Scientific Consensus Workshop

Omega-3 fatty acids for Baby Boomers

October 2008

Based on deliberations held on 10 July 2008
CSIRO Food Futures National Research Flagship
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Abbreviations

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<tr>
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<tr>
<td>AA</td>
<td>arachidonic acid 20:4 (long chain omega-6)</td>
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<tr>
<td>AI</td>
<td>Adequate Intake</td>
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<td>ALA</td>
<td>alpha-linolenic acid 18:3 (omega-3)</td>
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<tr>
<td>CVD</td>
<td>cardiovascular disease</td>
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<tr>
<td>DHA</td>
<td>docosahexaenoic acid 22:6 (long chain omega-3)</td>
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<td>DPA</td>
<td>docosapentaenoic acid 22:5 (long chain omega-3)</td>
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<tr>
<td>EPA</td>
<td>eicosapentaenoic acid 20:5 (long chain omega-3)</td>
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<td>GLA</td>
<td>gamma-linolenic acid 18:3 (omega-6)</td>
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<tr>
<td>NHMRC</td>
<td>National Health &amp; Medical Research Council</td>
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<td>NSAIDS</td>
<td>non-steroidal anti-inflammatory drugs</td>
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<td>Omega-3</td>
<td>omega-3 polyunsaturated fatty acids</td>
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<td>Omega-6</td>
<td>omega-6 polyunsaturated fatty acids</td>
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<td>PUFA</td>
<td>polyunsaturated fatty acids</td>
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<td>SDT</td>
<td>Suggested Dietary Target</td>
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Recommendations

Omega-3 intakes for Baby Boomers (born 1946-65)

1. Long chain omega-3s are important for overall health; however Baby Boomers do not regularly consume optimal amounts.

2. Long chain omega-3s play a major role in heart health and the prevention and management of cardiovascular disease (CVD), the management of rheumatoid arthritis and chronic pain management.

3. The Omega-3 Centre should support The National Health and Medical Research Council (NHMRC) Suggested Dietary Targets of 430mg/day and 610mg/day of EPA, DPA and DHA for females and males over 14 years. The Suggested Dietary Targets are similar to recent recommendations from the National Heart Foundation of Australia (NHFA), which the Omega-3 Centre should endorse. The recommendations for adult intakes in the NHFA Position Statement Fish, fish oils and omega-3 polyunsaturated fatty acids (2008) includes 500mg daily of DHA and EPA to lower risk of CVD.

4. The Adequate Intakes (AI) for long chain omega-3s in Australia and NZ are based on population median values of intakes. These levels reflect the current low intakes of long chain omega-3s in the Australian population.

4.1. Population median values are not appropriate as a basis for Adequate Intake recommendations where the population consumes low levels of long chain omega-3s and has a high incidence of chronic disease and other disorders associated with these low intake levels.

4.1.1. For example: CVD affects more than 3.5 million Australians and prevents 1.4 million people from living a full life because of disability caused by the disease.

4.2. The National Nutrition Survey (ABS 1999) indicates that the population consumes little fish which is reflected in the low median intakes of long chain omega-3s.

5. Public health recommendations for Baby Boomers should refer to dietary sources of long chain omega-3s including oily fish, other fish and seafood, and enriched foods. There are specific circumstances when supplements of long chain omega-3s are required. Advice by a health professional is recommended.

6. The Omega-3 Centre should develop a comprehensive strategy with key individuals and organisations to help progress the Omega-3 Index as a useful tool in clinical practice.

7. Calls to action for baby boomers:

7.1. Healthy Baby Boomers should ensure an intake of long chain omega-3s of at least 500mg/day from 2 or more serves of oily fish per week, foods enriched with long chain omega-3s and/or dietary supplements of fish oil within the context of an energy-balanced diet.

7.2. People with disease conditions such as rheumatoid arthritis and cardiovascular disease may benefit from higher levels of long chain omega-3s and should seek medical advice.

7.2.1. Around 3g EPA and DHA /day are recommended for assistance with analgesic relief in rheumatoid arthritis.

7.2.2. At least 1g EPA and DHA /day are recommended for existing cardiovascular disease.

7.2.3. 1.2 - 4g EPA + DHA (or DHA alone) has been shown to be effective for treatment of high blood triglycerides and is recommended by the NHFA.

7.2.4. High intakes of long chain omega-3s are likely to require dietary supplements of fish oil or algal oil.

8. There is a need for clear communications on omega-3s as an essential nutrient for optimal health which is in short supply in the diet of many adults.

Communication to health professionals

9. Inform health professionals of:

9.1. New NHFA recommendations for prevention and management of CVD with long chain omega-3s

9.2. Recommended intakes of long chain omega-3s for rheumatoid arthritis

9.3. The medicinal use of fish oil as an alternative to non-steroidal anti-inflammatory drugs (NSAIDS), for chronic rheumatoid arthritis pain, and the lack of negative effects of fish oil at analgesic doses (3 to 4g EPA+DHA per day, equivalent to 10 to 15ml standard fish oil) . It is important to note a delay in onset of analgesic effect of fish oil of up to three months. Fish oil alone may not be adequate treatment for arthritis and other painful conditions and medical oversight will often be warranted.
9.4. Apart from rare case reports of prolongation of INR (blood clotting measure) in patients on warfarin, there are no medications with significant interactions with omega-3 supplements.

9.5. Gastro-intestinal side effects of large doses of fish oil such as burping are usually alleviated by taking the fish oil with food or using frozen capsules.

10. The Omega-3 Centre should work with health professionals to determine a strategy for the understanding, acceptance and support of The Omega-3 Index.

11. Both consumers and health professionals need to know the difference between ALA and EPA, DPA and DHA and that current evidence indicates that the long chain omega-3s are more effective in improving omega-3 status.

12. Clear recommendations providing information on dietary sources of long chain omega-3s are required. Specific information on amount and type of appropriate food sources, including fish varieties is also required.

**Government and policy makers**

13. The Omega-3 Centre endorses use of the Suggested Dietary Targets for optimal intakes of long chain omega-3s.

14. The Omega-3 Centre questions the value of Adequate Intakes recommendations for long chain omega-3s.

15. The Omega-3 Index is developing into a useful tool for assessing risk of cardiovascular disease. The promotion of such a biomarker will assist in driving changes to eating habits and health professional advice. Government and policy makers need to be part of the process to develop a strategy for its acceptance and support with a view towards Medicare coverage.

16. There is sufficient evidence for Food Standards Australia New Zealand to permit health claims on foods containing long chain omega-3s in the proposed Nutrition, health and related claims standard.

17. There is a key role for government:

17.1. To revise nutrition policy to take account of the key role of long chain omega-3s in health and also in disease prevention and management in adults.

17.2. To provide appropriate dietary advice as part of overall diet and nutrition communications to encourage adults to have an optimal intake of long chain omega-3s.

17.3. To fund appropriate studies as outlined in Research Recommendations below.

17.4. To ensure that food choices available in government institutions supply adequate long chain omega-3s.

18. Messages to government:

18.1. The Suggested Dietary Targets for long chain omega-3s provide useful guidance for daily intakes and are consistent with recommendations from other authorities such as the NHFA (2008). The SDTs should be used in determining policy on food and nutrition. The levels set for Adequate Intakes of long chain omega-3s for adults are unhelpful.

18.2. We recommend that based on current knowledge, it would be helpful for a cost benefit analysis be undertaken to assess the potential contribution of an optimal intake of long chain omega-3s on health status and healthcare costs.

**Research recommendations**

**Intakes and status**

19. In the context of low apparent dietary intakes of long chain omega-3s in Australia and New Zealand, there is an urgent need for a National Food and Nutrition Survey to assess dietary intakes and status (red blood cell levels) of long chain omega-3s. Such a survey should be conducted at regular 5 yearly intervals. There is an indication from The Blue Mountains Eye Study that fish consumption is increasing among a cohort of older Australians, principally through greater intake of canned fish.

20. The development and validation of a simplified food frequency questionnaire (FFQ) to assess long chain omega-3 intake for use in clinical practice and health promotion.

21. Dietary patterns research to determine food and supplement sources of omega-3s and impact of food fortification.

22. Studies on the comparative effects of food sources and supplements and in the context of various background diets.

23. Input to future studies to examine evidence for links between intakes of long chain omega-3s, omega-3 status and disease risk.

24. Integrated studies of environment and food supply with respect to delivering required amounts to populations.
Research recommendations (continued)

Roles of omega-3s

25. Research on the roles of individual long chain omega-3s (EPA, DHA and DPA) to help elucidate their mechanisms of action in the body. DPA in particular needs further research on its roles in the body.

26. Further research on the roles and mechanisms of action of omega-3s in mental health as current evidence is of interest but still preliminary.

26.1. Animal studies reveal that the brain and retina hold onto DHA in situations of frank omega-3 deficiency.

26.2. Heterogeneity of tests in cognition studies makes it difficult to compare studies and accrue the findings.

27. Further research on visual benefits of omega-3s is recommended as epidemiological evidence is supportive but intervention trials are needed.

National database

28. The establishment of a system of monitoring red blood cell omega-3 levels in adults in Australia and New Zealand with a view to setting up national databases of this information.

Food analyses

29. Standardisation and harmonisation of the analytical procedures for measuring long chain omega-3s in foods.

Cost benefit analyses

30. There is a need for an assessment of healthcare costs linked to omega-3 related disorders – this is linked to recommendation 18.2.

Consumer research

31. Identification of barriers causing Baby Boomers’ resistance to enriched foods and dietary supplements providing long chain omega-3s.

32. Understanding the impact of the shift to cheaper foods and brands by Baby Boomers on omega-3 status.
A message from

Nu-Mega Ingredients

Welcome to your personnel edition of the outcomes from the Omega-3 Centre Scientific Consensus Workshop on Omega-3s for Baby Boomers.

This publication is provided to increase the awareness of nutritionists, health professionals and those involved in the food industry with the physiological importance of Omega-3 long chain fatty acids, such as DHA and EPA, and how they may assist in helping to address the many health issues that can arise as we age.

It is well documented that the intakes of Omega-3s by Baby Boomers are less than the amounts recommended. Therefore it is important to provide ways in which these important dietary lipids can be increased either through the diet or via supplements.

Nu-Mega Ingredients Pty Ltd is a world class manufacturer and supplier of Omega-3 DHA ingredients for use in foods, supplements and pharmaceuticals. Our products begin with tuna sourced from the pristine waters of the South Pacific, using only dolphin-safe fishing methods. The tuna oil, which is highly refined and deodorised in Australia, is used in many applications.

Enriching foods with Omega-3s is one important way to increase the consumption of Omega-3 DHA and EPA. However this can be very challenging. Nu-Mega offers a range of patented microencapsulation systems to stabilise and protect the tuna oil and other oils in powdered form. These powders, combined with Nu-Mega’s extensive technical knowledge and applications experience, allow our dedicated staff to assist manufacturers in developing Omega-3 DHA fortified foods.

Nu-Mega hopes that you find this information helpful in appreciating the importance of Omega-3s to Baby Boomers and for further information please contact us via our website www.nu-mega.com or call +61 (3) 8369 2100.

The New Zealand King Salmon Co Ltd

The New Zealand King Salmon Co Ltd is in the top 50 producers of farmed salmon in the world, harvesting approximately 6000 metric tonne (mt) per annum. However, we are a very small producer by world standards where production is over 1.5 million tonnes. To achieve success, we monitor and protect the disease free purity of the waters in which we rear our salmon—being the pristine waters of the Marlborough Sounds in New Zealand. This ensures we can deliver a safe, tasty and nutritious product. Innovation and flexibility are the other keys to our success, allowing us to deliver salmon with good value for money, quickly and according to our customers’ specific needs. We market salmon not only under New Zealand King Salmon brand but also with Regal, Seasmoke and the Southern Ocean brands.

To guarantee quality and reliability we must own and control every single stage of production with demonstrated traceability. The company is totally integrated and has full management of production and quality from the hatchery through to the market. Such control is our customer’s reassurance of the quality, reliability and dependability of our New Zealand King Salmon.

