induced by eccentric exercise.

Design
Knee extensor strength was measured in 39 sedentary male participants prior to and after 100 maximal eccentric muscle contractions of the knee extensors. Participants then consumed a flavoured water control, unhydrolysed whey protein or one of 3 whey protein hydrolysates daily and strength was reassessed over the next 7 days.

Outcomes
Muscle strength was reduced in all treatment groups after eccentric exercise (P<0.001). Muscle strength recovered steadily over the 7 day post-exercise period in all treatment groups, but strength recovery was significantly faster in participants who consumed NatraBoost XR (P<0.001), with muscle strength having recovered fully in participants who consumed NatraBoost XR by 2 days post-exercise.

Conclusion
Not all protein hydrolysates speed recovery of strength following muscle damage induced by eccentric exercise. This seems to be a property unique to NatraBoost XR.

Source of funding
This study was supported by a grant from MG Nutritionals.

Prospective associations of dietary animal protein intake with the insulin-like-growth-factor axis in adulthood

G Joslowski[1], T Remer[1], KE Assmann[1], D Krupp[1], G Cheng[1,2], SA Wudy[3], ALB Günther[2], AE Buyken[1]
[1] Research Institute of Child Nutrition, Dortmund, Rheinische Friedrich-Wilhelms-University Bonn, Germany, [2] Fulda University of Applied Sciences, Department of Nutritional, Food, and Consumer Sciences, Fulda, Germany, [3] Laboratory for Translational Hormone Analytics in Pediatric Endocrinology, Centre of Child and Adolescent Medicine, Justus-Liebig-University, Giessen, Germany

Background
Evidence from observational studies suggests that higher intakes of animal protein may predispose to some types of cancer and type 2 diabetes. This study addressed the hypothesis that such relations may already emerge during adolescence.

Objective
Examine the prospective association between animal and plant protein intakes during puberty and the IGF-axis and insulin sensitivity in adulthood.

Design
Multivariate regression analysis was performed on data from 213 (118 women) DONALD participants with at least two plausible 3-day weighed dietary records during puberty (girls: 9-14 years, boys: 10-15 years) and one blood sample in adulthood (18-36 years). Mean levels of IGF-1, IGFBP-3 (n=213) as well as IGFBP-1, IGFBP-2, and HOMA-IR index (n=201) were compared between tertiles of habitual pubertal animal and plant protein intake.

Outcomes
Among women, a habitually higher animal protein intake during puberty was independently associated with higher levels of IGF-1 (P=0.005), IGFBP-3 (P=0.04), lower IGFBP-2 (P=0.1), and higher HOMA-IR (P=0.099), but not with IGFBP-1 (P=0.6) in adulthood. IGF-1 values in energy-adjusted tertiles of animal protein were 194 (95% CI 165, 226), 243 (210, 279) and 231 (198, 266) ng/ml, adjusted for $age_{blood\ sample}$, early life, socioeconomic, nutritional factors and baseline fat mass. Mean adjusted HOMA-IR values were 2.2 (1.9, 2.5), 2.7 (2.4, 3.1) and 2.7 (2.3, 3.0). No prospective associations were observed for intakes of plant protein (P≥0.3). Protein intakes were not related to the IGF-axis or HOMA-IR among men.

Conclusion
Among women, a habitually higher animal protein intake during puberty may precipitate an upregulation of the IGF-axis and a modest adaptive change in insulin sensitivity, which are both still discernible in adulthood.

Source of funding
The DONALD study is supported by the Ministry of Science and Research of North Rhine Westphalia, Germany, and this analysis was partially funded by the World Cancer Research Fund International (grant no. 2010/248).

Concurrent Session 12: Clinical Nutrition

Understanding gluten- and wheat-intolerance in relation to gastrointestinal symptoms: Is it the protein fraction or the highly fermentable short-chain carbohydrates?

