Plenary 4: Infant and Child Health

Omega-3 fatty acids and perinatal outcomes: balancing benefits and risks

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Background

The last few years have witnessed the emergence of a multitude of supplements for pregnant and lactating women with n-3 (or omega-3) fatty acids, predominantly as marine or fish oil. The main motivation behind these supplements appears to be the suggestion that an increased supply of docosahexaenoic acid (DHA, 22:6n-3), a key n-3 long chain polyunsaturated fatty acid (LCPUFA), during the last trimester of pregnancy and early postnatal life may enhance the development of the fetal and infant brain, clearly building on the extensive body of work relating to LCPUFA supplementation of infant formulas for term and preterm infants.

Objective

To determine whether additional dietary DHA is necessary to enhance neurodevelopment in early childhood using two large-scale randomised controlled trials, DINO (DHA for the Improvement of Neurodevelopment of preterm infants) and DOMInO (DHA to Optimise Mother Infant Outcome).

Design

In DINO, 657 preterm infants born <33 weeks' gestation were randomly allocated to receive a diet with 1% total fatty acids as DHA or a control diet with 0.3% of total fatty acids as DHA. The intervention aimed to deliver the DHA level that a fetus would accumulate during the third trimester of pregnancy and was achieved by supplementing women expressing breast milk for their infants as well as supplementing preterm infant formula to allow for breastfeeding, formula feeding and mixed feeding. Neurodevelopment was assessed at 18 months corrected age.

In DOMInO, 2399 women with singleton pregnancies were randomly allocated to receive either DHA-rich fish oil capsules providing 800mg of DHA/day or vegetable oil capsules with no DHA from 19 weeks' gestation until birth. Neurodevelopment was assessed when children were 18 months old.

Outcomes

DINO: Supplementation of with high-DHA in the preterm period resulted in a 30% reduction in preterm children with mild mental delay and a 50% reduction in preterm children with major mental delay at 18 months, although mean scores did not differ between groups. Pre-planned subgroup analyses indicated greater responsiveness of DHA treatment in infants born weighing <1250g and in girls. **DOMInO**: On the other hand supplementing with DHA during the equivalent time in utero did not result in significant improvements in cognitive scores overall or in boys or girls, although fewer children had delayed cognitive development. Similarly the overall language scores did not differ between groups but the language scores of girls were lower with DHA treatment and there were more girls in the DHA group with delayed language development.

Conclusion

Important subgroups of preterm infants will benefit from higher-dose DHA supplementation during the preterm period, while DHA supplementation during pregnancy provides little neurodevelopmental benefit to the off-spring.

Source of funding

NHMRC project grants 250322 and 349301.

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Plenary 4: Infant and Child Health

The Western Australian Pregnancy Cohort Study (Raine): A longitudinal observational study

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Background

The Western Australian Pregnancy Cohort Study (Raine Study) is a longitudinal observational study that commenced 20 years ago and recruited pregnant women. The cohort has been folllowed up at regular intervals with information on the children and parents collected on demographic, developmental, psychological, physical, biochemical, nutritional and many other factors.

Objective

This paper will summarise data collected on cardiovascular health and features of the metabolic syndrome in the children at eight years, and the adolescents at 14 and 17 years.

Design

The Raine Study recruited 2900 pregnant women at approximately 18 weeks of gestation. Women enrolled through the public antenatal clinic at King Edward Memorial Hospital and nearby private clinics in Perth, Western Australia from 1989 to 1991. The resultant 2868 live births have been followed up at 1, 2, 3, 5, 8, 10, 14 and 17 years of age. At each follow-up, questionnaire, clinical and biochemical information has been collected from the parents and the children.