For further information contact us via our website www.kingsalmon.co.nz or call NZ 0800 725666 or Australia Phone: +61 2 9620 6200

Martek Biosciences Corporation

Martek Biosciences Corporation is a leader in the innovation and development of DHA omega-3 products that promote health and wellness through every stage of life. The company produces life’sDHA, a sustainable and vegetarian source of the omega-3 fatty acid DHA (docosahexaenoic acid), for use in foods, beverages, infant formula, and supplements. Fish are often thought to be the only source of DHA omega-3. However, life’sDHA offers a trusted, vegetarian form of DHA that contains no oceanic pollutants and toxins. Fish are good sources of DHA because of the DHA-rich microalgae in their food chain; life’sDHA is derived from microalgae and produced in an FDA-inspected facility from start to finish using a sustainable source that does not deplete ocean resources. life’sDHA is found in numerous foods, beverage and supplements for people of all ages. It is also the only source of DHA used in U.S. infant formula and is available in more than 95 percent of the formulas on the U.S. market. The company also produces life’sARA™ (arachidonic acid), an omega-6 fatty acid, from a sustainable, vegetarian source, for use in infant formula. For more information on Martek Biosciences Corporation, visit www.martek.com. For a complete list of products containing life’sDHA, visit www.lifesdha.com.
Introduction

This is the second Scientific Consensus Meeting convened by The Omega-3 Centre and it was held at the CSIRO Food Futures National Research Flagship in Sydney on 10 July 2008. The format of consensus meeting was a facilitated discussion between the nine expert participants, who each presented current evidence in their area of expertise.

The Centre’s objective was to produce a scientific consensus paper on omega-3s and Baby Boomers based on the Workshop’s outcomes to help raise community and government awareness and understanding of this key nutritional issue for the health of Baby Boomers. The aim is to encourage a supportive environment for optimal intake of long chain omega-3 fatty acids by this population group.

There is increasing scientific evidence for the role of long chain omega-3s in the prevention of chronic diseases as well as health maintenance. As the large population group, known as the Baby Boomers, ages the incidence of chronic diseases is expected to increase. The Centre identified a need to better understand the strength of evidence for omega-3s’ health benefits for Baby Boomers.

Recommendations for intakes of omega-3s were released by the NHMRC in 2006. The Workshop participants were asked to consider how these recommendations relate to actual intakes. Fish is the major source of long chain omega-3s yet dietary studies indicate that many people consume very little fish and seafood.

Government nutrition policy currently pays scant attention to the need for long chain omega-3 fatty acids in the health of Australians. There is a need to understand the role of omega-3s in Baby Boomers’ health and ensure recommendations and advice on omega-3s are communicated effectively to improve their intakes.

The first Scientific Consensus Meeting was held in April 2007 and focused on omega-3s for children. Copies of this report are available from The Omega-3 Centre.

Omega-3 Centre

The Omega-3 Centre Inc was established in 2006 and is dedicated to improving the health status of Australians and New Zealanders by:

- Effectively communicating the health benefits of omega-3s and where to find them
- De-mystifying omega-3s by translating the scientific evidence for these important nutrients
- Identifying barriers to optimal intakes of omega-3s and helping to address solutions
- Working with regulators and scientists to encourage a conducive environment for communications on omega-3s
- Differentiating between different types of omega-3s with a focus on the long chain omega-3s (EPA and DHA) which are of most potential benefit
- Facilitating and promoting research and development in this area
- Ensuring that sound science underpins all communications from the Centre
Who are Baby Boomers and what are their omega-3 requirements?

An introduction to the baby boomer generation

Dr Wendy Hunter, Deakin University

The ‘baby boomer generation’ is a term given to those born from 1946 to 1965, as a result of a lengthy period of high birth rates after the end of World War II. Approximately 24% of the population are Baby Boomers and it is projected that this will increase to 26% in 2021 (Australian Bureau of Statistics 2004).

What do we know?

This ‘generation’ differs from previous generations in a number of ways. Baby Boomers have experienced more social change than previous generations and it is likely that these experiences will have bearing on their future needs and expectations, some of these include more opportunities to attain education and to travel, greater access to technology and from that constant exposure to marketing via various forms of media (Quine et al 2006).

Family structures have also changed. For previous generations, divorce was expensive and difficult to obtain, however in the mid-1960s, no fault divorce was introduced in Australia, which saw a sharp increase in the number of divorces. Many of those who were divorced in the 1960s to 1980s were in the Baby Boomer generation. Some lose contact with children from a previous marriage and even when relationships are maintained, many of the Baby Boomers not only live in different cities to their children but sometimes in different countries, thus they may require greater provision of formal support, services and resources as they age and become increasingly dependent (de Vaus et al 2007). The effect of divorce can also influence personal wealth and have a negative impact on the financial security of the parties involved (de Vaus et al 2007).

Improvements in public health and social welfare over the past 40-50 years have had considerable benefits including increasing the longevity of the population in Australia and providing a basic level of support to provide for individuals needs. Baby Boomers were one of the first generations to reap the reward of welfare reform and this may have led to Baby Boomers forming a belief that they would be ‘looked after’ in old age (Quine et al 2006).

Financial security will influence Baby Boomers ability to lead healthy, active lives, purchase healthy food and to seek out appropriate support and resources when needed. Although they are the first generation who have benefited from a compulsory contribution to superannuation, these schemes were only widely introduced in the early 1990s and the financial support offered from these schemes depends on the length of time the person has contributed, the amount they have contributed and the type of scheme, therefore there will be some, for example new migrants or women who left the workforce to raise children, who will retire with minimal private income from superannuation and will depend on the state pension (Quine 2006). Lack of sufficient finances to support retirement, imposed changes to routine and a sense of loss of self-worth are important factors that have been recognised by Baby Boomers in a recent Victorian study (Hunter et al 2007).

According to the Australian Institute of Health and Welfare (AIHW) Australians have one of the highest life expectancies in the world with average life expectancies for Baby Boomers around 75 years for males and 80 years for women (AIHW 2008). However along with increased longevity is an increase in the incidence of chronic diseases amongst this age group, many of which are diet-related such as obesity, Type 2 diabetes, osteoporosis, cancer, cardiovascular diseases (CVD) and arthritis.

Figure 1: Good news and bad news

✓ Death rates from heart, stroke and vascular diseases are falling;
✓ 21% and 16% fall in smoking rates for males and females over the last decade;
✓ 50% fall in the prevalence of high blood pressure since the 1980s; and
✓ 25% fall in the incidence of coronary events over the last decade.

✗ The prevalence of obesity has doubled over the last 20 years;
✗ the prevalence of diabetes has doubled over the last 20 years;
✗ the prevalence of people doing insufficient physical activity for health benefits increased by 10% between 1997 and 2000; and
✗ the prevalence of high blood cholesterol has not fallen over the last 20 years.

From: AIHW 2004, NHFA 2004
In Australia, in 2001 54% of people aged 45-54 were overweight or obese (Quine et al 2006). Approximately 12% of people aged 45-64 reported having diabetes (AIHW 2008) and according to the Australian Bureau of Statistics (ABS), in 2002-04 around 20% of people aged 50 years and over died from ischaemic heart disease, and 10% died from strokes. During the same period, around 29% of people in this age group died from cancer. Cancer of the prostate, colon and breast are the most common diet-related cancers found in Australia (ABS 2006). It is estimated that up to 40% of cancer can be prevented by consuming a healthy diet. Both osteoarthritis and rheumatoid arthritis become more evident in middle age. In 2004-05 it was estimated that osteoarthritis affected over 1.5 million people in Australia, whilst the current prevalence of rheumatoid arthritis is around 1 in 100 persons. Not only do these conditions have detrimental effects on individual’s ability to perform daily activities and quality of life, they also substantially contribute to health care costs (AIHW 2008).

What don’t we know?

There are many questions still to be addressed regarding the future health needs of Baby Boomers.

There is an assumption by Baby Boomers that they have a sound knowledge of food and nutrition, however, there is little evidence to support this, particularly with the changing nutritional needs associated with ageing. Furthermore little is known about Baby Boomers skills and interests in food purchasing and preparation nor their current dietary practices. Currently a study looking at these issues is being conducted across Victoria by the author and her collaborators – see Figure 2.

Existing data on dietary intakes for this age group is based on the NHMRC 1995 National Nutrition Survey and needs to be updated. A new survey is due to be undertaken in the near future and if these surveys were to be conducted more frequently, this would enable us to monitor changes in food consumption behaviours.

Translating knowledge into action is difficult to achieve. Once sufficient evidence has been gathered from Baby Boomers on their dietary habits, food planning, shopping and preparation skills, their attitudes to food and so on, ways of changing established food behaviours to avoid diet-related disease need to be determined.

What should we know?

Along with the updated national data on dietary intake and nutritional status of Baby Boomers obtained from self-reported surveys, objective measures of nutritional status are required. Dietary variety and dietary quality should also be measured.

There needs to be a greater understanding of what Baby Boomers want in future and what they are prepared to do to achieve their plans and expectations. Furthermore we need to anticipate the effect that ethnic and cultural diversity will have on future food services and products including the acceptance and use of supplementation and fortified foods by this age group. In addition, it is important that we develop an awareness of the effects of divorce and other social changes on behaviour when trying to move from evidence to action on health issues.

Recommendations

More longitudinal and intervention studies are needed:

- What will trigger a change in behaviour for those Baby Boomers at risk of developing diet-related diseases?
- Nutrition education programs designed specifically for Baby Boomers.
- Feasibility studies for new products and services.

In particular social and cultural factors and the influence of social change need to be taken into consideration when trying to address the challenges of changing health behaviours. Ultimately, our goal should be to enhance people’s enjoyment of life as they age; being able to access food that they enjoy eating but that will support healthy ageing is one way to achieve this.
References


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NHFA (Cardiovascular Disease Series No. 22), 2004 accessed from www.heartfoundation.com.au

Australia and New Zealand are currently leading the world in having clear recommended intakes for omega-3s which include Adequate Intakes (AI), Upper Levels of Intake (UL) and Suggested Dietary Targets (SDT) for different age groups and genders (NHMRC 2006). Unfortunately few Australians and New Zealanders consume optimal intakes of long chain omega-3s because rich sources such as oily fish are consumed infrequently.

**Recommendations for intake**

In the revision of nutrient reference values in Australia and New Zealand endorsed by the NHMRC (2006), the essential roles of DHA and EPA were recognised and included:

- DHA's important role as a structural membrane lipid, particularly in nerve tissue and the retina;
- DHA as a precursor of certain eicosanoids;
- EPA as a precursor of the 3 series of prostaglandins and the 5 series of leukotrienes;
- Cardiovascular benefits of long chain omega-3s;
- Anti-inflammatory benefits of long chain omega-3s; and
- Suggested role of DHA as the primary mediator of cardiovascular benefits influencing gene expression of key metabolic regulators, particularly in endothelial cells.

Note that DPA is included in the recommendations for long chain omega-3s despite the lack of understanding of its role and extent of interconversion with EPA and DHA.

The AIs were based on the median intakes assessed in the National Nutrition Survey of Australia (Howe *et al* 2006).

The US Food and Drug Administration has set a ‘Generally Regarded as Safe’ level of 3,000mg/d for long chain omega-3s (DHHS 1997) and this was used as the basis of the Australian and New Zealand ULs.

The concept of SDTs is new for Australian and New Zealand nutrient reference values. They aim to set a level at which diets are optimised to help lower chronic disease risk as opposed to the AIs and RDIs which are determined on the basis of providing sustenance and avoidance of deficiency disease.

The SDTs for long chain omega-3s are based on the 90th centile of intake (NHMRC 2006) as this would seem to provide potential benefit whilst being a safe level. These levels are consistent with the NHMRC Dietary Guidelines for Australians (NHMRC 2003) which recommend increasing the intake of long chain omega-3s to around 400 mg/d and the National Heart Foundation of Australia advice (NHFA 2008) to consume about 500 mg/d of combined DHA and EPA through a combination of the following:

- two or three serves (150 g serve) of oily fish per week
- fish oil capsules or liquid
- food and drinks enriched with marine omega-3s.

| Table 1: Nutrient Reference Values for omega-3s for adults (mg/d) |
|-----------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Age | Gender | ALA AI | Total long chain omega-3s (DHA+DPA+EPA) UL | AI | SDT | UL |
| 31-50 y | men | 800 | 160 | 610 | 3,000 |
| women | 800 | 90 | 430 | 3,000 |
| 51 – 70 y | men | 800 | 160 | 610 | 3,000 |
| women | 800 | 90 | 430 | 3,000 |
| > 70 y | men | 800 | 160 | 610 | 3,000 |
| women | 800 | 90 | 430 | 3,000 |

NP – not possible to set

From: NHMRC 2006
Intakes of long chain omega-3s

The most recent national survey of dietary intakes in Australia was in 1995 (ABS 1999) and Table 2 indicates adults’ mean intakes of omega-3s at that time.