JR Biesiekierski, ED Newnham, JG Muir, PR Gibson
Eastern Health Clinical School, Monash University, Box Hill, VIC

Background
The existence of NCGS, defined as those without coeliac disease but whose gastrointestinal symptoms improve on a gluten-free diet (GFD), has been recently supported by a randomised controlled trial of a single dose of gluten without a controlled background in parallel groups.
Objective
To assess the specific and dose-dependent effects of gluten in subjects who believe they have NCGS on gastrointestinal symptoms and fatigue and to examine the mechanism while consuming a controlled diet.
Design
Following a 2-week run-in period on a diet low in FODMAPs, subjects with NCGS and IBS (Rome III) who were symptomatically controlled on a GFD underwent a double-blind, placebo-controlled, randomised cross-over trial of placebo, low-gluten (2 g/day) or high-gluten (16 g/day) for 1 week, followed by a 2-week washout period, before crossing over to the next diet. All food was supplied. Protein levels were balanced with whey protein. Symptoms were evaluated by a visual analogue scale and markers of intestinal inflammation/injury, immune activation, cognitive function and by-products of protein metabolism were assessed.
Outcomes
40 eligible participants (24-62 y, 7 men) completed the study. Symptoms consistently and significantly improved on restriction of FODMAP intake, but significantly worsened to a similar degree during each dietary treatment period, irrespective of diet. Only six participants had an average increase for overall symptoms (more than 20 mm) on the high-gluten arm. An order effect and nocebo response was found. There were no changes in an biomarker. There were no differences in any end-point in those with and without DQ2/DQ8.
Conclusion
No evidence of specific or dose-dependent effects of gluten was observed, but FODMAP restriction uniformly reduced residual symptoms. Either the patients do not have NCGS as self-reported or the trial design precluded its recognition because of a high nocebo effect.
Source of funding
Not applicable.

Enteral and oral nutritional supplement formulas deliver laxative doses of FODMAPs which cannot be predicted by ingredients lists

EP Halmos, KL Liels, O Rosella, JG Muir, PR Gibson
Central Clinical School, Monash University, Melbourne VIC

Background
Recent evidence linking enteral nutrition-associated diarrhoea to the FODMAP (Fermentable Oligosaccharides, Disaccharides, Monosaccharides And Polyols) content of the formula has highlighted the need to determine their composition.
Objective
To measure the FODMAP content of commonly used enteral and oral nutritional supplement formulas and determine if content may be estimated by ingredients lists.
Design
A selection of 55 enteral formulas/oral nutritional supplements commonly used in Australia were categorised as low or high FODMAP and the type of FODMAP present according to the ingredients lists ("estimated" content). If one or more known FODMAP-containing ingredient was listed, the formula was considered high FODMAP. Known FODMAP ingredients included inulin, FOS, GOS, fructose and milk solids/powder. The formulas were then assessed by HPLC and enzymatic assays for FODMAP content and type(s) ("measured" content). The cut-off for measured FODMAP content was defined as 10 g/day at the manufacturers' recommended daily volume, which is comparable to the average Australian intake, determined by detailed dietary analysis.
Outcomes
Only 18 formulas were estimated to be high FODMAP, with fructans (inulin, FOS) the main type observed. In contrast, the measured FODMAP content varied from 10-60 g/day. All formulas were high FODMAP, mainly due to the presence of unsuspected fructans (eg. Nutrison® 1.0 had a low estimated FODMAP content but high measured FODMAP content of 49.1 g/day). The sources of FODMAPs are not known.
Conclusion
Nutritional supplement formulas are three to seven times more concentrated in FODMAPs than an average Australian diet and cannot be predicted by ingredients lists. This is equivalent to 15-90 mL/day of lactulose. An association with laxation is not surprising. Investigation into FODMAP content of specific ingredients will lead to development of low FODMAP nutritional supplements and possible prevention of associated diarrhoea.
Source of funding
Not applicable

Concurrent Session 12: Clinical Nutrition

Exploring the use of oral α-galactosidase to improve digestion of legume galacto-oligosaccharides in healthy individuals and patients with irritable bowel syndrome.