Outcomes

Analyses of the children at 8 years of age determined perinatal and early children factors predisposing to cardiovascular disease, and features of the metabolic syndrome and Type 2 diabetes, including high blood pressure, abnormal lipids, abdominal obesity and insulin resistance. In a subset of 407 children in whom fasting blood samples were available, we used cluster analysis to distinguish children at highest risk of features of the metabolic syndrome. Cluster components included BMI, blood pressure, triglycerides, HDL-cholesterol and glucose. Analyses investigated the likelihood of being in 'high risk' cluster in relation to birth weight, postnatal weight and weight gain to 8 yrs, with adjustments for socioeconomic status, maternal diabetes and smoking. There were approximately 25% of children in the 'high risk' cluster. Children in the 'high risk' cluster had significantly higher BMI (19.2 $\pm$ 0.3 versus 16.0 $\pm$ 0.1 kg/m^2), weight (33.2 $\pm$ 0.6 versus 26.7 $\pm$ 0.2 kg, P<0.0001), fasting triglycerides, total cholesterol and blood pressure, and lower HDL-cholesterol compared with those in the 'low risk' cluster. There was a U shaped relationship between birth weight and risk of metabolic syndrome at 8 yrs., such that children in the 'high risk' cluster were more likely to be in the lowest or highest birth weight quintiles. Children in the 'high risk' cluster were more likely to be born of mothers who smoked during pregnancy, were breast fed for less than four months, and showed the greatest post natal weight gain from 1 to 8 years. These 'high risk' children also had elevated systolic blood pressure (SBP) (110.6 $\pm$ 0.9 versus 103.1 $\pm$ 0.4 mmHg, P<0.0001) and they already showed significantly higher SBP at 1 year (102.4 $\pm$ 1.2 versus 97.9 $\pm$ 0.7, P=0.019) and increased weight at 3 years.

At 14 years of age, 629 girls and 664 boys with biochemical and clinical data were assessed. Cluster analyses included gender, BMI, SBP, triglycerides and HOMA, with adjustments for age, socio-economic status, puberty, kilocalories/day and exercise. Approximately 29% of the adolescents were in the 'high risk' cluster. Those adolescents in the 'high risk' cluster had higher BMI, waist circumference, triglycerides, SBP, HOMA and lower HDL-cholesterol. The 'high risk' cluster associated with increased C-reactive protein (an inflammatory marker that has also been associated with cardiovascular endpoints particularly in Type 2 diabetes), gamma glutamyl transferase (GGT, a marker of oxidative stress), alanine aminotransferase (ALT) and uric acid. GGT and ALT both associate with increased risk of Type 2 diabetes; uric acid is associated with hypertension, cardiovascular risk and mortality.

Preliminary data from the 17 year cohort of 1248 adolescents will also be presented.

Conclusion

Our data show that a high proportion of children as young as 8 years are at increased risk of developing a metabolic syndrome-like phenotype. A number of perinatal factors and early weight gain appear most important. The trend persists at 14 years of age. These adolescents show features of the metabolic syndrome accompanied by increased levels of a range of inflammatory markers. To a large degree, our data show that preventing childhood obesity will have a significant impact on subsequent adult cardiovascular disease.

The Raine Study is a unique study in providing information that allows a better understanding of how events during pregnancy, as well as childhood and adolescence affect later cardiovascular health.

Source of funding and acknowledgements

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Plenary 5: Adapting Food Production Systems in a Changing Global Environment

Nutritious, sustainable and equitable food systems – can Australia demonstrate how to do it within a global framework?

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Introduction

Nutritious, safe, affordable and enjoyable food is vital for physical and mental human health. Unfortunately, the world faces high levels of food and nutrition insecurity and diet-related health risks.

This paper discusses the interface between food systems, climate change and food and nutrition security. The paper highlights the key issues that must be addressed if Australia is to ensure a nutritious, sustainable and equally accessible food supply, in the context of a changing climate and an increasingly globalised world.

How food systems affect food and nutrition security

The nature of global and domestic food systems - from the underlying conditions of governance and trade, issues of agricultural production, food processing, procurement and distribution, consumer price of food, marketing of foods and food waste – affects food security, diet and related health risks and benefits through matters of food yields and availability, nutritional quality and safety, affordability and desirability/acceptability.

Modern day globalisation has seen the increasing global integration of agricultural production and food distribution systems. Three important changes in the global food system - liberalization of international food trade and foreign direct investment; the growth of transnational food companies, including the growth of transnational supermarkets, and global food advertising and promotion – each affect diet by altering the availability, prices and desirability/acceptability of food.

In the last decade there have been significant changes in the make up of Australia's food supply. Australia's substantial food trade surplus decreased slightly and imports doubled to around $9 billion in 2007-08. Dominant contributors to the import increase were processed foods, dairy products, beverages and fruit and vegetables. Reduced grain and dairy exports explained most of the decline in exports. Supermarkets can be very influential on eating habits and nutrition security through the products they choose to sell, retail price, and the labelling and promotion of particular goods. Australia now has one of the most concentrated retail sectors in the developed world, with two supermarkets having a combined retail market share of around eighty percent. Using global vertical supply chains, these two supermarkets not only exert a major influence on Australian food and nutrition security but also influence food production and associated livelihoods in some developing countries.