Kris-Etherton et al (2000) indicated that in the United States the average intake of EPA and DHA is between 100 and 200 mg/d requiring a four-fold increase in fish consumption to meet recommendations for intake.

The average intake of long chain omega-3s in the United Kingdom has been estimated to be 120 mg for men based on The Dietary and Nutritional Survey of British Adults in 1990 according to Baldwin et al (2004). The 1994 report of the Committee on Medical Aspects of Food Policy entitled Nutritional Aspects of Cardiovascular Disease estimated that average intake of long chain omega-3s in the UK was about 100mg per person per day (UK Department of Health 1994).

Skewed distribution of intake of DHA and EPA

An analysis of the 1995 National Nutrition Survey in Australia by Howe et al (2006) indicates that the median intakes of PUFA were approximately 80% of the corresponding mean intake values. The exceptions are the long chain omega-3s where the median value of 121 mg/d was approximately 50% of the mean value of 246 mg/d. This is clearly evident with DHA and EPA, but less so with DPA. This finding is confirmed by the results of the food frequency questionnaire conducted with the same individuals. Howe et al (2006) surmise that the difference between mean and median intakes, particularly of DHA and EPA, is likely to reflect a less common consumption of fish. In other words a small proportion of the population eat large quantities of fish but most consume very little.

Table 2: Mean consumption of omega-3s in adults (mg/d)

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>ALA</th>
<th>EPA*</th>
<th>DPA</th>
<th>DHA*</th>
<th>Total long chain omega-3s*</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-64 y</td>
<td>both</td>
<td>1080</td>
<td>76</td>
<td>73</td>
<td>102</td>
<td>251</td>
</tr>
<tr>
<td>≥ 65 y</td>
<td>both</td>
<td>950</td>
<td>69</td>
<td>54</td>
<td>96</td>
<td>219</td>
</tr>
<tr>
<td>Adults ≥ 19 y</td>
<td>both</td>
<td>1070</td>
<td>75</td>
<td>71</td>
<td>100</td>
<td>246</td>
</tr>
<tr>
<td>Adults ≥ 19 y</td>
<td>men</td>
<td>1280</td>
<td>91</td>
<td>90</td>
<td>117</td>
<td>298</td>
</tr>
<tr>
<td>Adults ≥ 19 y</td>
<td>women</td>
<td>870</td>
<td>60</td>
<td>52</td>
<td>83</td>
<td>195</td>
</tr>
</tbody>
</table>

* Median intakes approximately 50% of mean intakes
From: Howe et al 2006
**Recommended intakes compared to actual intakes**

The most useful recommended intakes for Baby Boomers are the SDTs as these aim to lower the risk of chronic diseases. Comparing these levels to actual intakes of long chain omega-3s indicates a wide discrepancy. Figure 3 demonstrates the nutritional gap between optimal intakes of long chain omega-3s and the median intakes, calculated as approximately 50% of mean intakes (Howe et al 2006). When reviewing Figure 3, it is important to understand that 50% of the population consume less than the median intake.

**Main sources of long chain omega-3s**

Fish, seafood and meats provide most of the long chain omega-3s in the Australian diet, at 48% and 43% respectively, as assessed by Howe (2006). Egg products and dishes provide only 2% with cereal based products and dishes, some of which include egg and meat ingredients, provide around 6%.

Figure 4 demonstrates the contribution to the long chain omega-3s of fish, seafood and meat products and dishes. This reflects the different fatty acid profiles of these foods.

**Figure 5: % persons consuming fish and meats, aged 45 – 64 y**

![Figure 5](image)

From: ABS 1999

Meat and poultry products and dishes are consumed more frequently then fish and seafood according to the National Nutrition Survey of 1995 (see Figure 5).

However, fish and seafood are more popular with Baby Boomers than other age groups as demonstrated in Figure 6.

**Figure 6: % persons consuming fish and seafood dishes by age and gender (on the day of the survey)**

![Figure 6](image)

From: ABS 1999

Unfortunately Baby Boomers’ mean daily intake of fish and seafood is low as shown in Figure 7. Mean daily total meat, poultry and game intake is 156g/d compared to only 30g/d of total fish and seafood.
Conclusion and recommendations

There is a wide gap between Baby Boomers’ intake of long chain omega-3s and recommendations for optimal intakes based on 1995 data. Promotion of practical actions to increase intakes is recommended. These should be based on a sound understanding of effective strategies.

Research on intakes of long chain omega-3 should occur on a regular basis through NHMRC dietary surveys in order to track intakes over time and assess effectiveness of recommendations.

Both government agencies and health professionals can play an important role in the promotion of increased intakes of long chain omega-3s. Their activities should address barriers to increased consumption and take the form of a co-operative approach to ensure consistency and strength of messages.

References


Baldwin N, Rice R. Eating long chain omega-3 polyunsaturated fatty acids, as part of a healthy lifestyle, has been shown to help maintain heart health. Omega-3 Health Claim Consortium, 2004. Available at: http://www.jhci.org.uk/approv/omega.htm.


Omega-3s for the mind?

Omega-3s in mood and cognition

Daniella Tassoni and Professor Andrew J Sinclair, Deakin University

Basic research has established that the long chain omega-3 DHA, plays a fundamental role in brain structure and function – see Figure 9. Epidemiological and cross-sectional studies have also identified a role for long chain omega-3s in the etiology of depression. Depression is a disturbance in mood characterized by varying degrees of sadness, disappointment, loneliness, hopelessness, self-doubt, and guilt. These feelings can be quite intense and may persist long periods of time. Daily activities may become more difficult, but the individual may still be able to cope with them. It is at this level, however, that feelings of hopelessness can become so intense. Depression (Mood) Disorders have been divided into unipolar and bipolar. The bipolar type is manifested by mania or by both mania and depression. On the other hand, unipolar depression are manifested only by depression (Depression Alliance 2003).

In the past ten years, there have been twelve intervention studies conducted using various preparations of long chain omega-3s in unipolar and bipolar depression, with the majority of these utilizing long chain omega-3s as an adjunct therapy. The studies, summarized in Table 3, have been conducted over four to 16 weeks intervention, often with small cohorts. Four of seven studies in depressed individuals, and two of five studies in bipolar patients have reported a positive outcome following supplementation with ethyl-eicosapentaenoic acid (EPA) or fish oil containing long chain omega-3s. The three trials using DHA-rich preparations reported no significant effects of treatment. The mechanisms that have been invoked to account for the benefits of long chain omega-3s in depression include reductions in prostaglandins derived from arachidonic acid, leading to decreased brain derived neurotrophic factor (BDNF) levels and/or alterations in blood flow to the brain.

In view of the increasing interest in the role of omega-3s and brain function, especially in relation to ageing, we have conducted a literature search on the relationship between omega-3 intake or status (circulating levels) and mood and cognition in people aged between 44-65 years. The database searched was PubMed and the search terms were: omega-3, DHA, EPA linked with mood and cognition (see Table 4). Over the past few years, there have also been a substantial number of review studies that have been published on the brain and omega-3s (see for example Freeman et al 2006; Parker et al 2006, Sinclair et al 2007, Stahl et al 2008).

Figure 9: Omega-3 DHA is the major PUFA in the brain (% PUFA in brain grey matter)

<table>
<thead>
<tr>
<th>LA</th>
<th>AA</th>
<th>22:4n-6</th>
<th>22:5n-6</th>
<th>ALA</th>
<th>EPA</th>
<th>22:5n-3</th>
<th>DHA</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>25</td>
<td>20</td>
</tr>
</tbody>
</table>

The brain:

- The largest organ in the body.
- Like other organs, the brain is affected by what we eat and drink (e.g. caffeine, alcohol, substances of abuse).
- Unlike the other organs, the link between diet and the brain is not as well recognised.
- Is a lipid-rich tissue and develops in size in the first year of life and is susceptible to nutritional deprivation (e.g. iodine, iron, omega-3s) and insult (mercury).
- The brain is rich in complex lipids (phospholipids, sphingolipids, gangliosides and cholesterol), involved in cell membrane structure and function.
To summarise the studies located, three were intervention studies (number of subjects studied ranged from 21 to 218) and ten were observational studies (number of subjects studied ranged from 15 to 7814). Two of the intervention studies were negative and one found some benefit. Of the observational studies, all found a positive association between omega-3 intake/status and improved mood/cognition or vice versa.

This literature reveals that there is limited evidence to support the relationship between omega-3 intake and altered mood and cognition though there is enough significant support from observational studies to conduct thorough intervention studies in appropriate subjects using sufficiently sensitive tests designed to measure effects in mood and cognition.

### Table 3: Preparation and source of the long chain omega-3s utilised in the intervention studies undertaken to date in depression.

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Number of subjects</th>
<th>Outcome</th>
<th>Preparation</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peet &amp; Horrobin</td>
<td>Placebo: 18; Treatment 1: 17, Treatment 2: 18</td>
<td>1g E-EPA for 12 weeks, +ve; adjunctive therapy.</td>
<td>Ethyl-eicosapentaenoate (E-EPA), and liquid paraffin placebo</td>
<td>Laxdale Ltd, UK</td>
</tr>
<tr>
<td>Nemets et al (2002)</td>
<td>Placebo: 10, Treatment: 10</td>
<td>2g E-EPA for 4 weeks, +ve; adjunctive therapy.</td>
<td>E-EPA (96% pure from fish oil), and placebo</td>
<td>Laxdale Ltd, UK</td>
</tr>
<tr>
<td>Su et al (2003)</td>
<td>Placebo: 11, Treatment: 11</td>
<td>2.2g EPA+1.1g DHA for 8 weeks, +ve; adjunctive therapy.</td>
<td>EPA plus DHA (from menhaden fish body oil; 440mg EPA, 220mg DHA/capsule), and olive oil placebo</td>
<td>China Chemical and Pharmaceutical Company, Taipei, Taiwan</td>
</tr>
<tr>
<td>Nemets et al (2006)</td>
<td>Placebo: 10, Treatment: 10</td>
<td>0.4g EPA+0.2g DHA for 16 weeks, +ve; monotherapy (in children).</td>
<td>EPA plus DHA (fish oil; 400 mg EPA, 200mg DHA in 1 g capsules; 190mg EPA, 90mg DHA in 500 mg capsules), and safflower oil placebo</td>
<td>Sears Laboratory (1g caps), USA, Ocean Nutrition (500mg caps), Canada</td>
</tr>
<tr>
<td>Marangell et al (2003)</td>
<td>Placebo: 17, Treatment: 18</td>
<td>2g DHA for 6 weeks, not significantly different to placebo; monotherapy.</td>
<td>DHA (algal oil; 40% DHA and no EPA), and placebo</td>
<td>Martek Biosciences, USA</td>
</tr>
<tr>
<td>Silvers et al (2005)</td>
<td>Placebo: 37, Treatment: 40</td>
<td>0.6g EPA+2.4g DHA for 12 weeks, not significantly different to placebo; adjunctive therapy</td>
<td>DHA plus EPA (from tuna fish oil; 27% DHA, 7% EPA), and placebo</td>
<td>Clover Corporation, PLC- Australia</td>
</tr>
<tr>
<td>Grenyer et al (2007)</td>
<td>Placebo: 10, Treatment: 10</td>
<td>0.6g EPA+2.2g DHA for 16 weeks, not significantly different to placebo; adjunctive therapy.</td>
<td>DHA plus EPA (from tuna fish oil; 27.5% DHA, 7.5% EPA), and olive oil placebo</td>
<td>Clover Corporation, PLC- Australia</td>
</tr>
<tr>
<td>Stoll et al (1999)</td>
<td>Placebo: 16, Treatment: 14</td>
<td>6.2g EPA+3.4g DHA for 16 weeks, +ve; adjunctive therapy</td>
<td>EPA plus DHA (a concentrate from menhaden fish body oil; 440mg EPA, 240 mg DHA per g), and olive oil placebo</td>
<td>Fish Oil Test Materials Program, Charleston, USA</td>
</tr>
<tr>
<td>Frangou et al (2006)</td>
<td>Placebo: 26, Treatment 1: 24; Treatment 2: 25</td>
<td>1 or 2g E-EPA for 12 weeks, not significantly different to placebo; adjunctive therapy.</td>
<td>E-EPA, and liquid paraffin placebo</td>
<td>Laxdale Ltd, UK</td>
</tr>
<tr>
<td>Frangou et al (2007)</td>
<td>Placebo: 7, Treatment: 7</td>
<td>2g E-EPA for 12 weeks, not significantly different to placebo; adjunctive therapy.</td>
<td>E-EPA (95% pure from fish oil, LAX-101), and liquid paraffin placebo</td>
<td>Laxdale Ltd, UK</td>
</tr>
</tbody>
</table>
Table 4: List of studies from literature search on: Omega-3/DHA/EPA and cognition and mood disorder
Limits: 44-65 years

<table>
<thead>
<tr>
<th>Number</th>
<th>Author/s</th>
<th>Title</th>
<th>Journal</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Whalley LJ, Deary IJ, Starr JM, Wahle KW, Rance KA, Bourne VJ, Fox HC.</td>
<td>n-3 Fatty acid erythrocyte membrane content, APOE varepsilon4, and cognitive variation: an observational follow-up study in late adulthood.</td>
<td>Am J Clin Nutr. 2008 Feb;87(2):449-54. [n=&gt;10,000; +ve effect]</td>
</tr>
</tbody>
</table>
References


Conklin SM, Harris JI, Manuck SB, Yao JK, Hibbeln JR, Muldoon MF. Serum omega-3 fatty acids are associated with variation in mood, personality and behavior in hypercholesterolemic community volunteers. Psychiatr Res. 2007;152:1-10.