KE Kelly, JG Muir
Central Clinical School, Monash University, Prahran, Victoria

Background
Irritable bowel syndrome (IBS) is a major problem in Australian. Controlling the production of gas, generated from the bacterial fermentation of undigested short chain carbohydrates (FODMAPs) has become a major new diet therapy. The low FODMAP diet, however, presents a major challenge for an individual, who also follows a vegetarian diet. Vegetarians with IBS are required to restrict legume intake due to the high FODMAP galacto-oligosaccharide (GOS) content (legumes and nuts contain high levels of GOS). The use of oral α-galactosidase may offer a therapeutic approach to treating intolerance to the GOS present in legumes and so 'relax' the strict Low FODMAP diet for vegetarians with IBS.

Objective
Investigate the potential of 'enzyme therapy' using a commercially available α-galactosidase (GasX Prevention ™) to increase digestion of foods containing the FODMAP-GOS, and consequential improvement of IBS symptoms secondary to consumption.

Design
Using a randomised, double-blinded, placebo-controlled crossover study design. The efficacy of oral α-galatosidase (GasX Prevention ™) in 16 healthy individuals and 12 patients with IBS was tested. We provided one serve of legumes for 3 separate meals over one day. One capsule of α-galactosidase containing 600 GalU was used per meal. Changes in breath hydrogen production and gastrointestinal symptoms were monitored over a 12 hour period during the day. All food was provided to study participants.

Outcomes
Gas production was significantly reduced in both healthy volunteers (p=0.003) and patients with IBS (p=0.01). While there was a tendency for gastrointestinal symptoms to improve in the patients with IBS, this did not reach statistical significance.

Conclusion
The use of the oral α-galactosidase was found to significantly decrease breath hydrogen production, demonstrating improved digestion of GOS and consequentially decreased mal-absorption and fermentation in the large intestine. There was, however, no associated symptom improvement, questioning the clinical benefits of using this approach for IBS sufferers.

Source of funding
Not applicable.

Gluten causes depression in subjects with Non-Coeliac Gluten Sensitivity (NCGS)

SL Peters, JR Biesiekierski, G Yelland, PR Gibson , JG Muir
Central Clinical School, Monash University, Melbourne VIC Australia

Background
Gluten containing products are often blamed for contributing to abdominal symptoms, fatigue and depression, especially as the only condition proven to be due to gluten, coeliac disease (CD), is associated with these. There is another group who experience similar problems with gluten where CD has been excluded, so-called NCGS. However, NCGS is poorly studied and understood. A recent RCT found gluten induced greater gastrointestinal (GI) symptoms than placebo in NCGS patients. A subsequent study showed that many NCGS patients still had significant GI symptoms, but continued to follow a gluten-free diet (GFD) as they felt better.

Objective
To investigate whether a major effect of gluten in those with NCGS is on mental health and not GI symptoms.

Design
22 subjects with NCGS (mean age 45, SD 13, 5 male) undertook a double-blind, placebo-controlled, randomised rechallenge trial. Participants were provided with all food for each 3-day challenge followed by a minimum 3-day washout between each diet. Challenge food was supplemented with gluten 16 g/day or whey 16 g/day or not supplemented (placebo). End-points were GI symptoms, evaluated using a 10 cm visual analogue scale and the Spielberger State-Trait Personality Inventory (STPI). Endpoints were assessed prior to and on day 3 of each challenge period.

Outcomes
GI symptoms were induced similarly in each challenge (gluten [*M*=3.20, *SEM*=3.06], whey [*M*=6.18, *SEM*=3.68], placebo [*M*=6.90, SEM=3.10]; *p*=0.90; ANOVA Friedman). Gluten ingestion was associated with an increase in overall STPI 'state' depression score compared to whey (M=1.90, 95% CI [0.40, 3.40], *p*=0.02) and placebo (M=1.65, 95% CI [0.32, 2.99], *p*=0.02). Likewise, gluten (*p* <0.01) but not whey (*p*=0.73) or placebo (*p*=0.38) increased 'state' depression scores compared with baseline scores. No differences were found for other STPI' state' indices or for STPI 'trait' measures.

Conclusion
Gluten-specific induction of GI symptoms was not identified, possibly marked by large placebo responses. However, short-term exposure to gluten specifically induced current feelings of depression with no effect on other indices or on emotional disposition. Such findings might explain the basis for patients feeling better on GFD despite continuation of GI symptoms. Studies of longer duration and with more intense evaluation are warranted.

Source of funding
Study funded by NHMRC grant.