The added pressure of climate change on food systems and food security

There is growing recognition of the additional stress on food and nutrition insecurity presented by climate change.

The drought-prone and long-term drying conditions in Australia and in other subtropical regions around the world, higher temperatures, rising sea levels, increasing frequency of flooding, and acidification of oceans are contributing to impaired yield, quality and affordability of food in many countries.

The Australian food system is almost self-sufficient in terms of nutritious plant foods, although these foods have seen steady higher price increases relative to other foods, with nutrition equity implications. Usually one of the world's largest grain exporters, severe drought in the last decade has lead to two years (2001-02 and 2007-08) of net grain importing. Fresh food such as fruit and vegetables are produced and distributed largely domestically. Between 2005 and 2007, the price of vegetables was estimated to have increased by 33% and fruit by 43% due to the impact of drought on availability.

Food systems' contribution to climate change

There is a bi-directional relationship between climate change and food systems. All stages in the food system produce greenhouse gases (GHGs) and therefore contribute to climate change.

Farm-stage GHG emissions account for approximately 50% of all food sector emissions. These include nitrous oxide from soil and livestock processes, and methane from ruminant digestion and anaerobic fermentation of soil especially in rice cultivation. Carbon dioxide emissions arise from agriculturally induced land use change and on-farm fossil fuel use. According to calculations by the Intergovernmental Panel on Climate Change, agriculture along with the associated deforestation and land use changes account for about 29% of global emissions. In Australia, 16% of the total 541.2 million metric tonne carbon dioxide equivalent emitted in 2007 came from the agriculture sector (this figure excludes agriculture-associated land use change greenhouse gas emissions).

Post-farm, the bulk of emissions from foodstuffs are attributable to fossil fuel use in their processing, transportation, retail, refrigeration and cooking.

Implications for global and domestic

Ensuring a nutritious, sustainable and equally accessible food supply and dietary intake, globally and domestically, is a complex challenge in a changing climate and a world of globally integrated food production systems, vertical food supply chains and increasing demand among consumers in economically transitioning countries for foods that are resource intensive and have high GHG emissions. The policy implications cut across trade, agriculture, health, social and planning sectors. An evidence base is needed to inform how coherence between each of these sectors can provide a situation that is good for population health, good for the environment and good for the economy.

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Plenary 5: Adapting Food Production Systems in a Changing Global Environment

Adapting livestock production systems in a changing global environment

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Background

The global environmental faces two major changes: firstly the consequences of an increasing human population project to peak at approximately 9 billion by 2050 and secondly a global warming trend since the 1980s, most likely (>95%) due to anthropogenic increases in greenhouse gases from fossil fuels and food production systems. To feed a population of 9 billion would require a doubling of food supply, mainly through cereal grains, by 2050. To stabilise the warming trend to about 2°C average increase would require a 60% reduction in greenhouse gases (GHG) measured as carbon dioxide equivalents (CO_{2e}) by 2050 (relative to 2000 base data for CO_{2e}). Agriculture accounts for 15.9% of Australia's 2008 GHG emissions with the majority from animal production particularly red meat and dairy products.

Objective

This paper proposes that red meat production based predominantly on grazing is sustainable in Australia. Moreover, the Australian grazing system can preserve biodiversity while meeting global demand for animal protein, particularly red meat. Red meat remains one the most nutritionally available and sustainable sources of protein, iron, zinc and omega-3 fatty acids in human diets. Methane is the major source of GHG emissions from ruminant digestive physiology. Reducing methane production can be achieved by either reducing the number of ruminants or exploring other electron sink products as alternatives to methane in the hydrogen economy of the rumen microbial ecology or combinations of both.

Outcomes

While some have proposed that reducing or eliminating red meat from the diet would not only help to improve public health but also reduce its impact of global warming, this has not fully reckoned with the nutritional physiology of ruminants that allows them to occupy ecological niches that cannot be used for cropping. GCMs predict that the north of Australia will be less affected by climate change than the south. Thus the Australian beef industry could be further concentrated in pastoral northern regions. Moreover, medium grazing intensities have been consistent with conservation of biodiversity in these pastoral areas.