The most important diseases causing visual impairment in people as they age include age-related macular degeneration, cataract, glaucoma, diabetic retinopathy and retinal vein occlusion. This discussion paper will limit itself to reviewing common eye diseases which have investigated the relationship to the consumption of omega-3s and fish: age-related macular degeneration (AMD), cataract and retinal vessel changes.

Impaired Vision

Normal or good vision is considered to be 6/6: this refers to the ability to read at 6 metres the line a person with good vision can read at that distance. The term 20/20 actually represents the same level but is measured in feet, for the United States. Visual impairment is generally defined from the better eye as mild (6/12 to 6/18 vision), moderate (6/24 to 6/60) or severe (legal blindness; worse than 6/60).

In a population-based cohort of older Australians (aged 49 and over) AMD was the overwhelming cause of blindness (less than 6/60 vision in both eyes) and of moderate visual impairment, while cataract was the leading cause of mild impairment (Mitchell et al 2002).

Age-related macular degeneration

AMD is a term describing disease of the macula, the most central part of the retina at the back of the eye. When we look directly at someone or at text in a book, we are using our macula. When the macula is damaged, it is like having a dark, grayish or distorted patch in the centre of everything you view. AMD is the most frequent cause of severe vision loss and blindness in elderly people (Klein et al 2002, Mitchell et al 2002, Tomany et al 2004). Although new treatments targeting vascular endothelial growth factor (VEGF) have revolutionized the management of this condition, this therapy is not possible for many cases, requires regular injections into the eye and is costly. Therefore, identifying risk factors that could be targeted in preventive strategies has the potential to reduce the burden of macular degeneration in our ageing populations (Flood & Mitchell 2008).

Omega-3s, particularly DHA, constitute a high proportion of the human retina and macular composition, and may be important in cell membrane maintenance and retinal repair following oxidative stress. They may also protect against retinal inflammation (SanGiovanni & Chew 2005, Connor 2000). It is believed that AMD shares some aspects of the pathogenesis as cardiovascular disease (Hu et al 1997, Snow & Seddon 1999). Several recent reports have examined possible associations between dietary fat and progression of macular degeneration. The Blue Mountains Eye Study (BMES) examined the association between dietary fat and fatty acid components and the 5y incidence of AMD (Chua et al 2006). This is a population-based cohort study of vision and common eye diseases in non-institutionalised residents, 49 years or older, living in the Blue Mountains region, west of Sydney, Australia. Dietary data were collected from 2895 people at baseline using a validated food frequency questionnaire. Incidence of early and late AMD was assessed after a mean follow-up of 5.1y. Participants with the highest versus the lowest quintile of omega-3s had a lower risk of AMD (pooled odds ratio (OR), 0.41, 95% confidence interval (CI) 0.22-0.75). A 40% reduction of incident early AMD was associated with fish consumption of at least once a week (OR 0.58, 95% CI 0.4-0.9), and fish consumption of at least 3 times a week reduced the incidence of late AMD by 75% (OR 0.25, 95% CI 0.06, 1.0) – see Table 5. Although not statistically significant, the trend for long-chain omega-3s also suggested protection. Low intakes of the shorter chain omega-3, alpha-linolenic acid (ALA), were associated with increased risk, suggesting it too may be protective for AMD. This
study confirmed an earlier cross-sectional report in the same cohort of 50% protective effect of fish consumed more than once per week compared to less than once per month (Smith et al 2000).

Table 5: Incident cases of age-related macular degeneration (AMD) in BMES (5y)

<table>
<thead>
<tr>
<th>Total Fish* §</th>
<th>Early AMD</th>
<th>Late AMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1 /month</td>
<td>1.00 (ref)</td>
<td>1.00 (ref)</td>
</tr>
<tr>
<td>≥1 /week</td>
<td>0.58 (0.37-0.90)</td>
<td>0.44 (0.16-1.21)</td>
</tr>
<tr>
<td>≥3 /week</td>
<td>0.62 (0.38-1.03)</td>
<td>0.25 (0.06-1.00)</td>
</tr>
</tbody>
</table>

* Includes sardines, tuna, other fish
§ adjusted for age, sex, current smoking, antioxidants (diet & supplements)

From: Chua et al 2006

In a more recent study reported by the Age-Related Eye Disease Study (AREDS) group in which participants with varying levels of AMD severity were compared to a control group, people who consumed a higher intake of total long-chain omega-3s had a lower risk for neovascular AMD (OR 0.6, 95% CI 0.4-0.9), with a similar finding for DHA and fish intake. Arachidonic acid (AA), an omega-6, increased the risk of neovascular AMD by about 50% (OR 1.5, 95% CI 1.0-2.3) (SanGiovanni et al 2007). There were no other statistically significant associations with other sub-types of fatty acids and AMD.

In a recently published systematic review and meta-analysis of omega-3s and fish intake and the prevention of AMD (Chong et al 2008), 9 studies were identified for analyses (3 prospective cohorts, 3 case-control studies and 3 cross-sectional studies). A high dietary intake of omega-3s was associated with a 38% reduced risk of late AMD (pooled OR 0.62, 95% CI 0.48-0.82). Fish intake of at least twice a week was associated with a reduced risk of both early AMD and late AMD (pooled OR 0.76, 95% CI 0.64-0.9; 0.67, 95% CI 0.53-0.85).

Gaps in the literature

There are no randomised controlled trials which have evaluated omega-3s and fish intake in the prevention of AMD. A clinical trial has commenced in the US, the Age-Related Eye Disease Study (AREDS-2) which will evaluate the effect of long chain omega-3 supplements compared with a placebo in relation to the progression from early to late AMD, but it will be many years before the findings are available (AREDS2 2008). It is possible that people who consume diets higher in omega-3s, are also eating healthier diets in relation to other dietary factors protective of AMD, such as antioxidants (Kassoff et al 2001) and these factors may have been inadequately adjusted for in the epidemiological literature.

Conclusions and recommendations

Overall, findings from a range of epidemiological studies and a recent meta-analysis support the hypothesis that increased dietary intakes of omega-3s and regular fish consumption protect against the development and progression of AMD. A plausible mechanism is that long chain omega-3s promote healthy ocular tissue by regulating inflammatory and immune responses in the retina, thereby reducing the risk of AMD.

Given the increasing evidence from prospective cohort studies and the recent meta-analysis, it seems reasonable to recommend that patients with early AMD signs increase their consumption of long chain omega-3s and fish, including about 2 fish meals a week.

Cataract

Cataract is a term describing opacity that develops in the normally clear lens of the eye. Opacification in the lens causes scattering of light as it passes through the lens, leading to both reduced vision and also an increased perception of glare or sensitivity to bright light. There are three types of age-related cataract; nuclear (the most frequent), cortical and posterior subcapsular (least common). Nuclear cataract develops in the nucleus or centre of the lens. As it increases, there is an associated yellow or brown discoloration of the lens. Cortical cataract develops in the outer shell of the lens as spokes and wedges and commonly causes increasing glare sensitivity. Posterior subcapsular cataract develops at the back of the lens, often in the visual axis, and so affects vision rapidly and severely. The majority of people needing cataract surgery have some posterior subcapsular cataract present at that time.

Overall, there has been little epidemiological research investigating omega-3s consumption and cataract. In our BMES dataset, we examined 5y incidence of cataract and macronutrients, and found people with higher intakes of omega-3s had a 42% reduction in incident nuclear cataract (quintile 5 vs quintile 1, OR 0.58, CI 0.35-0.97, p for trend 0.027) (Townend et al 2007) – see Table 6.

Table 6: Nuclear cataract and omega-3s

<table>
<thead>
<tr>
<th>Omega-3s (quintiles)</th>
<th>Median intake (g/d)</th>
<th>OR* (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.52</td>
<td>1.0 (ref)</td>
</tr>
<tr>
<td>2</td>
<td>0.7</td>
<td>0.80 (0.49-1.30)</td>
</tr>
<tr>
<td>3</td>
<td>0.85</td>
<td>0.72 (0.43-1.19)</td>
</tr>
<tr>
<td>4</td>
<td>1.03</td>
<td>0.59 (0.35-0.98)</td>
</tr>
<tr>
<td>5</td>
<td>1.42</td>
<td>0.58 (0.35-0.97)</td>
</tr>
</tbody>
</table>

* Adjusted for age, sex, diabetes, use of oral or inhaled corticosteroids, hypertension, body mass index, alcohol and smoking history, myopia and dark brown iris colour.

From: Townend et al 2007
In a cross-sectional study based on Reykjavik Eye Study, Arnarsson et al (2002) examined risk factors for nuclear lens opacities among 1045 persons, aged 50y and over. They used a 26 item food frequency questionnaire (FFQ) and proxy measures for omega-3s intake (fish consumption) and found no association between these proxy measures and nuclear cataract. A role for polyunsaturated fatty acids in delaying nuclear cataract formation is biologically plausible, though the exact mechanisms have not been investigated. A potential mechanism may be related to positive effects on cholesterol from elevated serum levels of high-density lipoprotein (HDL) (Chan et al 2006, Gerasimova et al 1991, Visioli et al 2000). Omega-3s may also slow the process of oxidation, which is critical to the pathogenesis of cataract (Hodge et al 2005). Oxidation is thought to be crucial to the development of nuclear cataract (Truscott 2005). A lens ‘barrier’ is thought to form in middle age, through the oxidation of lens proteins. This virtually compartmentalizes the lens, so that oxidised substances penetrate and remain in the nucleus, and antioxidants cannot enter (Truscott 2005).

Conclusions

Further long-term prospective cohort studies and intervention studies are needed to clarify whether omega-3s affect the risk of cataract development.

Retinal vessel changes

Retinal vein occlusion occurs when the retinal arteries or retinal veins are blocked, decreasing the oxygen supply to the retina. The blockage is usually caused by a blood clot, fat deposit or atherosclerotic plaque fragment. Omega-3s (particularly DHA) may protect the blood vessels of the eye by inhibiting the development of plaques and blood clots (von Schacky et al 2000). Other work has investigated the diameter of retinal vessels and found that they may predict systemic vascular and ocular vascular events. For example, narrower retinal arterioles and wider retinal venules predict incident hypertension and coronary heart disease mortality (Ikram et al 2006). In the BMES we have found higher intakes of long chain omega-3s were associated with wider mean retinal arteriolar diameters and narrower mean venular diameters, a ‘protective’ direction. We also showed that fish in the diet at least twice per week was strongly associated with better retinal vessel outcomes. The findings were independent of blood pressure, past history of stroke and myocardial infarction, smoking, blood lipid levels, inflammatory factors, and socioeconomic status. Stratification by hypertension revealed a greater change in vessel diameter in persons with than without hypertension (Kaushik et al 2008).

Conclusions

These findings need to be further assessed in other prospective cohort studies and intervention studies.

References


Scientific Consensus Workshop Omega-3 fatty acids for Baby Boomers October 2008


With developed nations facing an obesity epidemic, feasible and affordable strategies to achieve and maintain a healthy weight are an international priority. The primary focus of such strategies has been to regulate energy balance by restricting intake and increasing energy expenditure. However, the ability of modern societies to adopt such strategies has been severely limited by plentiful food supplies and decreasing levels of physical activity.

An alternative approach is to modify metabolism by decreasing fat deposition and increasing its utilisation as an energy source. Pioneering work by Clarke and Jump (1993) and Pan et al (1994) indicated a potential role for PUFA and, in particular, long-chain omega-3s in inducing such a metabolic shift. Yet, despite the myriad of clinical studies supporting cardiovascular, anti-inflammatory, behavioural and developmental benefits of long chain omega-3s, there is a paucity of evidence for beneficial effects of omega-3s on body composition in humans. Two major US population surveys, the Nurses’ Health Study (Iso et al 2001) and the Health Professional Follow-up Study (He et al 2002), showed positive and negative relationships respectively between weight and dietary fish intake. Moreover, in the former study, the proportion of overweight women increased with increasing long chain omega-3s intake, while in the latter it reduced. However, there is no epidemiological data on long chain omega-3s intake with respect to body composition.

**Metabolic effects of long chain omega-3s**

How might long chain omega-3s influence body composition? Our understanding of the physiological functions of PUFA was initially based on the recognition of their essential roles as precursors of the vast family of eicosanoids, a family which has recently been expanded by the addition of resolvins and neuroprotectins. At the same time, a growing body of research in animal models has highlighted the potential for PUFA to mediate physiological roles independent of eicosanoid mechanisms by acting at nuclear membrane receptors to alter gene transcription and expression of enzymes regulating metabolic pathways, including those of fat synthesis and oxidation.

Feeding long chain omega-3s, particularly DHA, to mice has been shown to enhance thermogenesis and reduce body fat deposition by increasing the capacity for fat oxidation in skeletal muscle (Power & Newsholme 1997) and up-regulating the expression of genes and proteins involved in fatty acid oxidation in liver, cardiac muscle and skeletal muscle, while down-regulating the expression of genes involved in lipogenesis in adipose tissue (Clarke 2000). Long chain omega-3s supplementation increases the expression of mRNA for CPT-I (Mascaro et al 1998), peroxisomal acyl-CoA synthase (ACCoA) (Baillie et al 1999) and mitochondrial uncoupling protein 3 (UCP-3) (Baillie et al 1999), all of which are regulated upstream by peroxisome proliferator-activated receptors (PPARs) (Lopez-Soriano et al 2005) and PPARγ co-activator 1α (PGC-1α) (Puigserver & Spiegelman 2003). Therefore, part of the mechanism by which long chain omega-3s reduce body fat may be via the promotion of fat oxidation through the increased transcription of selected genes in liver, cardiac muscle, and particularly skeletal muscle which is a major site for whole body lipid metabolism (Dagenais et al 1976).

Feeding fish oil has also been shown to influence fat metabolism in adipose tissue. Omega-3s have been shown to up-regulate PGC-1α and nuclear respiratory factor-1 (NRF-1) in epididymal, but not subcutaneous, fat in mice (Flachs et al 2005), resulting in an increased capacity of epididymal fat to oxidise fatty acids. Long chain omega-3s have also been shown to down-regulate the expression of fatty acid synthase (FAS) (Mater et al 1998) and stearoyl-CoA desaturase (Flachs et al 2005) in subcutaneous fat. This combination of increased expression of genes which promote fat oxidation and reduced expression of genes favouring lipogenesis should contribute to a reduction in fat content of adipose tissue.

The abovementioned alterations in gene expression of mediators of fat metabolism are not necessarily specific for individual long chain omega-3s. Microarray analysis of genes regulated by dietary fatty acids shows considerable overlap in the influence of different PUFA on PPARs and other nuclear receptors (Vanden Heuvel 2008). The net influence on fat metabolism will be determined by a complex integration of the effects of individual PUFA on gene expression. Thus long chain
omega-3s supplementation may not necessarily improve body composition. Indeed, weight gain in obese db/db mice on a high saturated fat diet was exacerbated by long chain omega-3s (Todoric et al 2006).

Human intervention trials

The impact of long chain omega-3s supplementation on body composition in humans is even less certain, due to a lack of studies of adequate size and duration in which energy consumption has been monitored or controlled. Some (Couet et al 1997, Groh-Wargo et al 2005, Kunesová et al 2006, Hill et al 2007, Kabir et al 2007), but not all (Brilla & Landerholm 1990, Warner et al 1989, Fontani et al 2005, Krebs et al 2006) human studies have shown that long chain omega-3s consumption can assist in reducing body fat. In 1997, Couet et al (1997) first reported that substituting long chain omega-3s (predominantly DHA) for other fats in the diet could increase resting fat oxidation and reduce body fat. However, the outcome of this small (9 healthy adults), short term (3 week) one-way crossover trial could have been due to an order effect as the order of treatments was not randomised or balanced. Groh-Wargo et al (2005) subsequently showed that feeding long chain omega-3s (predominantly DHA) to pre-term infants for one year resulted in 15% less body fat accumulation than in controls. However, it is difficult to extrapolate the results of this developmental study to the maintenance of body composition in adults.

Kabir et al (2007) reported a ~1.6kg reduction in body fat in women with type 2 diabetes consuming 1.8g/d of long chain omega-3s (predominantly EPA) for 2m and Kunesová et al (2006) found that, in obese women consuming a low-energy diet, adding 2.8g/ of long chain omega-3s (predominantly EPA) resulted in a further 1.5kg weight loss over a 3w period. In a recent study conducted in our laboratory (Hill et al 2007), we found that 12w of supplementation with 1.9g/d of long chain omega-3s (predominantly DHA) in overweight and obese adults resulted in ~1kg loss of body fat compared with placebo (sunflower oil). In this study, the long chain omega-3s supplement was evaluated alone and in combination with regular moderate intensity aerobic exercise. The latter had an independent effect on body fat which was additive to that of the DHA rich oil – see Figure 11. Importantly, our study showed that the loss of body fat was attributable to increased fat oxidation and was accompanied by an improvement of endothelial function which is impaired in obesity. We hypothesise that improved perfusion of exercising muscles achieved by long chain omega-3s supplementation may have contributed to the reduction of body fat seen in these obese subjects.

While five studies provide evidence that long chain omega-3s may help to reduce body fat (Couet et al 1997, Groh-Wargo et al 2005, Kunesová et al 2006, Hill et al 2007, Kabir et al 2007), four studies have reported no such effect (Brilla & Landerholm 1990, Warner et al 1989, Fontani et al 2005, Krebs et al 2006). However, these four studies have a number of limitations including the use of lean participants (Brilla & Landerholm 1990), small sample sizes (Warner et al 1989), using skinfolds to assess changes in body fat (Fontani et al 2005), and using supplementation in conjunction with large reductions in body weight achieved through dietary restriction which may have masked any smaller effect of long chain omega-3s (Krebs et al 2006). In this latter study, weight loss was approximately 12% of body weight, double the 6% body weight reduction found in the study by Kunesová et al (2006) which reported additional weight loss when long chain omega-3s was combined with caloric restriction.

Parra et al (2008) recently claimed that a diet rich in long chain omega-3s can modulate satiety during weight loss in overweight and obese volunteers. Increased satiety may contribute to the weight loss effects of long chain omega-3s, but the data reported by Parra et al (2008) fails to support the conclusion of increased satiety.

Summary

Most evidence of body fat reduction in humans comes from short-term studies (3-12w in duration) which have shown up to ~1.5kg reduction in body fat or body
weight. There is little evidence of longer term benefits of long chain omega-3s supplementation, nor is it clear how much is required to attain the benefit and whether EPA or DHA is more effective. The longest study to show beneficial effects of long chain omega-3s supplementation on body composition was in developing infants and may not be relevant for overweight adults. Despite these limitations and the limited epidemiological evidence, the favourable metabolic effects of long chain omega-3s and the attractiveness of this supplementation approach for aiding weight management warrant further evaluation and confirmation with larger clinical trials of longer duration in which the responses to graded intakes of both EPA and DHA can be independently assessed and the underlying mechanisms elucidated. Importantly, in a large proportion of overweight individuals at risk of metabolic syndrome, the multifaceted health benefits of long chain omega-3s supplementation, both cardiovascular and metabolic, provide strong justification for this weight management approach.

**Figure 12: Overview: What we know and do not know**

<table>
<thead>
<tr>
<th>Gaps in the literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>This field of research is still in its infancy. There is little epidemiological evidence and very few human studies of acceptable quality evaluating effects of long chain omega-3s on body composition and weight maintenance.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What do we know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long chain omega-3s can favourably influence fat metabolism in animal models of obesity and can elicit fat loss in short term clinical trials in obese individuals, in conjunction with other cardiometabolic benefits.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What don’t we know</th>
</tr>
</thead>
<tbody>
<tr>
<td>The optimal type and intake of long chain omega-3s for improving body composition in obese individuals, the time course of effects and any impact of/on accompanying treatment modalities.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What should we know</th>
</tr>
</thead>
<tbody>
<tr>
<td>The long term effectiveness of feasible intakes of long chain omega-3s on body composition and weight maintenance; the relative efficacy of EPA and DHA; the necessity for concomitant energy restriction and/or energy expenditure interventions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larger, well-designed, longer term clinical trials are needed to address the above questions. Weight maintenance may prove to be another major benefit in the multi-faceted cardiometabolic health profile of long chain omega-3s, but this is yet to be adequately established.</td>
</tr>
</tbody>
</table>
References


Gaps in the literature

While evidence exists for beneficial effects of omega-3s for a broad range of inflammatory diseases, there are a great many inflammatory diseases and those in which well designed studies have been undertaken are not numerous. With regard to arthritis, most evidence for benefit from omega-3s has come from studies in rheumatoid arthritis, in which fish oil has been used as the source of dietary omega-3s (Cleland et al. 2006). Arthritic conditions for which studies are needed include osteoarthritis, the most prevalent form of arthritis. A multicentre NHMRC-funded study is currently addressing this issue. Gout is a common disorder, which is characterised by episodic arthritis in its early phase and chronic arthritis later. Studies with omega-3s in gout are lacking but potentially productive, both with regard to prevention of attacks and improvement in associated dyslipidaemia.

What don’t we know?

We do not know whether/what dietary intakes of omega-3s would reduce frequency of human inflammatory diseases. This possibility certainly exists since experimental studies have shown that omega-3 rich fish oil diets can have preventive effects in animals predisposed genetically to inflammatory disease and populations with high intakes of the marine omega-3s EPA and DHA have relatively low prevalence of rheumatoid arthritis. The medicinal use of fish oil is currently under-utilised for prevalent inflammatory diseases. Considering global threats to fish stocks, we do not know how long chain omega-3s in amounts sufficient to meet established therapeutic and potential preventive indications could be sourced sustainably.

What should we know?

Fish oil in anti-inflammatory doses, and the long chain omega-3s (EPA and DHA) therein, are natural product inhibitors of the enzyme cyclo-oxygenase COX, which exists in two isoforms COX-1 and COX-2. These isozymes are involved in the synthesis of prostaglandin $E_2$ (PGE$_2$), which is produced at sites of inflammation where it has nociceptive effects, i.e. it sensitises nerve endings to generate a pain response to otherwise normal stretch and pressure conditions. Inhibition of COX-2 is the mechanism of action of the widely used analgesic type anti-inflammatory drugs, which are known as NSAIDs (non-steroidal anti-inflammatory drugs) or COX-2 inhibitors. The advent of newer COX-2 selective NSAIDs led to long term studies which showed that these agents increase cardiovascular risk and mortality (Peat & Kronmal 2008). In recognition of the increased risk for serious cardiovascular and gastro-intestinal events associated with NSAIDs/COX-2 inhibitors, it is recommended by the National Prescriber Service of Australia that these agents be used for as short a period as possible in as low a dose as possible (RADAR 2005).

As fish oil achieves analgesia safely and has been shown to reduce NSAID use in clinical trials, it follows that fish oil should be used as alternative or supplementary therapy whenever NSAIDs/COX-2 inhibitors are thought warranted. There are no important drug interactions with fish oil, which is safe to use with both low dose aspirin and warfarin, subject to usual precautions. At the Royal Scientific Consensus Workshop Omega-3 fatty acids for Baby Boomers October 2008

Inflammation including arthritis

Professor Les Cleland, Rheumatology Unit, Royal Adelaide Hospital

What do we know?