Conclusion

The growing impact of climate change will necessitate difficult and timely choices at both an enterprise level and through government policy if the livestock industries are to remain sustainable. Nevertheless, meat production, including red meat, is the most palatable way for the world to meet future demand for high quality protein and other essential nutrients

Plenary 5: Adapting Food Production Systems in a Changing Global Environment

Climate change impacts on animal and human nutrition

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Background

Climate change impacts are expected to be felt on a wide range of agricultural production systems with the potential for downstream effects through the food supply chain. Both temporal and spatial impacts are likely, which will affect not only quantity of food but also the quality of food supply. Current research indicates that mid-latitude regions will be affected first and with potentially significant effects on food supply. A worst case scenario of 2-4^{0}C temperature rise and 30% reductions in rainfall during the growing season in these latitudes over the next century will have major effects on animal and human nutrition.

Outcomes

Numerous studies have been conducted to estimate the impact of changed temperature and rainfall profiles on agricultural productivity. Many of these focus on the major crops, wheat, rice, corn and soybeans. Increasingly many take into consideration rising CO2 levels as an offsetting component to the other climate effects. These studies, usually using downscaled climate simulations from Global Circulation Models and crop simulation models, allow for estimates in the changed yield of crops.

While it is often expected that production changes from climate change are negative there are regions within some environments which are favoured by climate change. Analysis of wheat production in Western Australia for a simulated climate at 2030-2050 shows yield at up to 15% below current levels at most locations, but with yield increases to 15% in the parts of the higher rainfall zone as winter waterlogging is alleviated.

Global production of the major crops is expected to be maintained at least through the next 30 years so long as climate change is slow and does not have tipping points where climate is quickly transitioned from one state to another. The offsetting effects of CO2 rises can counter the temperature and rainfall deficits for some time, while warmer conditions in northern hemisphere countries may lead to expansion of grain production in areas now considered too cold for crop growth.

The frequency of climate events is also indicated to change. CSIRO modeling for Australia indicates that the frequency of drought and high temperature will both increase strongly. Both types of event will impact on production through altered plant available water with more seasons having longer periods between rain events. For grazing animals this is expected to reduce both quality and quantity of food and leading to longer foraging times. Higher temperatures during the day will result in more resting periods and higher demand for water. Higher temperatures will result in increased algae growth in dams which may be detrimental to livestock health.

For many communities the potential for extreme events is of major concern. Events such as flooding, tropical cyclones and extended heat waves all have major impacts on nutrition through food availability. In some cases the extreme events disrupt income earning ability which reduces disposable income necessary for food purchase, while in others the effect of a single event may prevent food production for another 12 months.

Horticultural production is threatened with slightly different problems in that for some crops the amount for cold to achieve flowering and bud burst will be reduced, while the requirement for irrigation water may be difficult to achieve in some climate change scenarios. Re-location of horticultural industries to more favourable climatic regions comes at a significant cost if irrigation infrastructure must be built. Yet without this change the availability of fresh food may be limited with an increasing requirement for humans to use preserved food.

Food quality can be affected in different ways with climate change. Higher temperatures leading to faster spoilage is an obvious example, while in production system these same temperature increases exacerbate sunburn in fruit crops and leaf damage in many vegetable crops. The cooler temperatures required for high quality white wine production may be difficult to achieve in the current vineyard locations as summer temperatures increase.

While the effects of climate change might be regional in nature the global nature of food supply chains means that global effects can be rapid and large. A single weather event in a key grain producing region has global impacts on supply, and flow on effects to the price of food in countries dependent on imported food. The food riots of 2008 in many parts of the world as prices rose rapidly were in large part due to weather related production impacts in a few key rice and wheat growing countries. We have already seen in 2010 Russia banning exports of wheat as its crop is devastated by drought. Prices have risen quickly in response, though a global 190 million tonne stockpile of wheat helps offset these price effects.

Global planning that ensures sufficient food reserves are available for key foodstuffs may become a greater requirement as population continues to grow, often in areas at greatest risk from the worst impacts of climate change.

Conclusion

Climate change will bring about change to the availability and quality of food. Adaptation planning to minimise the worst effects of such change should be implemented early if we are to plan where future food production is to occur. For Australia a national approach to food supply and quality is warranted which links all components of the supply chain from growers, researchers, food manufacturers, retailers and consumers so as to minimise the impacts on nutrition.