We know that fish oil in sufficient doses has anti-inflammatory and analgesic effects. Inflammatory diseases in which fish oil has been shown to have beneficial effects include rheumatoid arthritis, systemic lupus erythematosus, IgA nephropathy, Crohn’s disease and psoriasis. Rheumatoid arthritis has been the most thoroughly studied with beneficial effects being shown on meta-analysis using Cochrane methodology (Goldberg & Katz 2007). Improvement in symptoms is often delayed until the third month of treatment. The dose of fish oil showing benefit in inflammatory diseases has been sufficient to deliver 3g or more of long chain omega-3s. These doses are substantially greater than those needed to show cardiovascular benefit. The higher anti-inflammatory/analgesic doses can be given most economically and efficiently as bottled fish oil on juice or milk taken with food. The dose required is 10ml or more daily which is broadly equivalent to ten 1000mg capsules of 18/12 (percent EPA/DHA) fish oil. Fish oil concentrates allow the smaller volumes/tablet numbers to be taken but at a higher cost. Anti-inflammatory doses of fish oil when taken regularly for three or more months achieve a similar reduction in pain scores to commonly used analgesic type anti-inflammatory drugs (Goldberg & Katz 2007).
Adelaide Hospital, fish oil is used routinely for first-line analgesia for chronic arthritis pain. In rheumatoid arthritis, long-term fish oil therapy has been shown to reduce multiple cardiovascular risk factors (Cleland et al 2006).

**Overview of the science**

Because the fatty acid class determining omega-6 and omega-3 double bonds cannot be produced by humans, the relative amounts of omega-6s and omega-3s in the diet influences their relative proportions in the tissues. However, not all dietary omega-3s are equivalent and, with regard to anti-inflammatory effects, the omega-3 α-linolenic acid (ALA) found in certain vegetables and vegetables oil is not bio-equivalent with the long chain omega-3s EPA and DHA found in marine fish and fish oil. The enzyme COX is pivotal to the synthesis of multiple fatty acid-derived inflammatory and vascular mediators. In people consuming a typical Western diet, the main substrate for the COX is the omega-6, arachidonic acid (AA). EPA is very similar in structure to AA, differing only by the presence of its additional omega-3 bond. Both AA and EPA are metabolised by COX to versions of the product prostaglandin H2 (PGH2) and prostacyclin and thromboxane). PGH is in turn metabolised by different ‘terminal synthases’ to a variety of products that are involved in inflammation (e.g. PGE2) and cardiovascular homeostasis (prostacyclin and thromboxane). PGE2 is derived from AA and its synthesis is inhibited EPA. EPA also inhibits synthesis of thromboxane (prothrombotic) and promotes synthesis of prostacyclin (a vascular patency factor).

Also EPA can be metabolised by lipooxygenases to novel anti-inflammatory agents known as resolvins (Arita et al 2005). These biochemical observations help explain the anti-inflammatory and vasoprotective effects of fish oil. The latter contrast with the adverse cardiovascular effects of NSAIDs/COX-2 inhibitors, which inhibit prostacyclin synthesis by COX-2 in vascular endothelium and increase cardiovascular risk.

**Recommendations including communications**

- Fish oil is a rich source of anti-inflammatory long chain omega-3s.
- The doses of long chain omega-3s EPA and DHA in fish oil needed for analgesic and anti-inflammatory effects cannot be readily acquired otherwise in the diet.
- The symptomatic benefits of fish oil require regular use in appropriate doses (10ml or 10g daily or more) and may be delayed up to three months.
- For chronic arthritis pain, fish oil can be substituted for analgesic type anti-inflammatory drugs with reduction in cardiovascular risk factors.
- Fish oil can improve disease control in rheumatoid arthritis and other inflammatory diseases.

**References**


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**Table 7: Comparative effects : NSAIDs v. Fish Oil**

<table>
<thead>
<tr>
<th></th>
<th>NSAIDs</th>
<th>Fish Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSAID sparing</td>
<td>no</td>
<td>Yes (↓PGE2)</td>
</tr>
<tr>
<td>Serious CV Events</td>
<td>increased</td>
<td>reduced</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>increased</td>
<td>reduced</td>
</tr>
<tr>
<td>TNF &amp; IL-1</td>
<td>increased</td>
<td>reduced</td>
</tr>
<tr>
<td>Upper GI Bleeding</td>
<td>increased</td>
<td>? (?reduced)</td>
</tr>
<tr>
<td>Mortality</td>
<td>increased</td>
<td>reduced</td>
</tr>
<tr>
<td>Time to effect</td>
<td>prompt</td>
<td>delayed</td>
</tr>
</tbody>
</table>

*From: Cleland, James, Proudman – Fish oil: what the prescriber needs to know*

http://arthritis-research.com/content/8/1/202
Cardiovascular disease and omega-3 fatty acids

Cardiovascular disease and omega-3s, in particular EPA and DHA rich in seafood oils, are essential fatty acids for human beings. High intakes or supplementation prevents progression of atherosclerosis, myocardial infarction and ventricular fibrillation in the context of myocardial ischaemia.

There is compelling evidence that support the benefits of fish consumption; in particular fish rich in omega-3s. Seafood is by far the richest, but not the only means of EPA/DHA in the diet.

The American Heart Association recommends that in all patients with coronary heart disease, 1g of combined EPA + DHA be consumed per day and the National Heart Foundation of Australia has now made similar recommendations (Kris-Etherton et al 2002, Colquhoun et al 2008). Modern industrial societies are characterised by an increased intake of saturated, omega-6 and trans-fatty acids and are decreased omega-3s. The ratio of omega-6:omega-3 in the Palaeolithic period was 0.79, similar to Crete prior to 1960. In contrast, in the United States and Northern Europe the ratio is now 15. There have been a number of meta-analyses of cohort studies comprising over 200,000 individuals with follow-up of 13 years or so which have shown high intakes of fish associated with low rates of heart attack and stroke.

The two most important omega-3 supplement trials to show clinical benefit are the GISSI-P and JELIS trials (GISSI-Prevenzione Investigators 1999, Marchioli et al 2002, Yokoyama et al 2007). In the GISSI-P trial 11,324 patients who had sustained a myocardial infarction were randomised to a 1g capsule of fish oil (850-882mg) of omega-3 EPA and DHA in a 2:1 ratio or no capsule and follow-up in 3.5y. There was a 20% reduction in mortality and 45% reduction in sudden death. In the first four months the reduction of sudden death in the fish oil consumption group was 53%.

In the JELIS trial 18,645 subjects were randomised to placebo or high dose EPA (1,800mg/d). Of these patients 3,664 had a history of coronary heart disease. All patients had a cholesterol level greater than 7mmol/L. All patients were randomised to Pravastatin or Simvastatin. Follow-up was 4.6y. In the patients that had a myocardial infarction prior to randomisation there was a 19% reduction in major coronary heart disease events (p=0.048). There was no reduction of sudden death and there was a 28% reduction of admissions to hospital for unstable angina (p=0.019).

Figure 15: Mechanisms by which fish and fish oil decrease cardiovascular events

- decreases triglyceride and remnant lipoprotein levels
- alters metabolism of n-6 PUFA eicosanoids to inhibit inflammatory processes
- increases HDL cholesterol levels (variable response)
- improves heart rate variability and lower heart rate
- elevates ventricular fibrillation threshold
- decreases risk of thrombosis and anti-platelet effects
- slows progression of atherosclerotic plaques
- improves endothelial function
- modestly reduces blood pressure
- lowers plasma leptin levels

From Colquhoun et al 2008
The National Heart Foundation of Australia has completed an extensive review of the literature and a summary of the key findings are:

1. Fish and fish oil consumption reduces the risk of cardiovascular disease.
2. Consumption of DHA, EPA and ALA improves cardiovascular outcomes.
3. Australian fish and other seafood are generally very low in methyl mercury, dioxins and other environmental contaminants.
4. While caution should be taken consuming fish potentially high in mercury, the benefits of consuming fish and fish oil are numerous and should be encouraged in the general population.

In addition the review concluded that marine omega-3s, enrichment of food and farmed fish are likely to play an increasing role in the Australian diet.

**Figure 16: NHFA Summary of evidence for long chain omega-3s and CVD**

**Summary of evidence**

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Level of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individuals with a higher intake of fish have a lower risk of CHD mortality, total CHD and total stroke.</td>
<td>III-2</td>
</tr>
<tr>
<td>Consuming fish at least once a week is associated with a lower risk of total stroke and CHD mortality in the general population and in post-myocardial infarction patients.</td>
<td>III-2</td>
</tr>
<tr>
<td>In secondary prevention, a diet with 2 g/day of ALA decreases the risk of CHD.</td>
<td>II</td>
</tr>
<tr>
<td>In secondary prevention, &gt; 850 mg/day marine n-3 PUFA supplementation reduces the risk of CHD mortality and ≥1,800 mg/day reduces major coronary events.</td>
<td>II</td>
</tr>
<tr>
<td>In secondary prevention, there is conflicting evidence about the effects of marine n-3 PUFA supplementation on the risk of sudden death in patients.</td>
<td>n/a</td>
</tr>
<tr>
<td>Marine n-3 PUFA supplementation of 1000-4000 mg/day decreases serum TG levels by 25-30% and increases high-density lipoprotein (HDL) cholesterol levels by 1-3%. A dose relationship exists between intake of marine n-3 PUFA and decreased serum TG levels.</td>
<td>I</td>
</tr>
<tr>
<td>Marine n-3 PUFA has an additive effect to statin therapy in decreasing serum TG levels and increasing HDL cholesterol.</td>
<td>II</td>
</tr>
<tr>
<td>Consuming fish with high levels of methylmercury may result in long-term neurological damage. Gestational exposure to methylmercury may result in neurodevelopmental deficits.</td>
<td>III-3</td>
</tr>
<tr>
<td>The consumption of oily fish twice a week promotes cardiovascular health without excessive exposure to mercury.</td>
<td>III-1</td>
</tr>
<tr>
<td>There is inconclusive evidence to support a relationship between mercury exposure and the incidence of CVD.</td>
<td>n/a</td>
</tr>
<tr>
<td>Fish oil capsules available in Australia have zero or near zero methylmercury content.</td>
<td>IV</td>
</tr>
<tr>
<td>Fish oil capsules in Australia contain very low levels of dioxins (polychlorinated biphenyl (PCB)).</td>
<td>IV</td>
</tr>
</tbody>
</table>

From NHFA 2008

NHRMC levels of evidence have been used to rate the evidence.
**Fig. 17: NHFA recommendations for consumers and health professionals**

### All adult Australians

To lower their risk of coronary heart disease (CHD), all Australians should:

1. Consume about 500 mg per day of combined DHA and EPA through a combination of the following:
   - two or three serves (150 g serve) of oily fish per week
   - fish oil capsules or liquid
   - food and drinks enriched with marine n-3 PUFA.
2. Consume at least 2 g per day of ALA.
3. Follow government advice on fish consumption regarding local safety issues.
4. Discuss healthy eating and concerns about nutrition with an Accredited Practising Dietitian or a doctor.

### Health professionals

Health professionals should advise adult Australians with documented CHD to:

1. Consume about 1000 mg per day of combined DHA and EPA through a combination of the following:
   - two or three serves (150 g serve) of oily fish per week
   - fish oil capsules or liquid
   - food and drinks enriched with marine n-3 PUFA.
2. Consume at least 2 g per day of ALA.
3. Follow government advice on fish consumption regarding local safety issues.
4. Discuss healthy eating and concerns about nutrition with an Accredited Practising Dietitian or a doctor.

Health professionals should advise adult Australians with elevated triglycerides (TG) to take fish oil capsules or liquid and marine n-3 PUFA enriched foods and drink as first-line therapy by:

- starting with a dose of 1200 mg per day of DHA and EPA; and if appropriate increasing the dose to 4000 mg per day of DHA and EPA and checking their patient’s response every 3 to 4 weeks when the dose is changed, until target TG levels are reached.

From NHFA 2008


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### References


The cardiovascular benefits of the long chain omega-3s, DHA and EPA, are well recognised. Clinical trials have confirmed that these long chain omega-3s provide important cardio-protective benefits, including lowering triglyceride levels. An elevated triglyceride level represents an independent risk factor for cardiovascular disease and is prevalent among the Australian population (Table 8).

### Current recommendations

Long chain omega-3s are effective at reducing triglyceride levels and are comparable to other treatment regimes (Table 9). The American Heart Association recommends consuming a variety of oily fish, at least twice per week, for prevention of cardiovascular disease. This type of fish is generally a good source of long chain omega-3s. For people with documented cardiovascular disease it is recommended that they consume 1-2g of DHA plus EPA per day. For individuals with hypertriglyceridemia (> 2.3mM), 2-4g of DHA plus EPA per day is recommended (Kris-Etherton et al 2002).

The NHMRC recommends intakes of DHA, DPA and EPA at 430mg per day for women and 610mg per day for men to reduce the risk of chronic disease (NHMRC 2006). The National Heart Foundation of Australia (NHFA) advises adult Australians with documented cardiovascular disease to consume about 1g per day of combined DHA and EPA through a combination of the following:

- two or three serves (150g serve) of oily fish per week
- fish oil capsules or liquid
- food and drinks enriched with marine omega-3s.

The NHFA also recommends that health professionals should advise adult Australians with elevated triglycerides to take fish oil capsules or liquid and marine omega-3 enriched foods and drink as first-line therapy by:

- starting with a dose of 1.2g per day of DHA and EPA; and if appropriate
- increasing the dose to 4g per day of DHA and EPA and checking their patient’s response every 3 to 4 weeks when the dose is changed, until target triglyceride levels are reached. (NHFA 2008)

### Table 8: Elevated triglycerides: CVD risk category

<table>
<thead>
<tr>
<th>Patient risk category</th>
<th>Serum triglyceride level mM (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>≥5.6 (≥500)</td>
</tr>
<tr>
<td>High</td>
<td>2.3-5.6 (200-499)</td>
</tr>
<tr>
<td>Borderline high</td>
<td>1.7-2.2 (150-199)</td>
</tr>
<tr>
<td>Normal</td>
<td>&lt;1.7 (&lt;150)</td>
</tr>
</tbody>
</table>

From: National Institutes of Health 2002

### Figure 18: Causes of elevated triglycerides

**Lifestyle**
- Physical inactivity
- High carbohydrate intake (>60% total energy)
- Excessive alcohol
- Overweight/Obesity
- Cigarette smoking
- Pregnancy

**Genetic Factors**
- Familial hypertriglyceridemia

**Medications**
- Steroids
- Beta-blockers
- Estrogens
- Protease inhibitors (HIV)
- Retinoids

**Associated Diseases**
- Metabolic syndrome
- Type-2 Diabetes
- Nephrotic syndrome
- Chronic renal disease
- Cushing’s Disease

From: National Institutes of Health 2002

### Table 9: Efficacy of various treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Reduction in Triglyceride Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statins</td>
<td>7%-30%</td>
</tr>
<tr>
<td>Fibrates</td>
<td>20%-50%</td>
</tr>
<tr>
<td>Niacin</td>
<td>20%-50%</td>
</tr>
<tr>
<td>Long chain omega-3s</td>
<td>30%-45%*</td>
</tr>
</tbody>
</table>

From: National Institutes of Health 2002; *Bay et al 2006
Overview of the science

In the 1970s (Bang et al. 1972), it was reported that Greenland Inuits, who have diets high in fish, have a lower incidence of cardiovascular disease when compared to Danes. In addition, the Inuits also had lower triglyceride levels. Subsequent studies confirmed that fish oil has significant hypotriglyceridemic effects. The active component found in fish and fish oil for the potent hypotriglyceridemic effect was the long chain omega-3s DHA and EPA. Several systematic reviews, meta-analyses and clinical overviews have been conducted to determine the effect of DHA and EPA on triglyceride reduction.

i) Fish and fish oil long chain omega-3s

The review by Harris and colleagues (1997) analysed 72 clinical trials (parallel and cross-over study designs) and determined that an average intake of 3–4g of DHA and EPA lowered triglycerides by 25-35%. In addition, the effects were greater in those individuals with higher triglyceride levels (≥2mM).

The meta-analysis by Balk and colleagues (2006) reported on 21 trials using doses of DHA and EPA ranging from 0.1 to 5.9g/d. This dose range of DHA and EPA resulted in a net decrease in triglycerides of 0.3mM. Across studies, each increase in fish oil dose of 1g/d was associated with a decrease in triglycerides of 0.1mM. The triglyceride lowering effect of long chain omega-3s was also related to the level of triglycerides at baseline prior to treatment. For each additional triglyceride level of 0.12mM at baseline, long chain omega-3 intake was associated with an additional 0.18mM decrease in triglycerides. Thus, the effect of DHA and EPA on triglyceride lowering is dependent on both the dose of long chain omega-3s and the baseline triglyceride concentration. The dose-dependent effect of DHA-enriched fish oil on triglyceride levels was recently determined (Milte et al. 2008). This study reported that for subjects with a mean baseline triglyceride level of 1.9mM, every 1g/d increase in DHA was associated with a 23% reduction in triglycerides.

ii) Prescription long chain omega-3s

The purified prescription product of omega-3 ethyl esters of DHA and EPA (Omacor or Lovaza) for the treatment of hypertriglyceridemia at a dose of 2 to 4g/d has been made available in the USA. Each capsule contains 84% long chain omega-3s (465mg EPA and 375mg DHA derived from fish oil) for a 1g capsule. This product is prescribed at 2-4g/d for patients with hypertriglyceridemia and in some locations coronary heart disease. The dosage regimen varies depending on locality and local approvals.

Bay et al. 2006 conducted a clinical overview of Lovaza and identified 12 studies that reported its safety and efficacy on biomarkers or risk factors of cardiovascular disease. This overview reported that Lovaza at doses of 4g/d significantly lowered triglycerides by as much as 45% when used as a monotherapy and 30% in combination with a statin. Furthermore, this product was well tolerated with few side effects other than mild gastrointestinal symptoms.

Statin therapy alone is effective at lowering LDL cholesterol but may be insufficient to achieve the optimal triglyceride target in patients with hypertriglyceridemia.

Figure 19: Effects of algal-DHA

A) Regression analysis of percent change from baseline in triglyceride (TG) levels versus dose of algal-DHA
B) Regression analysis of absolute change from baseline in triglyceride levels versus baseline triglyceride levels.

Modified from: Ryan et al 2008
Thus, in patients with persistent hypertriglyceridemia, one approach is to combine long chain omega-3s with a statin. The COMBOS (COMbination of prescription Omega-3 with Simvastatin) trial (Davidson et al. 2007) reported on the triglyceride lowering effect of Lovaza in patients on stable statin therapy. This study showed that statin treated patients with persistent hypertriglyceridemia had a greater reduction in triglycerides when given Lovaza (30%) when compared to placebo (6%).

**iii) Algal-derived long chain omega-3s**

Another source of long chain omega-3s is algal-derived DHA (Martek Biosciences Corporation, Maryland, USA). Clinical trials with this source of DHA (essentially devoid in EPA) indicate comparable triglyceride lowering effects. A recent clinical overview of the effect of algal-derived DHA on triglyceride levels was conducted (Ryan et al. 2008). Sixteen studies were identified: 12 studies supplemented subjects with algal oils from Cryptothecodinium cohnii and 4 from Schizochytrium sp. (both oils contain 35-40 % DHA, <3 % EPA). Twelve studies investigated normal subjects. The remaining four studies investigated hypertriglyceridemic subjects (triglycerides >1.6 mM) of which two were conducted with concomitant statin therapy. DHA supplementation significantly reduced fasting triglycerides in a dose-dependent fashion, regardless of type of algal oil (Figure 1A). Supplementation of 1-2 g/d of DHA, with or without concomitant statin therapy, effectively lowered triglycerides by 15-20%. The absolute decrease in triglycerides in the hypertriglyceridemic subjects was markedly greater than that observed in normals (Figure 1B). Algal-derived DHA was well tolerated with few side effects other than mild gastrointestinal symptoms.

What we know

1. DHA alone (from algae) or DHA+EPA from fish or fish oil are effective at reducing triglycerides.
2. DHA or DHA+EPA reduce fasting triglycerides in a dose-dependent fashion.
3. The triglyceride lowering effect of DHA and EPA is markedly greater in those individuals with hypertriglyceridemia.
4. DHA or DHA+EPA can be used as monotherapy or in combination with statins.
5. Sources of DHA or DHA+EPA at doses up to 4g/d are well tolerated with few side effects other than mild gastrointestinal symptoms.

What we don’t know

The hypotriglyceridemic effects of DHA and EPA are well explored. Research has been undertaken in each of the areas highlighted below, however additional research is required to further substantiate the role of long chain omega-3s in lowering triglycerides.

1. What is the minimum dose of DHA and EPA needed for effectiveness (for both triglyceride lowering and cardioprotection)?
2. What is the dose of DHA and EPA needed for prevention of hypertriglyceridemia?
3. Are the hypotriglyceridemic effects of long chain PUFAs attributed to DHA alone or does EPA play a role?
4. What is the precise mechanism of action?
   - Inhibition of triglyceride synthesis?
   - Stimulation of fatty acid oxidation?

Evidence

Taken together, these findings suggest that DHA alone (from algae) or DHA+EPA (from fish) are effective at reducing triglyceride levels. The evidence supporting the use of these long chain omega-3s in the lowering of triglycerides during hypertriglyceridemia is strong.

References


Much of the evidence of nutrition related health benefits comes from research examining the functions of nutrients or food components. Translating this evidence to practice means identifying suitable delivery agents (in the main foods and supplements), and then positioning intakes in the context of a whole diet. Where the nutritional target is prevention of lifestyle related disease, this whole diet is then positioned in a broader context which includes provision for physical activity and mental wellbeing. Today, nutrition science itself is being positioned to not just consider the biological aspects of nutrition but also the social and environmental conditions in which nutritional health may be attained (Wahlquist et al 2005).

For the Baby Boomer generation, the prevention of lifestyle related disease (obesity, diabetes and heart disease) as well as maintenance of functionality are key targets with nutritional implications. There is evidence that omega-3s have an impact on each of these targets, so ensuring functional intakes of this nutrient will be significant. Bearing in mind the issues raised above, however, this will need to be achieved within a total diet addressing all metabolic parameters, and in particular energy balance, and with foods and/or supplements that fit easily in the social and environmental context.

Omega-3s in a diet addressing lifestyle related disease

Managing weight is one of the most important health factors for Baby Boomers as a group today. The main associated dietary factor is energy intake, but other dietary components also need attention. In the recent review of nutrient reference values, the NHMRC noted the growing body of evidence that major imbalance in the relative proportions of macronutrients increase chronic disease risk (NHMRC 2005). The type of fat is also well recognized as significant, particularly in view of the impact on nutrient-gene interactions (Storlien et al 2005). Animal model studies have demonstrated the impact on feeding behaviour, weight gain and satiety control mechanisms through lowering dietary saturated fats and increasing omega-3s (Huang et al 2004). Recent reviews are also suggesting that disequilibrium of polyunsaturated fatty acid metabolism may contribute to excessive adipose tissue development (Ailhaud et al 2008).

Experimental research in humans indicates that omega-3s may stimulate fat oxidation and reduce body fat mass (Couet et al 1997), a significant factor in the metabolism of obesity and its related disorders. Translating this knowledge to practice means there is good reason to include omega-3s in a diet that meets an acceptable macronutrient distribution range and supports the energy requirements of the individual. The NHMRC proposes the ideal range (expressed as % energy) as 15-25% protein, 20-35% fat, 45-65% carbohydrate, with 610mg long chain omega-3s for men and 430mg long chain omega-3s for women respectively. The next step in translation is to convert this to a combination of foods that deliver the desired proportion of macronutrients, including the desired levels of long chain omega-3s.

There are few foods in the Australian diet, however, that deliver significant amounts of long chain omega-3s, and the emphasis is on oily fish. Our own research found that there are challenges in assuring an intake of fish twice a week within groups of people with broad ranges of food preferences (Gillen et al 2005). When omega-3 enriched foods are built into the plan, it is important to consider the cuisine context and whether these foods would be considered staple (replacing non-fortified foods) or peripheral (eaten as extras and adding unwanted calories) (Patch et al 2005). The amount of omega-3s consumed will depend on the concentration in foods and the amounts of these foods consumed in the total diet. Supplementation may be considered in this context.

Figure 20: Fish versus supplements trial currently underway at University of Wollongong

12 month trial
- Low fat diet (P:F:CHO = 20:30:50)
- Low fat high fish
- Low fat high fish + omega 3 supplements

Primary outcomes
- Body weight
- Fat oxidation

Secondary outcomes
- Other biomarkers (insulin, glucose, lipids)

From: Tapsell 2008
Social and environmental considerations as raised above will see the cost and availability of enriched foods as an important factor, and this will be balanced against the environmental considerations for fish production. In the first instance, developing a food guide for adequate omega-3 intakes will need to be clear on desired levels of nutrient consumption, the amount and range of foods and/or supplements to deliver this level within energy requirements, and the consequences of this framework on social and environmental concerns.

**Gaps, limitations and future directions**

With expanding knowledge in nutrition, one of the emerging challenges is a better working framework for food and nutrition. There is increasing awareness of the limitations of taking a purely nutrient focused approach to the nutrition-health interface (Jacobs et al 2007). The concept of food synergy accepts that the nutrient composition of primary foods (plants or animals) is purposeful and reflects the systems biology of the organism. Thus there are inherent relationships between nutrients in foods, and it may be that fish, for example, provides greater benefits than purified omega-3 supplements. On the other hand, there may be components in fish that are harmful if consumed in large quantities. Either way, there needs to be a balance in research that focuses on nutrients, whole foods and whole diets in their own rights.

A corollary to this is that the methodologies for studying the effects at various levels may be different and require a range of research capabilities. It will be important to consider the value chain of research that delivers on the best available understanding of the area under focus. This includes an appreciation of the possibility of harm as well as benefit, and where the limits to these extremes might lie.

Finally, the consideration of other nutritional requirements needs to be addressed concurrently. The discussion above is limited to energy and macronutrients, with some emphasis on fat. The protection of health will not be achieved with a focus on a single nutrient, or foods that deliver this nutrient. The combination of foods and nutrients in a healthy lifestyle is the paradigm by which the effects of nutrition are best seen. There is a great deal of methodological development required here which maps out how best to observe health protective effects as opposed to disease treatment.

**References**


Tapsell L. Fish versus supplements trial, University of Wollongong, unpublished

conclusions

A number of recommendations were agreed relating to intakes of long chain omega-3s. Communications, and the role of government, research and publications. These are set out on page 2 – 4.

The panel considered the areas discussed in the Workshop and ranked them according to the level of evidence available at the current time.

There is no evidence that long chain omega-3s cause harm in Baby Boomers. On the positive side, the evidence is rated from interesting (+1) to conclusive (+4) for effects on mental health, obesity, metabolic syndrome, vision, long term analgesia, arthritis and cardiovascular disease – see Table 10 below.

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Participant details

Dr David Roberts  
BSc (Hons) Biochemistry (Liverpool University, Uk), PhD (ANU)  

Regulatory Affairs Adviser,  
The Omega-3 Centre

Dr David Roberts was Deputy CEO and scientific and technical Director of the Australian Food and Grocery Council for 5 years until October 2007. Prior to that, he held the Foundation Chair in Nutrition and Dietetics at the University of Newcastle (established 1991) for 10 years. He was at Sydney University for 12 years teaching and researching in nutritional biochemistry. He was Chairman of the Federation of Australasian Nutrition Organisations, President of the Nutrition Society of Australia for 3 years, chaired the inaugural Complementary Medicines Evaluation Committee of the Therapeutic Goods Administration in Canberra for 4 years and is the Australasian correspondent for the British Nutrition Foundation. He is currently scientific adviser to GoGrains Limited, regulatory policy adviser to the Omega3 Centre and Chairman of the NSW Branch of AIFST.

Dr Wendy Hunter  
PhD (Public Health Nutrition); BAppSc Hons (Food Science and Nutrition); BAppSc (Home Economics).  

School of Exercise and Nutrition Sciences,  
Deakin University, Victoria, Australia

Dr Wendy Hunter completed a PhD at Deakin University, Melbourne, Australia in 2002, exploring the relationship between constipation, laxative use and diet amongst Older Australians. On completion, she moved to the UK to take on the role of postdoctoral research fellow on the Food in Later Life – EU Senior Food QoL study, a 3 year project that involved investigating and comparing factors influencing food choices, quality of life and maintaining independence amongst people aged 65 years and over in 8 countries in Europe. Currently she is a Postdoctoral Research Fellow in the School of Exercise and Nutrition Sciences at Deakin University, Melbourne. Her current research work includes Project Management of the Baby boomer Project. The aims of this project are to identify food consumption patterns and health behaviours of baby boomers, the factors that influence these behaviours and the expectations of the baby boomers.
boom by boom, as the sort of food products, food services and preventative strategies will they be looking for in the coming decade. Wendy is also working on a number of other studies including exploring the social determinants of food access and food choice for women and determining recipient satisfaction with formal meals services and has lectured in Health Promotion, Family Studies, Population Nutrition and Social Nutrition.

Ms Wendy Morgan
BSc, GradD NutDiet, GradD ComM, R Nutr

Nutrition Adviser, The Omega-3 Centre; Director, innovations & solutions, Australia

Wendy Morgan is Director of innovations & solutions, a company which provides advice to research organisations, government departments and food companies. She is a Registered Nutritionist and was the inaugural Executive Director of The Omega-3 Centre. Her expertise is in assisting clients in the application of nutritional science and consumer understandings to new product development and consumer communications. Functional foods, food regulatory issues and nutrition policy are special areas of interest and raising the profile of Omega-3s is a passion.

Wendy has degrees in science, nutrition and communication management.

Professor Andrew J Sinclair
B Agric Sci, PhD

Scientific Adviser, The Omega-3 Centre; School of Exercise and Nutrition Sciences, Deakin University, Victoria, Australia

Andrew Sinclair is currently Professor of Human Nutrition and Director of the Metabolic Research Unit at Deakin University. He previously held the position of Professor of Food Science at RMIT University. He is a Fellow of the Australian Institute of Food Science & Technology and the Nutrition Society of Australia where he currently holds the position of President. He is also the President of ILSI Australasia and a Senior Associate Editor the journal Lipids and on the Editorial Board of Prostaglandins, Leukotrienes & Essential Fatty Acids. His current research interests include food science (composition of food), nutrition (fatty acid metabolism in man and animals), functional foods (omega-3s, lycopene, olive oil, polyphenols, stearic acid), effect of omega-3s, meat-containing and vegetarian diets on cardiovascular health in humans, neuroscience (the role of omega-3s in brain and retina on neural function including blood pressure regulation, zinc transporters and Alzheimer’s disease in mammals). Professor Sinclair has more than
200 publications in peer-reviewed journals. He has consultancies with many of the major food companies on project by project bases over the past 15 years, providing expert advice to companies on issues relating to patent defence, functional foods, and nutrition. He has had significant interaction with agricultural organisations such as Dairy Australia, and Meat & Livestock Australia.

Dr Victoria Flood
BAppSc, Grad DipNutr&Diet, MPH, PhD, APD
University of Sydney Department of Ophthalmology (Centre for Vision Research, Westmead Millennium Institute, Westmead Hospital), NSW, Australia.

NSW Centre for Public Health Nutrition, Institute of Obesity, Nutrition and Exercise, University of Sydney, NSW, Australia

Dr Victoria Flood is a nutritional epidemiologist who has conducted research and work in public health nutrition and dietetics over the last twenty years. Vicki currently holds two part-time positions as a Nutritional Epidemiologist with the University of Sydney: the Centre for Vision Research and NSW Centre for Public Health Nutrition. Vicki has published and conducted research in a number of topics, including: nutrition and eye disease, overweight and obesity, fruit and vegetable intake, indigenous health research, food and nutrition monitoring, and nutrients of particular interest include folate, vitamin B12, carotenoids and fatty acids.

Professor Peter Howe
BSc (Sydney), MSc (Oxon), PhD (Monash)
Nutritional Physiology Research Centre, University of South Australia, Adelaide, Australia

Peter Howe is a research professor in Health Sciences and Director of the Nutritional Physiology Research Centre at the University of South Australia. Peter is a leading authority on cardiovascular and metabolic health benefits of bioactive nutrients, in particular omega-3 fatty acids. Formerly a Senior Principal Research Scientist in CSIRO’s Division of Human Nutrition, he established the ARC Key Centre for Smart Foods at Wollongong University and, more recently, the ATN Centre for Metabolic Fitness, a national collaboration aimed at optimising physical and mental health through diet and lifestyle. He has built strategic alliances with the food industry to develop healthier foods and contributed to regulatory developments for functional foods.
Professor Les Cleland
MD, FRACP
Royal Adelaide Hospital, Adelaide, South Australia

Les Cleland has been the Clinical Professor at Adelaide University since 2000

Research Interests include:

- Health related effects of dietary n-3 fatty acids, particularly in relation to inflammatory and cardiovascular diseases.
- Pathways of eicosanoid synthesis including substrate alternatives, enzymology and pharmacological inhibitors, especially cyclo-oxygenase-2 inhibiting non steroidal anti-inflammatory drugs.
- Systems for improved outcomes in bone and joint diseases, including early intervention and preventive approaches.
- Immunobiology of polyarthritis, with particular reference to T cell-dendritic cell interactions.

A/Professor David Colquhoun
MBBS FRACP
Wesley Medical Centre, Auchenflower, Queensland

Associate Professor David Colquhoun is a Cardiologist in Private Practice in Brisbane at the Wesley Hospital. He is extensively involved in research and has a private research group – Core Research. His group is involved in multi-centre international trials and investigator initiated trials in the area of lipids, nutrition, nutraceuticals and psychological aspects of heart disease. Currently his research group is involved in 20 ongoing trials.

He was a member of the National Heart Foundation’s (NHF) Nutrition and Metabolism Committee and NHF’s Psycho-Social Working Group. He was a member of the National Heart Foundation, Scientific Committee for their first Scientific Meeting that was held on 23-25 March 2006, Sydney. He is the Chairman of the organising Committee of the NHFA 2nd Scientific Committee, Brisbane 2009 – the 50th Anniversary of NHFA. He is the chief author of the NHFA Position Statement Fish, fish oils and omega-3 polyunsaturated fatty acids (published online @ NHFA website August 2008).

He was invited to the Federal Government’s 2020 Summit (April 2008) to participate in the long-term national health strategy stream. He is a member of the Queensland Government Task Force for Chronic Disease Prevention 2008.

Dr Michelle Keske
BSc, PhD
Menzies Research Institute, University of Tasmania, Hobart, Tasmania

Michelle Keske is a Senior Research Fellow at the Menzies Research Institute. Dr Keske’s research focuses on the effects of pharmacological and nutritional (dietary lipids) interventions on capillary blood flow in muscle and their impact on insulin resistance. She previously held a position as Senior Clinical Research Scientist at Martek Biosciences Corporation, Maryland, USA. This company is an innovator in the development of long chain polyunsaturated omega-3 and omega-6 fatty acid products derived from single cell sources (e.g. microalgae). While working at this company Dr Keske studied the effect of DHA supplementation on triglyceride levels. Dr Keske continues to consult for Martek Biosciences Corporation.

Professor Linda Tapsell
PhD FDAA
Smart Foods Centre School of Health Sciences, University of Wollongong, Northfields Ave, Wollongong, NSW 2522, Australia

Professor Tapsell is a leading research dietitian with a focus on diet and metabolic syndrome. With an early career in the health system, her research track record lies in the conduct of clinical trials to test the effects of dietary patterns on health outcomes. With research funded by NHMRC, ARC and industry she has been able to expose the effects of diet through careful dietary modelling and an understanding of consumer food choice. Her understanding of dietary strategies (dietetics) to achieve targeted interventions enables her to test theoretical positions from mechanistic research, or to substantiate the effects of single foods from a considered position in an overall diet plan. Her work in the public health area brings understanding of diet to community interventions and Primary Healthcare services as well as general nutrition communications. She publishes extensively on the evidence base for diet, mostly related to metabolic syndrome (clinical trials, reviews, observational studies, methodological analyses) and to a lesser extent on dietary behaviour and professional skills and practice in Dietetics She is asked to present at a large number of national and international conferences in the food and nutrition area and works with a number of national and international nutrition organisations, contributing to peer review, strategic direction and policy formulation She is a fellow of the Dietitians Association of Australia and Editor of the journal, Nutrition and Dietetics.
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- De-mystifying omega-3s by translating the scientific evidence for these important nutrients
- Identifying barriers to optimal intakes of omega-3s and helping to address solutions
- Working with regulators and scientists to encourage a conducive environment for communications on omega-3s
- Differentiating between different types of omega-3s with a focus on the long chain omega-3s (EPA and DHA) which are of most potential benefit
- Facilitating and promoting research and development in this area
- Ensuring that sound science underpins all communications from the Centre

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- Nu-Mega Ingredients | Ocean Nutrition Canada | DSM Nutritional Products Australia
- BASF Human Nutrition | Nutricia Australia | Simplot Australia Pty Ltd
- New Zealand King Salmon | Fisheries Research and Development Corporation (FRDC)
- George Weston Foods | CSIRO Food Futures National Research Flagship
- Meat and Livestock Australia (MLA)

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For more information about long chain omega-3s or to become a member of the centre please visit our website www.omega-3centre.com

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